PROCEEDING

ISOPHA

INTERNATIONAL SEMINAR AND WORKSHOP OF PUBLIC HEALTH ACTION

"Ensure Healthy Life Supported by Sustainability Energy, Environment and Health Literacy in The Era of Society 5.0"

Building E 3th Floor, Universitas Dian Nuswantoro Semarang, 25-26 Sept 2023

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PROCEEDING OF INTERNATIONAL SEMINAR AND WORKSHOP ON PUBLIC HEALTH ACTION (ISWOPHA)

"Ensure Healthy Life Supported by Sustainability Energy, Environment and Health Literacy in The Era of Society 5.0"

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PREFACE

Assalamualaikum Warohmatullahi. Wabarokatuh.

We express our gratitude to the Almighty for His abundant blessings that have made the smooth realization of this proceeding possible. This document summarizes various scientific articles from higher education institutions in Indonesia that were discussed and presented at the International Seminar and Workshop on Public Health Action 2023, organized by the Faculty of Health at Dian Nuswantoro University, Semarang on September 25-26, 2023. The event had a theme "Ensure Healthy Life Supported by Sustainability Energy, Environment, and Health Literacy in The Era of Society 5.0".

This proceeding is compiled to document concepts and findings related to the theme of realizing a healthy life supported by sustainable energy, the environment, and health literacy in the era of Society 5.0. We hope this proceeding can provide a profound perspective on issues encompassed within the theme. It is expected to foster active collaboration in education and health to develop an outstanding Indonesian society by continuously exploring innovations in healthcare, aligning with the theme "Ensure Healthy Life Supported by Sustainability Energy, Environment, and Health Literacy in The Era of Society 5.0".

In completing this proceeding, we acknowledge that our efforts would not have succeeded without the abundant support of various parties. Therefore, we would like to express sincere gratitude and extend high appreciation to:

1. The Rector of Universitas Dian Nuswantoro, Prof. Dr. Ir. Edi Noersasongko, M.Kom., who has provided support and facilitated this event.
2. The Dean of the Faculty of Health Science, Universitas Dian Nuswantoro, Enny Rachmani, SKM, M.Kom, Ph.D., for all the support and motivation provided during this even.
3. The Keynote Speakers, namely Prof. Shabbir H. Gheewala (King Mongkut's University of Technology Thonburi, Thailand), Prof. Angela M. Leung (President of Asia Health Literacy Association, Hong Kong Polytechnic University), Prof. Amanda Reichelt-Brushett (Southern Cross University, Australia), Dr. Kristine Sorensen (President of International Health Literacy Association, Founder of Global Health Literacy Academy, Denmark), Sugianto Tandio, M.Sc (Chief Innovation Officer and Co-founder Greenhope, Indonesia), dr. Lily Kresnowati, M.Kes (Director of Health Service, BPJS Indonesia), and Dr. dr. Anung Sugihantono, M.Kes (Chairman of PPPKMI Central Java, Indonesia)
4. To all the committee members, whether they are faculty members, staff, or students, who have dedicated their time, energy, and thoughts to the success of this event.
5. To all the lecturers and officials from contributing institutions who have submitted research articles and scholarly thoughts for this international seminar.

We acknowledge that this proceeding is not without shortcomings. Therefore, we welcome suggestions and criticisms for improving the proceeding in future editions. Finally, we hope that this proceeding will benefit all parties involved.

Wassalamualaikum Warohmatullahi. Wabarokatuh.

Semarang, 22 December 2023
Chair of the Committee

Dr. Nurjanah, SKM, M.Kes

Welcome Remarks from the Rector

Assalamu'alaikum warahmatullaahi wabarakaatuh

In the name of Allah, the Most Beneficent and the Most Merciful. May peace, mercy, and blessings of Allah be upon you.

Dear distinguished professors, speakers, delegates, and participants. I am pleased to be speaking to all of you today. I would like to express my sincere gratitude and welcome you to Universitas Dian Nuswantoro, Semarang, Indonesia.

The 4th ISWOPHA 2023 is held by the Faculty of Health Science Universitas Dian Nuswantoro, with the theme "Healthy Life Supported by Sustainability, energy, environment, and Health Literacy in the Era of Society 5.0".

Health is a significant source of human life. A healthy life should be supported by a healthy environment and technology that makes it easy for people to make healthy choices. Nowadays, our cities have many problems with environmental issues like air pollutants, clean water, and our people experience diseases that can be prevented by healthy behavior. As the researchers and academians, we should be responsible for supporting the efforts in achieving the solutions. I aspire that the 4th ISWOPHA 2023 will achieve its objective in providing an effective forum for academicians, researchers, or practitioners to advance knowledge, research, and technology for supporting healthy life.

I convey my deepest gratitude to the Advisory Board, Organizing Committee, International Scientific Committee, institutions, and sponsors, who have contributed to the success of this seminar.

We particularly thank the Directorate of Research, Technology and Community Service (DRTPM), Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology, Indonesia, since this conference is among the conference that gained the support from International Conference Support Funding.

To all the amazing attendees of the 4th ISWOPHA 2023, thank you for being part of this conference. The committee has organized and worked hard to present a vibrant scientific program, with highly respected and internationally notorious speakers to lead it.

We are grateful for your presence and hope this conference will be successful, with exciting, encouraging discussions, knowledge exchange. I believe we can look forward to a future of groundbreaking knowledge, research, and technology for a healthy life.

May God bless us all with good health and happiness.

Wassalamu'alaikum warahmatullaahi wabarakaatuh

Prof. Dr. Ir. Edi Noersasongko, M.Kom

Rector of Universitas Dian Nuswantoro

Welcome Remarks from Dean

Assalamu'alaikum warahmatullaahi wabarakaatuh

The honorable Rector, Vice Rectors, Dean, and all Faculties of Universitas Dian Nuswantoro

The Honorable Distinguished Speakers,

Honorable Delegates, and Participants.

First, let us praise to Allah SWT that today, all of us could join this conference with excellent health.

It is my great pleasure to welcome you to the 4th International Seminar and Workshop on Public Health Action (ISWOPHA) 2023 here in Semarang, Indonesia, with the topic 'Ensure Healthy Life Supported by Sustainability Energy, Environment and Health Literacy in The Era of Society 5.0"

The 4th ISWOPHA 2023 is organized by the Faculty of Health Universitas Dian Nuswantoro collaborates with Asian Health Literacy Association (AHLA), and Professional Organizations: Indonesian Society for Health Promotion and Education (PPPKMI), the Environmental Health Specialists Association (EHSA), Indonesia Public Health Association (IAKMI), and supported by the Directorate of Research, Technology and Community Service (DRTPM), Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology, Indonesia.

It is a glorious moment to extend my warm wishes on behalf of the Faculty of Health Science Universitas Dian Nuswantoro.

I want to convey my gratitude to all speakers, delegates, and participants who are willing to join and share the excellent experiences and hard work in this conference so we can learn from each other for better public health.

Ensure a healthy life and improving human welfare globally is the main goal of sustainable development (SDG) 2030. All SDG targets and goals are divided into four pillars and seven twelve main points, where the four pillars are the Pillars of Social Development, Pillars Economic Development, Environmental Development Pillars, and Development Pillars Law and Governance. The four pillars in the SDGs are the scope of all aspects needed to improve health status and human welfare throughout the world. To provide space and facilities that support the implementation of the four pillars of the SDGs, it is necessary to hold scientific meetings to discuss current issues, the latest research, and supporting innovations the realization of a healthy human life. Digital transformation slowly changes human behavior; the growth of digital penetration has already reached Digital Industry 4.0 and still moving forward to Society 5.0.

4th ISWOPHA 2023 invites keynote speakers from Australia, Thailand, Denmark, and Hong Kong as well as national speakers from BPJS, Professional Organizations, and from Universitas Dian Nuswantoro. Apart from that, other speakers from the Health Office will also be invited, Environmental Office and other universities will be invited speakers based on topics in parallel sessions.

My heartiest congratulations to all the delegates and the organizing committee; this conference proved beneficial to this extent with all your support.

Please enjoy this ISWOPHA, and we all can get important take-home messages for our personal development and experience happy moments during the conference.

Thank you one and all.

Wassalamualaikum Wr.Wb

Best Regards

Enny Rachmani, BPH, M.Cs, Ph.D

Dean of Faculty of Health Science, Universitas Dian Nuwantoro

Welcome Remarks from The Committee

Assalamu'alaikum wrahmatullaahi wabaarakaatuh

Praise the almighty God for giving us health and an excellent opportunity to conduct and participate in the 4th ISWOPHA.

Dear distinguished honorable speakers, presenters, participants, and guests.

On behalf of the committee, I would like to extend our warmest welcome to the 4th International Seminar and Workshop on Public Health Action (ISWOPHA) 2023. The main theme of the 4th ISWOPHA 2023 is "Ensure Healthy Life Supported by Sustainability Energy, Environment and Health Literacy in The Era of Society 5.0."

The 4th ISWOPHA 2023 is a hybrid conference that organized by the Faculty of Health Universitas Dian Nuswantoro collaborated with Asian Health Literacy Association (AHLA) and Professional Organizations: Indonesian Society for Health Promotion and Education (PPPKMI), the Environmental Health Specialists Association (EHSA), Indonesia Public Health Association (IAKMI), and supported by the Directorate of Research, Technology and Community Service (DRTPM), Directorate General of Higher Education, Research and Technology, Ministry of Education, Culture, Research and Technology, Indonesia.

We are very grateful to our outstanding keynote speakers, Prof. Shabbir H. Gheewala (the King Mongkut's University of Technology Thonburi, Thailand), Prof. Amanda Reichelt-Brushett (Southern Cross University, Australia), Prof. Angela M. Leung (President of Asia Health Literacy Association, Hong Kong Polytechnic University, Hongkong), Kristine Sørensen, Ph.D. (President of International Health Literacy Association, Founder of Global Health Literacy Academy), Dr. dr. Anung Sugihantono, M.Kes (Chairman of Indonesian Society for Health Promotion and Education Central Java Province), and Sugianto Tandio, M.Sc (Chief Innovation Officer and Co-founder of Greenhope, Indonesia). We also highly appreciate the attendance of our distinguished invited speakers: Prof. Anamarija Jurcev Savicevic, MD, PhD and Dr. Marijana Geets-Kesić, MD, EMDM (Split University, Croatia), Dr. Maharani Abubakar (Universiti Malaysia Terengganu), Dr. Irma Damayanti, S.Hut., MM. (Environment & Forestry Office of Central Java Province), Dr. Patience Alice Venus-Muchada (Ujuizi Laboratories, Netherlands) and Dr. Khamsiah Ahmad (Southern Cross University, Australia).

We would like to sincerely thank for the support from Universitas Dian Nuswantoro, Directorate General of Higher Education, Research and Technology, Ministry of Education,

Culture, Research and Technology Indonesia, our sponsors Greenhope Indonesia, Happylab, and all organizations and individuals who have furnished their support in every possible way to make this seminar being successful.

With a record number of participants this year, we are delighted to see that these annual seminars and workshops are becoming more significant yearly. We are committed to preparing the program to foster vibrant exchanges and dynamic collaborations among the academia and research communities in dealing with a healthy life to support sustainable development goals in The Era of Society 5.0.

Lastly, we would also like to thank all the paper authors and registered participants for their stimulating academic contributions to the vibrant intellectual exchange in the 4th ISWOPHA 2023. Thank you!

Sincerely yours,

Dr. Nurjanah, S.K.M., M.Kes
The Chairman of The 4th ISWOPHA 2023

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The Relationship Between Long Suffering from DM and Cigarette Exposure in DM-TB Lung Patients at RSI Siti Aisyah Madiun

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Abstract

The prevalence of the incidence pulmonary tuberculosis with comorbid diabetes mellitus (DM-TB) increases every year, it was found that the highest incidence in 2021-2022 originating from RSI Siti Aisyah. The purpose of this study was to analyze the long suffered DM and cigarette exposure in DM-TB patients. This research method uses analytical observational research with a case control approach and using questionnaire for the research instrument. The number of respondents was 32 patients (cases) and 32 patients (control). There is relationship between Long Suffered from DM ≥5 years (adj. RR = 0.235, 95% CI: 0.082-0.672, P value 0.0 1 2) and Cigarette Exposure (adj. RR = 4.333, 95% CI: 1.405-13.363, P value 0.018). The conclusion of this study is that DM patients who suffer from DM ≥5 years and are exposed to cigarettes have the opportunity to experience comorbid DM-TB events so it is recommended to routinely do physical activity, and routine blood sugar control.

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Keywords:
Hyperglycemia1; Cigarettes2; Pulmonary Tuberculosis3

Introduction

Non-communicable diseases (NCDs) are commonly known as chronic diseases, long duration of time and are the result of collaboration of physiological, genetic, environmental, and behavioral factors. It is known that NCDs cause the deaths of as many as 41 million people every year (74%) of the total deaths globally. One of the main types of NCDs is Diabetes Mellitus (WHO, 2022). Diabetes mellitus or commonly abbreviated as DM and known as diabetes is a chronic metabolic disorder caused by the hormone insulin in the body which cannot be used effectively in regulating blood sugar balance so as to increase the concentration of sugar levels in the blood (hyperglycemia) (Ministry of Health of the Republic of Indonesia, 2020).

DM patients can be at triple risk of exposure to active TB (Muhadi et al., 2015). According to Setiyowati (2020) in the book Know Tuberculosis defines that Tuberculosis is an infectious disease caused by Mycobacterium tuberculosis bacteria. This disease usually attacks the lung organs and infection occurs for 2-10 weeks. TB cases in Indonesia are estimated at 824,000 cases and East Java province itself has 42,913 TB cases (databoks.ID, 2022). Based on data from the East Java Health Office, in Madiun City the incidence of TB cases reached 10% (East Java Provincial Health Office, 2021)

DM patients automatically experience beta cell failure earlier and more severely than previously predicted due to hyperglycemia which causes insulin resistance so that macrophages and T lymphocytes decrease in small numbers which can interfere with the immune system of DM patients. The increased risk of active TB in patients with DM may be due to immune system disorders, increased adhesion of *Mycobacterium tuberculosis* germs to cells of DM patients, microangiopathy, macroangiopathy and neuropathy (Arliny, 2015),

According to data from the Madiun City Health Office in 2020 , the number of TB cases reached 526 people, in 2021 it reached 447 people. Meanwhile, according to health facilities in Madiun City , namely RSI Siti Aisyah Madiun, it is known that in 2020 the trend of TB cases reached 31 people and in 2021 it reached number 112 people (Madiun City Population Control and Family Planning Health Office, 2021) (Madiun City Population Control and Family Planning Health Office, 2021).

Methods

In this study,it used analytical observation with a case-control study approach. This research was conducted at RSI Siti Aisyah Madiun in May-June 2023. The total sample subjects were 64 respondents at RSI Siti Aisyah Madiun, the division into case groups was 32 respondents and the control group was 32 respondents. Respondents in the case group were given criteria, namely diabetes mellitus patients with comorbid TB, had Form TB 01, and were registered as outpatients at the study location. While the control group used the criteria of non-comorbid tuberculosis diabetes mellitus patients and were willing to be respondents to this study.

This study has inclusion and exclusion criteria in both case and control groups. The case group has inclusion criteria, namely DM patients diagnosed by doctors with pulmonary TB and proven by the TB 01 form and recorded in SITB (Tuberculosis Information System), have complete medical record data and patients are willing to be respondents. Meanwhile, the criteria for exclusion of case groups include pulmonary DM-TB patients diagnosed by doctors with severe complications (stroke, end-stage renal failure), HIV-TB patients and patients who have died. The control group in this study had inclusion criteria, including non-pulmonary TB DM patients recorded in medical records, having complete medical record data. Meanwhile, exclusion criteria include patients who are not willing to become repondents and die.

Questionnaires, observation sheets, and patient medical records. statistical analysis using the Chi-square test and *p* value is considered related if <0.05 independent variables of the study are long suffering from DM and exposure to cigarettes. The study-bound variable was the incidence of pulmonary tuberculosis.

Results

This research has been conducted on patients with comorbid diabetes pulmonary tuberculosis andpatients with non-comorbid diabetes pulmonary tuberculosis in the outpatient service department and has met the inclusion and exclusion criteria. Sample selection using *purposive sampling* technique. This research was conducted on 64 research subjects.

Table 1.
Characteristics of the subject of study by demographics

Variable	Case		Control		Total	
	f	%	f	%	f	%
Age						
- Productive Life	19	59,4	28	87,5	47	73,4
- Non-Productive Age	13	40,6	4	12,5	17	26,6
Sex						
- Male	18	56,2	12	37,5	30	46,9
- Female	14	43,8	20	62,5	34	53,1

Table 1. showed that DM-TB patients classified as productive age were more in the control group 87.5%. while non-TB DM patients classified as non-productive age were more in the case group 40.6%. Among the age categories in the study subjects who had the most productive age 73.4%. Judging by

gender. The majority of respondents in the case group were male 56.2%. While the control group was the majority of respondents female sex 62.5%.

Table 2.
Bivariate Analysis between Variables using Chi Square Test

Variable	Category	Incidence of Pulmonary Tuberculosis				P value
		Cases		Control		
		f	%	f	%	
Long Suffering from DM	- ≥ 5 years	12	37.5	23	71,9	0.012
	- < 5 years	20	62.5	9	28.1	
	RP (95% CI) : 0.235 ((0.082-0.672)					
Cigarette Exposure	- Exposed	26	81.2	16	50	0.018
	- Not exposed	6	18.8	16	50	
	RP (95% CI) : 0.231 (0.075-0.712)					

Based on the table above, it is known that the majority of respondents who suffered from DM ≥5 years occurred in the control group by 71.9%. Meanwhile, respondents who suffer from DM <5 years are the majority in the case group by 20%.

The results of the *chi-square* statistical test obtained *P value* = 0.012 (<0.05) which means that there is a relationship between the length of suffering from DM ≥5 years with the incidence of pulmonary TB at RSI Siti Aisyah Madiun. This variable is included in the category of risk protective factors which means DM patients suffering from DM ≥5 years tend to experience 0.235 times the incidence of pulmonary TB as well as DM patients suffering from DM <5 years.

Based on the variable of cigarette exposure, it can be seen that the majority of respondents were exposed to cigarettes in the case group by 81.2%. While the majority of respondents who were not exposed to the control group amounted to 50%.

The results of the *chi-square* statistical test obtained a *P value* = 0.018 (<0.05) which means that there is a relationship between cigarette exposure and the incidence of pulmonary TB at RSI Siti Aisyah Madiun and and this variable is included in the category of risk protective factors with a risk of 0.231 times to get pulmonary TB.

Discussion

This study aimed to analyze the relationship between the length of suffering from diabetes mellitus and cigarette exposure to the incidence of pulmonary tuberculosis .

Transmission of pulmonary tuberculosis in DM patients results from hyperglycemia which interferes with blood sugar control with the meaning that the body fails to manage sugar into energy, thus disrupting macrophages and T cell lymphocytes in the body (Bailin et al., 2020). The incidence of pulmonary tuberculosis is influenced by multifactors, including HIV, socioeconomic status, gender, age, exposure to cigarettes , history of contact with patients with pulmonary TB.

Diabetes mellitus is one of the risk factors for pulmonary tuberculosis (Utomo et al., 2016). Diabetes mellitus patients automatically have a low immune system so it is easy to contract pulmonary TB germs if treatment is not done.

The incidence of hyperglycemia in diabetes mellitus patients causes the body's resistance to more easily invite other diseases to the body of diabetes mellitus patients . Diabetes mellitus causes disruption in chemotaxis function, activation of cell presenting antigens, phagocytosy so that patients are susceptible to infection (Solá et al., 2016). Hyperglycemia in DM patients is considered an important factor in the transmission of Mycobacterium tuberculosis because it affects the body's innate immune system and adaptive immune system (Tiara &; Tri, 2021)

Long suffering from diabetes mellitus is also one of the risk factors for the incidence of pulmonary tuberculosis. Research from Vega Adlanta, et al (2019) states that hyperglycemia in DM patients exceeds normal limits for a long period of time so that it can reduce immunological responses so that bacteria TB easily infects the lungs of DM patients (Adlanta et al., 2022). Long suffering from DM in this study has a relationship with the incidence of pulmonary TB. Consistent research from Amare et al (20, 13) showed that there was an association between the duration of suffering from DM with the incidence of pulmonary

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tuberculosis (p 0.008 < 0.05) and had a risk of 8.89 times (Amare et al., 2013). The duration of DM associated with the risk of developing BTA-positive majority already suffered DM of more than 10 years compared to those with DM duration less than five years (Jabbar et al., 2006). Another study from Arulita, et al (2019) is also in line with this study, long suffering from DM has a risk relationship of 1.303 for pulmonary tuberculosis (Fibriana et al., 2020). The duration of suffering from DM causes the immunity of DM patients to be more risky due to micro and macro-vascular complications as a tolerance for disease treatment (Abera &; Ameya, 2018).

In this study, cigarette exposure has a relationship and risk of 0.231 times the incidence of pulmonary tuberculosis. Cigarette exposure in the study was also associated with active and passive smoking. Cigarette exposure can be interpreted as self-exposure through active smoking or passive exposure by others who smoke (Risna Dewi et al., 2017). Based on interviews with respondents, the majority are active smokers in the male sex and passive smokers in respondents who are female. According to research from Muh. Jusman Rau and Mifta Huldjannah (2020) showed that smoking behavior has a risk of 3.8 times to get active pulmonary TB and a p value of 0.030 which means it has a relationship with the incidence of DM-TB (Muh. Jusman Rau, 2021). In addition to the consequences of smoking behavior, long smoking can also contribute to cigarette exposure in respondents, in this study it was found that the majority of male respondents smoked ≥10 year. Prolonged exposure to cigarettes will cause alveolar macrophages of the lungs to be damaged, thus affecting the number of T lymphocytes in increasing immunity every time the body of DM patients is exposed to pathogens. Nicotine in cigarettes also causes a decrease in insulin secretion (Sasmita et al., 2019). The presence of active smokers Another study from Bebita Sharma et al (2019) shows that a history of smoking has a risk of 2.463 times to get active pulmonary TB and has a p value of 0.001 which means it has a relationship with the incidence of DM-TB (Sharma et al., 2019)

Cigarettes have components that can weaken the immune system, so smokers are susceptible to lung infections. Exposure to passive smoking increases the risk of tuberculosis infection becoming active (Lin et al., 2019). One of the cigarette ingredients is nicotine which is proven to be more sensitive in type 2 DM patients by interfering with insulin work in lowering blood glucose levels (Price et al., 2002). (Price et al., 2002). Alveolar macrophages in smokers are more difficult to respond to bacteria in the lungs. In addition, the immune system response is suppressed in people who smoke. Exposure to cigarettes causes the person to cough more often transmitting M. tuberculosis in the air from the lungs of infected smokers can increase the transmission of the spread of the disease (Ardhi, 2014). Based on a longitudinal study based on African-American and white adult populations in four U.S. cities to evaluate the association of smoking and passive exposure to tobacco smoke with the risk of glucose intolerance events (fasting glucose disorder or diabetes) and to explore potential causes of risk, including weight distribution, insulin resistance, and inflammation. Current smokers will have a higher incidence of impaired fasting glucose and diabetes during follow-up than never-smokers and that people exposed to secondhand tobacco smoke will have a moderate risk (Houston et al., 2006).

Conclussion

The conclusion of this study was found a relationship between the length of suffering from Diabetes Mellitus and exposure to cigarettes with the incidence of Pulmonary Tuberculosis. Long suffering from DM has a risk of 0.235 times, while exposure to cigarettes has a risk of 0.231.

Advice for readers, especially DM patients, to stay away from exposure to cigarettes and smoking behavior, keep using masks when in places that are usually used for smoking. As well as trying to control blood sugar levels to stay within normal limits

Patents

This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

Author Contributions

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, First Author, Second Author and Third Author.; methodology, first Author; software, Second Author.; validation, , First Author, Second Author and Third Author.; formal analysis, First Author.; investigation, Second Author.; resources, Third Author.; data curation, First Author.; writing—original draft preparation, Second Author.; writing—review and editing, First Author.; visualization, Third Author.; supervision, First Author.; project administration,

First Author.; funding acquisition, First Author, Second Author and Third Author. All authors have read and agreed to the published version of the manuscript." Authorship must be limited to those who have contributed substantially to the work reported.

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Institutional Review Board Statement

This research has been approved by the Code of Ethics of STIKes Bhakti Husada Mulia Madiun and RSI Siti Aisyah Madiun to be conducted with human respondents and has met the requirements of human protocol approval as a research subject.

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Conflicts of Interest:

The authors declare no conflict of interest."

Appendix A

None

Appendix B

None

References

Abera, A., &; Ameya, G. (2018). Pulmonary Tuberculosis and Associated Factors Among Diabetic Patients Attending Hawassa Adare Hospital, Southern Ethiopia. *The Open Microbiology Journal*, *12*(1), 333–342. https://doi.org/10.2174/1874285801812010333

Adlanta, V., Sari, R. S., &; Octavia, N. A. H. (2022). The incidence of pulmonary tuberculosis in type II diabetes mellitus patients hospitalized at Dr. Pirngadi Medan Regional General Hospital. *Ibn Sina: Journal of Medicine and Health - Faculty of Medicine, Islamic University of North Sumatra*, *21*(2), 223–232. https://doi.org/10.30743/ibnusina.v21i2.303

Amare, H., Gelaw, A., Anagaw, B., &; Gelaw, B. (2013). Smear positive pulmonary tuberculosis among diabetic patients at the Dessie referral hospital, Northeast Ethiopia. *Infectious Diseases of Poverty*, 2(1), 2–9. https://doi.org/10.1186/2049-9957-2-6

Ardhi, T. june. (2014). DESCRIPTION OF THE RESULTS OF SPUTUM EXAMINATION ON SMOKING AND NON-SMOKING PULMONARY TB PATIENTS IN THE WORKING AREA OF THE VILLAGE HEALTH CENTER IN EAST PONTIANAK DISTRICT IN 2012-2013. in *Publication Manuscripts*.

Arliny, Y. (2015). Tuberculosis and diabetes mellitus have clinical implications of two epidemics. *Kuala Journal of Shia Medicine*, *15*(1), 36–43.

Bailin, S. S., McGinnis, K. A., McDonnell, W. J., So-Armah, K., Wellons, M., Tracy, R. P., Doyle, M. F., Mallal, S., Justice, A. C., Freiberg, M. S., Landay, A. L., Wanjalla, C., &; Koethe, J. R. (2020). T Lymphocyte Subsets Associated with Prevalent Diabetes in Veterans with and without Human Immunodeficiency Virus. *Journal of Infectious Diseases*, *222*(2), 252–262. https://doi.org/10.1093/infdis/jiaa069

databoks.ID. (2022). *Provinces with the Most TB Cases in 2021*. https://databoks.katadata.co.id/datapublish/2022/08/23/ini-provinsi-dengan-kasus-tbc-terbanyak-pada-2021

Health Office of Population Control and Family Planning of Madiun City. (2021). *Health Profile of Madiun City in 2020*.

East Java Provincial Health Office. (2021). Health Profile of the East Java Provincial Health Office 2021. In *East Java Provincial Health Office*.

Fibriana, A. I., Azam, M., Maryuni, S., Indrawati, F., Windraswara, R., &; Turnbull, N. (2020). Risk Factors of Pulmonary Tuberculosis Among Diabetes Mellitus Patients: a Case-Control Study in Dr. Kariadi General Hospital, Seamrang, Indonesia. *Malaysian Journal of Public Health Medicine*, *20*(2), 101–

107. https://doi.org/10.37268/mjphm/vol.20/no.2/art.307

Houston, T. K., Person, S. D., Pletcher, M. J., Liu, K., Iribarren, C., &; Kiefe, C. I. (2006). Active and passive smoking and development of glucose intolerance among young adults in a prospective cohort: CARDIA study. *British Medical Journal*, *332*(7549), 1064–1067. https://doi.org/10.1136/bmj.38779.584028.55

Jabbar, A., Hussain, S. F., &; Khan, A. A. (2006). Clinical characteristics of pulmonary tuberculosis in adult Pakistani patients with co-existing diabetes mellitus. *Eastern Mediterranean Health Journal*, *12*(5), 522–527.

Ministry of Health of the Republic of Indonesia. (2020). Stay Productive, Prevent and Overcome Diabetes Mellitus. In *Data and Information Center of the Indonesian Ministry of Health*.

Lin, Y., Harries, A. D., Kumar, A. M. V, Critchley, J. A., Crevel, R. van, Owiti, P., Dlodlo, R. A., &; Dejgaard, A. (2019). Management of Diabetes Mellitus-Tuberculosis: a guide to the essential practice. In *International Union Against Tuberculosis and Lung Disease*. https://theunion.org/technical-publications/management-of-diabetes-mellitus-tuberculosis-a-guide-to-the-essential-practice

Yep. Jusman Rau. (2021). RISK ANALYSIS OF DIABETES MELLITUS EVENTS IN TB PATIENTS IN THE WORKING AREA OF THE KAMONJI HEALTH CENTER, PALU CITY. *Health*, *3*(2), 1–13.

Muhadi, Kamelia, T., Nawas, A., Isbaniah, F., Giriputro, S., Rudijanto, A., Yunir, E., Aswar, A., Indawati, E., Triningsih, E., Soesanti, F., Widyahening, I., Abdurohim, K., Suryanto, B., Ervita, Laksono, S., Sihombing, B., Apsari, P., Putri, F., ... et al. (2015). *National consensus TB-DM*.pdf.

Price, T. B., Krishnan-sarin, S., Rothman, D. L., Thomas, B., Krishnan-sarin, S., & Rothman, D. L. (2002). Smoking impairs muscle recovery from exercise. *American Physiological Society*, *06510*, 116–122. https://doi.org/10.1152

Risna Dewi, D. P., Eka Putra, I. W. . A., Sagung Sawitri, A. A., &; Pradnyaparamita Duarsa, D. (2017). Risk factors of pulmonary tuberculosis among diabetes mellitus patients in Denpasar City. *Public Health and Preventive Medicine Archive*, *5*(1), 24. https://doi.org/10.24843/phpma.2017.v05.i01.p04

Sasmita, H. Y., Prasetyowati, I., &; Wahjudi, P. (2019). *PREVALENCE AND RISK FACTORS OF DIABETES MELLITUS IN TUBERCULOSIS PATIENT AT PATRANG DISTRICT INDONESIA*. *7*(4).

Sharma, B., Khanal, V. K., Jha, N., Pyakurel, P., &; Gurung, G. N. (2019). Study of the magnitude of diabetes and its associated risk factors among the tuberculosis patients of Morang, Eastern Nepal. *BMC Public Health*, *19*(1), 2–7. https://doi.org/10.1186/s12889-019-7891-x

Solá, E., Rivera, C., Mangual, M., Martinez, J., Rivera, K., &; Fernandez, R. (2016). Diabetes mellitus: An important risk factor for reactivation of tuberculosis. *Endocrinology, Diabetes and Metabolism Case Reports, 2016*(July). https://doi.org/10.1530/EDM-16-0035

Tiara, R., &; Tri, A. (2021). The relationship between type 2 diabetes mellitus and the increased risk of pulmonary tuberculosis. *National Seminar on Medical Research 2 (SENSORY)*, *2*(1), 95.

Utomo, R., Nugroho, H. K. H., &; Margawati, A. (2016). The relationship between type 2 diabetes mellitus status and pulmonary tuberculosis status is extensive lesions. *Diponegoro Medical Journal*, *5*(4), 1536.

WHO. (2022). *Noncommunicable diseases*. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

Women's Sexual Autonomy Index in Indonesia : A Principal Component Analysis (PCA) Method

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Abstract

Many studies have shown that women's sexual autonomy has an important impact on sexual and reproductive health such as sexually transmitted infections (STIs) including HIV/AIDS, fertility, neonate and infant mortality, parity, contraceptive use, and domestic violence. Although there are many known benefits of women's sexual autonomy on various reproductive and sexual health issues, national-scale research in Indonesia on the distribution of women's sexual autonomy and what are the components of the sexual autonomy index has not been conducted. This study aims to determine the index of women's sexual autonomy and its composite factors. The research was a quantitative study using secondary data from the 2017 Indonesian Demographic and Health Survey (IDHS) with a cross sectional approach. The population in this study were women in union (married/cohabiting) aged 15 - 49 years in Indonesia, while the sample was women in union who were respondents in the 2017 IDHS who had complete data totalling 28,673 respondents from 34 provinces in Indonesia. We used Principal Component Analysis (PCA) to determine the sexual autonomy index and frequency distribution to see the proportion of each composite factors. The results showed that there were 2 components and 4 factors identified with an initial eigenvalue of 0.5974 which means that the amount of variance that can be explained by the new components formed is 59.794% while the rest is explained by other components that are not studied. Conclusion: PCA test results showed that there were 2 components which are a summary of the 4 variables analyzed. Further research is needed on other independent variables that affect women's sexual autonomy and its correlation to sexual health and reproductions outcomes.

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Sexual autonomy; women; Factor analysis, PCA

Introduction

Sexually Transmitted Infection (STI) is a disease caused by infection from bacteria, viruses, or other microorganisms that are transmitted from one person to another through blood, semen, vaginal fluids, or other body fluids through oral, anal, or genital sexual intercourse (National Cancer Institute, 2011). Quoting from WHO (WHO, 2022a) nearly one million pregnant women were infected with *syphilis* in 2016 which caused 200,000 pregnancy disorders including neonatal deaths and stillbirth. HPV infection causes cervical cancer of which an estimated 570,000 new cases occurred in 2018, and 311,000 deaths from cervical cancer

each year. Hepatitis B caused 820,000 deaths in 2019, most of which led to cirrhosis and *hepatocellular* cancer. *Gonorrhoea* and chlamydia are the main causes of *pelvic inflammatory disease* (PID) and infertility in women. Research (Fu et al., 2022) shows that from 1990 to 2019 the incidence of the top 5 STI diseases (syphilis, chlamydia, gonococcal, thricomoniasis, and genital herpes) experienced a significant increase of 58.15%. From the same data, it can be seen that the majority of sufferers are aged 30-34 years. Based on the highest incidence of STIs in 2019, Indonesia is third after China and India.

One of the strategic directions to overcome the problem of STIs has been prepared by WHO (WHO, 2022b) with the aim that the incidence of STIs can be reduced by 90% by 2030. The direction of the strategy consists of 5 aspects, namely: delivering high-quality, evidence-based, and community-centered services; optimization of systems, sectors, and cooperation for impact; based on data in determining decisions in action; increase community and civil society empowerment; and drive innovation for impact. In accordance with the direction of strategy number 4 on increasing community empowerment, women and adolescent girls groups are one of the concerns of WHO. This is because they have a high risk related to gender inequality and violence issues, and are vulnerable to sexual biological risks, one of which is STIs.

Sexual autonomy refers to women's role in decision-making related to when, with whom, and how sexual relations are performed as well as the ability of these women to negotiate safer sex (Adu et al., 2023; Crissman et al., 2012; Viswan et al., 2017). This includes the ability to refuse to have sex and ask couples to use condoms before sex (Memiah et al., 2019). Lack or absence of sexual autonomy increases the risk of reproductive and sexual losses such as STIs (Adu et al., 2022; Osuafor & Mturi, 2014; Willie et al., 2018), unwanted pregnancy, violence, and sexual coercion (Memiah et al., 2019; Montgomery et al., 2008). Therefore, more research is needed to understand women's sexual autonomy using several approaches.

Previous research on sexual autonomy has been conducted in several countries. Most of these studies link sexual autonomy as an independent variable to various women's reproductive and sexual health issues such as HIV infection (Ogbodo, 2023), cervical cancer screening (Midaksa et al., 2022; Tiruneh et al., 2017), parity (Adu et al., 2023), contraceptive use (Viswan et al., 2017), domestic violence (Aboagye et al., 2022; Ibitoye &; Ajagunna, 2021), neonatal and infant mortality (Memiah et al., 2019), and fertility (Forty et al., 2022). As far as the knowledge of researchers, Indonesia has only one national-scale study focusing on the relationship between women's empowerment, individual factors, and partner factors (sociodemographics) with the ability to negotiate safer sex (Putra et al., 2021). Although there are many known benefits of women's sexual autonomy on various reproductive and sexual health issues, national-scale research in Indonesia on the distribution of women's sexual autonomy and what are the components of the sexual autonomy index has not been conducted. Based on this, we wanted to know what are the factors of the women's sexual autonomy and how their distribution in Indonesia using IDHS data in 2017.

Methods

Data, Population, and Samples

This study used an analytical observational design with a *cross sectional* approach. The data used is secondary data from the 2017 Indonesian Health Demographic Survey (IDHS). IDHS is one of the 5-year, national-scale and representative routine surveys organized by BKKBN, BPS, Ministry of Health in collaboration with USAID and ICF International. Data was collected from 34 provinces from July – September 2017. The sampling technique in this survey was *multistage random sampling* using 1970 census blocks covering 49,250 households.
The population in this study was women age aged 15-49 years married/living together (in union) who were respondents to the 2017 IDHS amounting to 34,086, while the sample used was respondents to the 2017 IDHS women in union aged 15-49 years who had complete data of 23,294 respondents.

Research Variables

The variable studied was the female sexual autonomy index measured using 4 factors that had "yes" and "no" answer choices, while for respondents who answered "don't know" elimination was carried out. The selection of these variable factors refers to previous research on women's sexual autonomy (Aboagye et al., 2022; Jesmin & Cready, 2016; Memiah et al., 2019; Midaksa et al., 2022; Solanke et al., 2022). The constituent factors of women's sexual autonomy variables were tested for construct validity *using Principal Component Analysis* (PCA), while to see their reliability using *Cronbach's Alpha* value. This is done because sexual autonomy is a composite variable of several factors. The four factors in question are:

    a. If you do not want sexual intercourse, could you say no to husband/partner
    b. Can you ask your husband/partner to use condom
    c. Reason for not having sex: husband has STI

d.   Reason for not having sex: husband has other women

Principal Component Analysis (PCA)

Principal Component Analysis in factor analysis basically aims to simplify the observed variables by reducing their dimensions. This is done by eliminating the correlation between independent variables through the transformation of the original independent variable to a new variable that is not correlated at all or commonly called the principal component. The PCA result component will be a new independent variable free from multicollinearity (Purba, Mardaus, 2021). The main difference between PCA and other factor analysis techniques is that PCA will try to explain the variation in correlation between variables to the maximum in its first component (Ariawan, 2006).

Results

Table 1.
Descriptive Factors of Women's Sexual Autonomy

Variabel	Jumlah	
	N	%
If you do not want sexual intercourse, could you say no to husband/partner		
No	8899	38.2
Yes	14395	61.8
Can you ask your husband/partner to use condom		
No	16758	71.9
Yes	6536	28.1
Reason for not having sex: husband has STI		
No	2531	10.9
Yes	20763	89.1
Reason for not having sex: husband has other women		
No	3413	14.7
Yes	19881	85.3
Total	23294	100

Whether or not factor analysis is feasible can be done by looking at Kaiser-Meyer-Olkin's (KMO) measure of adequacy and Bartlett's Test of Spericity. If the KMO value ranges from 0.5 to 1, then factor analysis is feasible. In the other hand, if the KMO value is below 0.5 then factor analysis is not feasible. From table 1 below it can be seen that the KMO value is 0.531, so factor analysis is feasible. The KMO test is used to see if there is multicollinearity among the variables to be tested.

Bartlett's Test is a statistical test to test whether the independent variables involved are correlated. Factor analysis can be performed if the value of Bartlett's test of Sphericity has a significance value of < 0.05. In Table 2 below it can be seen that the Chi-Square value is 2200.833, with a free degree of 6, and a p-value (sig) of 0.000. Because the p-value (0.000) < 0.05, it can be concluded that there is a correlation between the independent variables tested

Table 2.
KMO and Bartlett's Test from 4 Factors of Women's Sexual Autonomy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.531
Bartlett's Test of Sphericity	Approx. Chi-Square	2200.833
	df	6
	Sig	0.000

Table 3.

Anti Image Matrices From 4 Factors of Women's Sexual Autonomy

		Anti-image Matrices			
		If you do not want sexual intercourse, could you say no to husband/partner	Can you ask your husband/partner to use condom	Reason for not having sex: husband has STI	Reason for not having sex: husband has other women
Anti-image Covariance	If you do not want sexual intercourse, could you say no to husband/partner	.963	-.171	.004	-.058
	Can you ask your husband/partner to use condom	-.171	.955	-.094	-.028
	Reason for not having sex: husband has STI	.004	-.094	.949	-.190
	Reason for not having sex: husband has other women	-.058	-.028	-.190	.953
Anti-image Correlation	If you do not want sexual intercourse, could you say no to husband/partner	**.524**[a]	-.179	.004	-.061
	Can you ask your husband/partner to use condom	-.179	**.537**[a]	-.099	-.030
	Reason for not having sex: husband has STI	.004	-.099	**.525**[a]	-.199
	Reason for not having sex: husband has other women	-.061	-.030	-.199	**.535**[a]

a. Measures of Sampling Adequacy(MSA)

In addition to KMO and Bartlett's Test values, factor analysis can be continued or not seen from the Measure of Sampling Adequacy (MSA) value. In table 3 above, it can be seen that the correlation number is marked a (diagonal direction from top left to bottom right). Numbers range from 0 to 1, with the following criteria:
1. MSA = 1, the variable can be predicted without error by other variables.
2. MSA > 0.5, variables can still be predicted and can be analyzed further.
3. MSA < 0.5, variables cannot be predicted and cannot be analyzed further, or excluded from other variables.

By looking at the MSA number criteria above, all MSA numbers have values above 0.5 which means, factor analysis can continue.

Table 4.

Communalities From 4 Factors of Women's Sexual Autonomy

	Communalities	Initial	Extraction
a.	If you do not want sexual intercourse, could you say no to husband/partner	1.000	.631
b.	Can you ask your husband/partner to use condom	1.000	.565
c.	Reason for not having sex: husband has STI	1.000	.613
d.	Reason for not having sex: husband has other women	1.000	.582

Extraction Method: Principal Component Analysis.

Communalities indicate how much variance can be explained by the factors extracted (factors formed). The variable a is magnitude 0.631. This means that about 63.1% of the variance of variable a can

be explained by the factors formed. Variable b is 0.565, this means that 56.5% of the variance of variable b can be explained by the factors formed. Likewise for other variables. An extraction value of > 0.50 indicates that all factors can explain the variables of female sexual autonomy. The greater the value of communalities means the stronger the relationship with the factors formed.

Table 5.
Total Variance Explained

Compo nent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
a	1.332	33.290	33.290	1.332	33.290	33.290	1.209	30.225	30.225
b	1.060	26.504	59.794	1.060	26.504	59.794	1.183	29.569	59.794
c	.850	21.255	81.048						
d	.758	18.952	100.000						
Extraction Method: Principal Component Analysis.									

If there are 4 factors involved, then there will be 4 factors (also called components) proposed in the factor analysis. Each factor represents the variables analyzed. The ability of each factor to represent the analyzed variables is indicated by the magnitude of the variance described, called the eigenvalue. The variance in question is the variance of variables that have been standardized. With standardization, the average value of each variable becomes zero and its variance becomes one. Since the variance of each variable is one, then the total variance is 4 because in this case there are 4 independent variables. Eigenvalues indicate the relative importance of each factor in calculating the variance of the three variables analyzed. The arrangement of eigenvalues is always sorted from largest to smallest, with the criterion that the number of eigenvalues below 1 is not used in calculating the number of factors formed. From table 4 above it can be seen that there are 2 factors formed (factor 1 and factor 2), because of two factors, the number of eigenvalues has a value above 1. As for the other 2 factors, the eigenvalues number is below 1. From the initial eigenvalues column in the cumulative sub-column, it can be seen that the reduction of 4 variables to 2 factors can explain 33.290% of variances, while the division of 2 factors explains 59.794% of variances. It can also be said that the magnitude of variance that can be explained by the new factor formed is 59.794% while the rest is explained by other factors that are not studied.

If the Total Variance Table (Table 5) explains the basis for the number of factors obtained by calculating numbers, the Scree Plot shows this with a graph like figure 1:
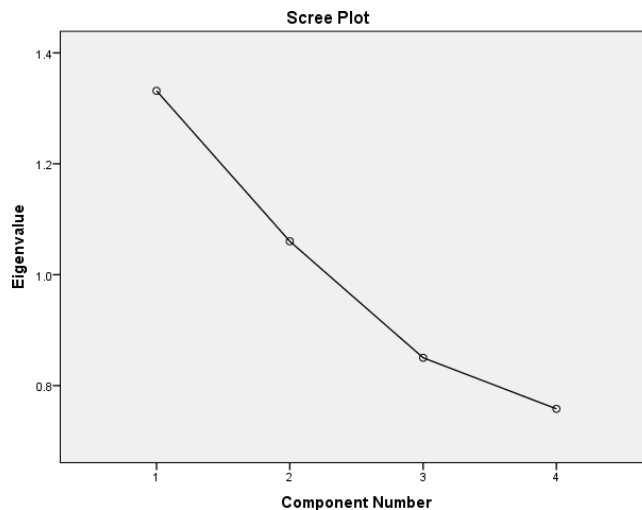
Figure 1. Scree Plot

Table 6.
Total Variance Explained

Component Matrix[a]		
	Component	
	1	2
a. If you do not want sexual intercourse, could you say no to husband/partner	.506	.612
b. Can you ask your husband/partner to use condom	.593	.462
c. Reason for not having sex: husband has STI	.607	-.494
d. Reason for not having sex: husband has other women	.596	-.477
Extraction Method: Principal Component Analysis.		
a. 2 components extracted.		

Table 6 contains factor loading (correlation values) between the analysis variables and the factors formed. Based on the table above, it can be seen that there are 2 factors formed from 4 variables. This shows that two factors are the most optimal number to reduce the 4 independent variables.

Table 7.
Total Variance Explained

Rotated Component Matrix[a]		
	Component	
	1	2
a. If you do not want sexual intercourse, could you say no to husband/partner	-.037	**.794**
b. Can you ask your husband/partner to use condom	.128	**.741**
c. Reason for not having sex: husband has STI	**.782**	.042
d. Reason for not having sex: husband has other women	**.762**	.048
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.[a]		
a. Rotation converged in 3 iterations.		

Table 7 above shows the number of factors that appear as well as the correlation between items and factors. We know that there are 2 factors that arise, namely component 1 and component 2. In the lines of items "a" and "b", it can be seen that the item has a large correlation with component 2 compared to component 1 so that item a is included in component 2. So it can be seen that items "c" and "d" enter component 1 and items a and b enter component 2.

Table 8.
Total Variance Explained

Component Transformation Matrix		
Component	1	2
1	.740	.672
2	-.672	.740
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		

Table 8 shows that in component 1 the correlation value is 0.740 and component 2 the value is 0.740. Since it is more than 0.50, these two factors can be concluded to be worthy of summarizing the four items analyzed

Discussion

Autonomy in the current context implies the right to refuse sexual contact and the right to seek it from a willing partner. Specifically, this has implications for bodily integrity, internal capacity for moderately mature and rational choices and external freedom from impermissible pressures and constraints (Berger, 2001). Human rights in sexual and reproductive health are central to health, well-being, and development in human life. The aggregate gains in sexual and reproductive health and rights over the past two decades have been widely researched. However, stark gaps remain across and within regions, with many countries showing progress among households in the top wealth quintile, while progress remains flat or marginal among poorer households. It highlights the inequalities inherent in development models that continue to leave many behind and underscores the nearly impossible to realize health for all and universal access to sexual and reproductive rights without sustained attention to strengthening the reach, completeness, and quality of health systems (ICPD, 2014). WHO defines sexual autonomy as the ability and control to make decisions regarding one's sexual life related to the individual's personality and social ethics (WHO, 2015). In the context of public health, sexual autonomy becomes a concept related to law and ethics within the scope of human rights issues (Willie et al., 2023).

This study produced 4 variables that can be used as an index of sexual autonomy. Variable items a (refusing a partner to have sexual intercourse) and b (asking the husband/partner to use a condom) correlate with women's sexual autonomy. This supports research by (Willie et al., 2023) which states that asking partners to wear condoms and refuse to have sex is one factor of sexual assertiveness. Research from Korea also shows the same thing that the question of whether it can refuse to have sexual intercourse is an factor of the measurement of sexual autonomy in college students with a correlation value of 0.695 (Chang, 2002).

The use of condoms is one way to prevent sexually transmitted infections including HIV / AIDS. Research shows that women who lack sexual autonomy will be more susceptible to STIs than women who have higher sexual autonomy (Adu et al., 2022). However, the study found that most women (71.9%) were unable to ask their partners or husbands to use condoms. This can happen due to stigma about HIV and condoms where some people assume that if a man has a condom it is assumed to be a customer of sex workers and if a woman has a condom she will be considered a sex worker, naughty woman and porn (Dewi et al., 2019). Of course, this stigma is not the only reason women cannot ask their partners to use condoms. Research from 2 countries in Africa states that women's ability to refuse to have sex and ask their partners to wear condoms is influenced by many factors such as education level, faith / religion, family economic level, attitudes towards wife beating, and knowledge about HIV transmission (Feyisetan &; Oyediran, 2020).

Research Limitations

The study was limited to variables available in the DHS data set for analysis. The 2017 data may be old, but this data is the last IDHS data in Indonesia. The *cross-sectional* nature of the data limits the causal relationship between individual characteristics and sexual autonomy. In addition, DHS data collection is carried out by means of interviews and sexual questions are considered quite sensitive. This can allow respondents to feel embarrassed in answering questions according to actual conditions. Despite these limitations, this study is one of the few that provides an empirical study about sexual autonomy among women in Indonesia.

Conclussion

From the results of the PCA test, 2 factors are a summary of the 4 factors analyzed, namely: 1. Factors (Component 1): variables c and d, and 2. Factors (component 2): a and b. The positive correlation shown by each variable shows that the higher the value of these variables, the greater the value of the female sexual autonomy index. Further research is needed on other independent variables that affect women's sexual autonomy and its correlation to sexual health/reproduction health

Patents
Not applicable.

Author Contributions
Conceptualization, P.L. and B; methodology, P.L and B; Performed data analysis, P.L; resources, P.L; data curation, P.L; writing—original draft preparation, P.L ; writing—review and editing, P.L and B; supervision, B. All authors have read and agreed to the published version of the manuscript

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Institutional Review Board Statement
The DHS reports that ethical clearances were obtained from ICF Institutional Review Board (IRB). A well as the Ethics Boards of partner organisations of the various countries such as the Ministries of Health. The DHS follows the standards for ensuring the protection of respondents' privacy. Since this was a secondary analysis, no further ethical approval was required because the datasets are available for download in the public domain on the following website : www.dhsprogram.com. The authors sought permission to use the data and authorization was granted by MEASURE DHS to download and analyse the Indonesian women's data set.

Conflicts of Interest:
The authors declare no conflict of interest.

References
Aboagye, R. G., Dadzie, L. K., Arthur-Holmes, F., Okyere, J., Agbaglo, E., Ahinkorah, B. O., & Seidu, A.-A. (2022). Intimate partner violence against married and cohabiting women in sub-Saharan Africa: Does sexual autonomy matter? *Reproductive Health*, *19*(1), 79. https://doi.org/10.1186/s12978-022-01382-1

Adu, C., Frimpong, J. B., Mohammed, A., Tetteh, J. K., Budu, E., Ahinkorah, B. O., & Seidu, A.-A. (2023). Safer sex negotiation and parity among women in sub-Saharan Africa. *Journal of Biosocial Science*, *55*(1), 74–86. https://doi.org/10.1017/S0021932021000651

Adu, C., Mohammed, A., Budu, E., Frimpong, J. B., Tetteh, J. K., Ahinkorah, B. O., & Seidu, A.-A. (2022). Sexual autonomy and self-reported sexually transmitted infections among women in sexual unions. *Archives of Public Health*, *80*(1), 40. https://doi.org/10.1186/s13690-022-00796-4

Ariawan, I. (2006). Indeks Sosio-ekonomi Menggunakan Principal Component Analysis. *Kesmas: National Public Health Journal*, *1*(2), 83. https://doi.org/10.21109/kesmas.v1i2.317

Berger, V. (2001). Review essay / defending sexual autonomy. *Criminal Justice Ethics*, *20*(1). https://doi.org/10.1080/0731129X.2001.9992100

Chang, S. B. (2002). Development of Sexual Autonomy Measurement for College Students. *Korean Journal of Women Health Nursing*, *8*(1), 106. https://doi.org/10.4069/kjwhn.2002.8.1.106

Crissman, H. P., Adanu, R. M., & Harlow, S. D. (2012). Women's Sexual Empowerment and Contraceptive Use in Ghana. *Studies in Family Planning*, *43*(3), 201–212. https://doi.org/10.1111/j.1728-4465.2012.00318.x

Dewi, D. M. S. K., Wulandari, L. P. L., & Wirawan, D. N. (2019). DETERMINAN SOSIAL KERENTANAN PEREMPUAN TERHADAP PENULARAN IMS DAN HIV. *Journal of Public Health Research and Community Health Development*, *2*(1), 22. https://doi.org/10.20473/jphrecode.v2i1.16250

Feyisetan, B., & Oyediran, K. A. (2020). Can married or cohabiting women negotiate protective sex? Findings from Demographic and Health Surveys of two West African countries. *Journal of Biosocial Science*, *52*(6), 785–808. https://doi.org/10.1017/S0021932019000798

Forty, J., Navaneetham, K., & Letamo, G. (2022). Determinants of fertility in Malawi: Does women autonomy dimension matter? *BMC Women's Health*, *22*(1), 342. https://doi.org/10.1186/s12905-022-01926-4

Fu, L., Sun, Y., Han, M., Wang, B., Xiao, F., Zhou, Y., Gao, Y., Fitzpatrick, T., Yuan, T., Li, P., Zhan, Y., Lu, Y., Luo, G., Duan, J., Hong, Z., Fairley, C. K., Zhang, T., Zhao, J., & Zou, H. (2022). Incidence Trends of Five Common Sexually Transmitted Infections Excluding HIV From 1990 to 2019 at the Global, Regional,

and National Levels: Results From the Global Burden of Disease Study 2019. *Frontiers in Medicine*, *9*, 851635. https://doi.org/10.3389/fmed.2022.851635

Ibitoye, T. R., & Ajagunna, F. (2021). Sexual autonomy and violence against women in Nigeria: Assessing the impact of Covid-19 pandemic. *De Jure Law Journal*, *54*(1), 141–159. https://doi.org/10.17159/2225-7160/2021/v54a9

ICPD. (2014). *Sexual and Reproductive Health Rights*. https://www.unfpa.org/sites/default/files/resource-pdf/Sexual_and_Reproductive_Health_Rights.pdf

Jesmin, S. S., & Cready, C. M. (2016). Community Influences on Married Women's Safer Sex Negotiation Attitudes in Bangladesh: A Multilevel Analysis. *Archives of Sexual Behavior*, *45*(2), 383–393. https://doi.org/10.1007/s10508-015-0572-7

Memiah, P., Opanga, Y., Bond, T., Cook, C., Mwangi, M., Fried, J., Joseph, M. A., Owuor, K., Mochache, V., & Machira, Y. W. (2019). Is sexual autonomy a protective factor for neonatal, child, and infant mortality? A multi-country analysis. *PLOS ONE*, *14*(2), e0212413. https://doi.org/10.1371/journal.pone.0212413

Midaksa, M., Destaw, A., Addissie, A., Kantelhardt, E. J., & Gizaw, M. (2022). Women's sexual autonomy as a determinant of cervical cancer screening uptake in Addis Ababa, Ethiopia: A case–control study. *BMC Women's Health*, *22*(1), 236. https://doi.org/10.1186/s12905-022-01829-4

Montgomery, C. M., Lees, S., Stadler, J., Morar, N. S., Ssali, A., Mwanza, B., Mntambo, M., Phillip, J., Watts, C., & Pool, R. (2008). The role of partnership dynamics in determining the acceptability of condoms and microbicides. *AIDS Care*, *20*(6), 733–740. https://doi.org/10.1080/09540120701693974

National Cancer Institute. (2011, February 2). *Definition of sexually transmitted disease—NCI Dictionary of Cancer Terms—NCI* (nciglobal,ncienterprise) [NciAppModulePage]. https://www.cancer.gov/publications/dictionaries/cancer-terms/def/sexually-transmitted-disease

Ogbodo, S. C. (2023). *HIV infection risk among women in South Africa: Exploring the interplay between financial autonomy, sexual autonomy and intimate partner violence* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2679557/v1

Osuafor, G. N., & Mturi, A. J. (2014). Attitude towards sexual control among women in conjugal union in the era of the HIV/AIDS epidemic in Mahikeng, South Africa. *African Population Studies*, 538–550. https://doi.org/10.11564/28-1-506

Purba, Mardaus. (2021). ANALISIS PENGARUH UMUR, LAMA MENGANGGUR, DAN KEMAMPUAN AKADEMIK TERHADAP INDEKS PRESTASI MAHASISWA DENGAN MENGGUNAKAN PRINCIPAL COMPONENT ANALYSIS (PCA). *Jebit Mandiri : Jurnal Ekonomi, Bisnis, Dan Teknologi*, *1*(1), 1–6.

Putra, I. G. N. E., Dendup, T., & Januraga, P. P. (2021). The roles of women empowerment on attitude for safer sex negotiation among Indonesian married women. *Women & Health*, *61*(1), 95–108. https://doi.org/10.1080/03630242.2020.1831685

Solanke, B. L., Adetutu, O. M., Sunmola, K. A., Opadere, A. A., Adeyemi, N. K., & Soladoye, D. A. (2022). Multi-level predictors of sexual autonomy among married women in Nigeria. *BMC Women's Health*, *22*(1), 114. https://doi.org/10.1186/s12905-022-01699-w

Tiruneh, F. N., Chuang, K.-Y., Ntenda, P. A. M., & Chuang, Y.-C. (2017). Individual-level and community-level determinants of cervical cancer screening among Kenyan women: A multilevel analysis of a Nationwide survey. *BMC Women's Health*, *17*(1), 109. https://doi.org/10.1186/s12905-017-0469-9

Viswan, S. P., Ravindran, T. K. S., Kandala, N.-B., Petzold, M. G., & Fonn, S. (2017). Sexual autonomy and contraceptive use among women in Nigeria: Findings from the Demographic and Health Survey data. *International Journal of Women's Health*, *9*, 581–590. https://doi.org/10.2147/IJWH.S133760

WHO. (2015). *Sexual health, human rights and the law*. World Health Organization. https://apps.who.int/iris/handle/10665/175556

WHO. (2022a). *Sexually Transmitted Infections (STIs)*. https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-(stis)

WHO. (2022b, March 1). *A New Framework Guides Support for Sexual and Reproductive Self-Care*. Breakthrough ACTION and RESEARCH. https://breakthroughactionandresearch.org/new-framework-guides-support-for-sexual-and-reproductive-self-care/

Willie, T. C., Callands, T. A., & Kershaw, T. S. (2018). Intimate Partner Violence, Sexual Autonomy and Postpartum STD Prevention Among Young Couples: A Mediation Analysis. *Perspectives on Sexual and Reproductive Health*, *50*(1), 25–32. https://doi.org/10.1363/psrh.12050

Willie, T. C., Callands, T., Alexander, K. A., & Kershaw, T. (2023). Measuring women's sexual autonomy: Development and preliminary validation of the women's sexual autonomy scale. *Women's Health*, *19*, 17455057231183836. https://doi.org/10.1177/17455057231183837

Determinant Factors of Length of Stays in Hospital for Diabetes Mellitus Patients

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Abstract

The prevalence of diabetes mellitus is increasing every year. The length of stay is one indicator of the effectiveness of the treatment carried out by the hospital. The length of stay is related to several factors, including age, comorbidities, and severity. This study presents the correlation between age, comorbidities, and severity with the length of stay in diabetes mellitus patients at Budhi Asih Regional Hospital. The study design used a cross-sectional with data sources from inpatient claims data for National Health Insurance patients from January to December 2021 at Budhi Asih Regional Hospital. The number of samples is 136 patients. The Spearman correlation test was used to see the correlation between age and secondary diagnosis with length of stay. The Kruskal-Wallis H test was used to see the relationship between severity and length of stay. Majority of patients were female (59.6%). Median at age 56.5 years, comorbid 2, and length of stay seven days. As many as 61.8% of patients were at moderate severity, 93.4% were discharged with the doctor's approval, and 67.6% had type 1 diabetes mellitus. There was no correlation between age and length of stay (p-value 0.636 and ρ 0.041). There is a correlation between comorbidities (p-value 0.000 and ρ 0.533) and severity (p-value 0.000) with length of stay. This study shows a relationship between comorbidities and severity with length of stay. In comparison, age is not associated with length of stay.

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Introduction

Diabetes mellitus is a chronic disease that occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. Increased blood sugar is a common effect of uncontrolled diabetes causing damage to the body's systems (Mahmud et al., 2018). Diabetes mellitus has become a global health problem because the number of cases increases every year. According to the International Diabetes Federation (IDF) in 2021 in Indonesia there are 19.5 million people with diabetes mellitus and it is predicted to increase to 28.6 million in 2045 (International Diabetes Federation, 2021). The results of national basic health research in 2018 showed that DKI Jakarta Province was the province with the highest prevalence of diabetes mellitus (3.4%) in Indonesia (Kementerian Kesehatan, 2018).

In general, diabetes mellitus is divided into type 1 and type 2 (T1D and T2D) (Arneth et al., 2019). Type 1 diabetes mellitus is a condition where insulin stops producing due to damage to pancreatic cells. This type of diabetes is usually diagnosed in children or young adults. Children with type 1 DM not only face short-term complications such as hypoglycemia and diabetic ketoacidosis (DKA), both of which have significant risks of morbidity and mortality, but also long-term complications in the form of macrovascular and microvascular changes (Adelita et al., 2020). Studies show the incidence of this type of diabetes is 15 per 100,000 population and the prevalence is 9.5% (95% CI 0.07-0.12) (Mobasseri et al., 2020).

Type 2 diabetes mellitus is also called non-insulin dependent where insulin works less effectively (Milita et al., 2021). In 2017, around 462 million people were diagnosed with type 2 diabetes mellitus which is equivalent to 6.28% of the world's population (4.4% aged 15-49 years, 15% aged 50-69, and 22% aged >69 years) with an incidence of 6,059 cases per 100,000 world population (Khan et al., 2020). Complications that occur include cardiovascular system disorders such as atherosclerosis, retinopathy, impaired kidney function, and nerve damage (Milita et al., 2021).

Length of stay (LOS) is an indicator of medical services provided by the hospital to patients. LOS can show how long a patient is hospitalized with one treatment period (Alfiani et al., 2021). LOS is an indicator in patient care, in which the less LOS results in a change in the degree of health the better for the patient indicating effective treatment (Khairi Lubis, 2017). If it is related to costs, then reducing the length of stay, the patient and family can reduce the burden of inpatient costs (Nirmalasari et al., 2020). Differences in age (D'Agostino et al., 2019), severity of disease, and the presence of comorbidities (Dimitri et al., 2018; Ghosh et al., 2021; Toptas et al., 2018) have a relationship with length of stay. The aim of this study was to analyze the relationship between age, comorbidities and severity with length of stay.

Methods

The design of this research is cross sectional. The sample is all data on inpatient claims from National Health Insurance (JKN) patients with a primary diagnosis of diabetes mellitus (ICD-10 E10-E14) from January to December 2021 at one of the type B government hospitals in East Jakarta. This research has been carried out an ethical review at the Research Center of the hospital where this research was conducted with the issuance of a letter passing the ethical review 418/KEP-ETIK/XI/2022 dated 14 November 2022. Meanwhile, the samples were taken from patients whose discharge status was deceased and who experienced readmission within a period of time. 30 (thirty) days are excluded as a sample. So the total sample was obtained, namely 136 cases.

The age variable is the difference between the patient's date of birth and the date the patient was treated. The patient's length of stay variable is the difference between the date of discharge and the date of admission of the patient to the hospital. Meanwhile, comorbid variables were measured by the number of comorbidities in the patient. The severity variable refers to the INA CBG guidelines for category 1 mild severity, category 2 moderate severity, and category 3 severe severity.

To describe each variable in numerical data, center size is used, while in categorical data, frequency distribution is used. In testing the hypothesis to see the relationship between age, comorbidities, severity and length of stay using several statistical tests. To examine the relationship between age and comorbidities with length of stay using Spearman correlation. Meanwhile, the Kruskal-Wallis H test was used to test the relationship between severity level and length of stay. An illustration of the distribution of length of stay at each level of severity is presented using a boxplot.

Results
Patient Characteristics

The characteristics of all patients in the study (n = 136) are shown in Tables 1 and 2. Most of the patients were female, 81 patients (59.6%) with a patient age range of 11-82 years (mean = 55.84, median = 56,5). The length of patient stay ranged from 1 to 22 days (mean = 7.72, median = 7) and the number of patient comorbidities ranged from none to eight comorbids (mean = 7.72, median = 2). The majority of patients were treated with moderate severity in 84 patients (61.8) and discharge status with doctor's approval in 127 patients (93.4%). Most patients were treated with a primary diagnosis of Type 1 Diabetes Mellitus with a total of 92 patients (67.6%).

Table 1.
Patient Characteristics based on Gender, Severity, Discharge Status, Type of Diabetes Mellitus (n=136)

Variable	n	%
Gender		
Male	55	40,4
Female	81	59,6
Severity illness		
Mild	21	15,4
Moderate	84	61,8
Severe	31	22,8
Discharge status		
Doctor's approval	127	93,4
Referred	1	0,7
At own request	7	5,1
Others	1	0,7
Type of diabetes mellitus		
Type 1 diabetes mellitus	92	67,6
Type 2 diabetes mellitus	36	26,5
Unspecified diabetes mellitus with ketoacidosis	8	5,9

Table 2.
Patient Characteristics based on Age, Length of Stay, and Comorbidities

Variable	Min-Max	Mean	Median	SD
Age (Years)	11-82	55,84	56,5	13,1
Length of stay	1-22	7,72	7	3,9
Comorbidities	0-8	2,68	2	1,60

Correlation between Age, Comorbidity, and Severity with Length of Stay for Diabetes Mellitus Patients

Before testing the hypothesis in this study, a normality test was carried out on the length of stay variable. The normality test results show that the p-value is 0.000, which means the data is not normally distributed. Table 3. presents the relationship between age and comorbidities with length of stay in patients with diabetes mellitus. There is no relationship between age and length of stay (p-value 0.636). There is a relationship between comorbidities and length of stay (p-value 0.000) and the correlation value is positive with a very strong relationship (ρ 0.533).

Table 3.
Correlation between Age and Comorbidities with Length of Days of Care for Diabetes Mellitus Patients

Variable	ρ	p-value
Usia	0,041	0,636
Komorbid	0,533	0,000

Table 4. describes the relationship between severity and length of stay in patients with diabetes mellitus. From the results of the Kruskal-Wallis H test, it appears that there is a difference in the average length of stay based on the severity of diabetes mellitus patients (p-value 0.000). Based on Figure 1, the trend of length of stay increases with increasing severity. At mild severity, the average length of stay is 3 days. At moderate severity, the average length of stay is 7 days, with 3 (three) respondents having a length of stay of more than 15 days. At the severity level, the average length of stay was 8 days, with 2 (two) respondents having a length of stay of more than 21 days.

Table 4.
Mean Different Test Based on Severity Level of Diabetes Mellitus Patients

Variable	p-value
Severity illness	0,000
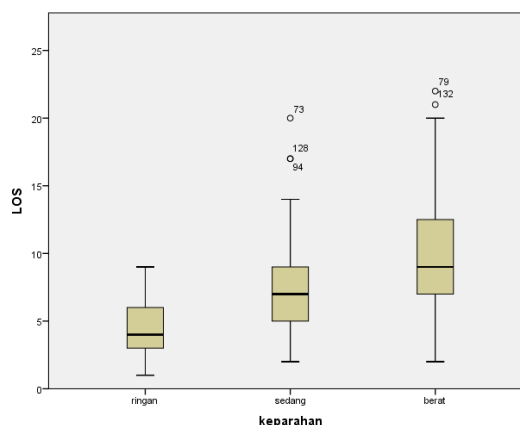
Figure 1. Boxplot Distribution of Length of Stay based on Severity Level of Diabetes Mellitus Patients

Discussion

Age had no relationship with length of stay in this study. These results are different from findings in other studies which state that age has an effect on length of stay, where differences in length of stay occur more in the elderly (D'Agostino et al., 2019).

In this study, the presence of comorbidities was related to the length of stay. This is in line with research by Toptas, et al which concluded that there was an increase in length of stay in diabetes mellitus patients who had complications (p-value 0.0004) (Toptas et al., 2018). Likewise, in research by Olthof, et al, several comorbidities in diabetes mellitus patients can result in complications that require longer treatment (Olthof et al., 2014). Complications of diabetes mellitus are classified into acute and chronic complications. Acute complications are short-term complications due to glucose imbalance such as hypoglycemia, diabetic ketoacidosis (DKA), hyperglycemic hyperosmolar non-ketotic syndrome (NHNK). Chronic complications generally occur after 10 to 15 years including macrovascular complications, microvascular complications and foot neuropathy (Valent et al., 2017). Diabetes mellitus patients often also have other comorbidities such as hypertension, obesity and tuberculosis (Cannon et al., 2018; Ekoru et al., 2019).

The severity of disease in INA CBG is related to the number of comorbidities/complications in the patient (Cannon et al., 2018). The level of severity and length of stay in this study were related. This study is in line with previous research that there is a difference in the length of stay in the severity of the disease (p-value 0.000) (Setareh et al., 2021). The higher the severity, the more intensive care is needed which requires a longer length of stay than the usual severity (Oktadiana, 2021).

The length of stay is a reflection of the efficiency of health services and is an important indicator for measuring the quality of health services. By reducing the length of stay, cost efficiency will be achieved because the costs of accommodation and inpatient treatment will be reduced. Therefore, efforts that can be made to reduce the length of stay are through the implementation of clinical pathways so that patients get services according to their needs.

Clinical pathways combine medical care protocols, nursing care plans, and related health care professional activities into a single plan of care, which clearly defines the progress and outcomes expected of patients through the hospital system. This clinical pathway begins either at patient admission or the start of the procedure and ends at discharge (Firmansyah & Widjaja, 2022). Medical and nursing personnel will provide a therapy plan that the patient must carry out when they go home. Insulin therapy and diet are therapies commonly used by diabetes mellitus patients. However, some patients during post-hospital treatment do not comply with the therapy plan given (Fitriani et al., 2019). Consistency in treating diabetes mellitus patients after discharge from the hospital can control the course of the disease and complications in patients so that patients do not experience readmission due to recurrence (Silvina Marbun et al., 2022).

The limitation of this study is that it only collects data on JKN patients, does not differentiate between patients with other types of financing. In addition, data on JKN claims cannot differentiate between comorbidities and complications.

Conclussion

This study shows that there is a relationship between comorbidities and severity with length of stay in patients with diabetes mellitus. In this study, there was no relationship between age and length of stay. Standardized care refers to clinical pathways that can reduce length of stay. However, consistent care after discharge from the hospital is also important so that diabetes mellitus patients do not experience a recurrence which results in a readmission in a worse condition than the previous admission.

Author Contributions

Conceptualization, writing proposal, project administration, and reporting N.A.T; methodology, and collecting data W.Z.Q and M.N; analyzing and interpretation M.N, W.Z.Q, and N.AT; review and editing, P.P. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This research has been carried out an ethical review at the Research Center of the hospital at Budhi Asih Hospital where this research was conducted with the issuance of a letter passing the ethical review 418/KEP-ETIK/XI/2022 dated 14 November 2022.

Conflicts of Interest:

The authors declare no conflict of interest.

References

Adelita, M., Arto, K. S., & Deliana, M. (2020). Kontrol Metabolik pada Diabetes Melitus Tipe-1. *Cermin Dunia Kedokteran*, *47*(3), 227–232. https://garuda.kemdikbud.go.id/documents/detail/2888232

Alfiani, D. N., Yani, A., & Hermanto, R. A. (2021). Gambaran Lama Hari Rawat Inap, Perubahan Kadar Glukosa Darah, Asupan Energi Dan Karbohidrat Pada Pasien Diabetes Mellitus Tipe II Rawat Inap dI RSU Holistic Purwakarta. *Journal of Holistic and Health Sciences*, *5*(1), 9–13.

Arneth, B., Arneth, R., & Shams, M. (2019). Metabolomics of type 1 and type 2 diabetes. In *International Journal of Molecular Sciences* (Vol. 20, Issue 10). MDPI AG. https://doi.org/10.3390/ijms20102467

Cannon, A., Handelsman, Y., Heile, M., & Shannon, M. (2018). Percentage with diabetes Number with diabetes. *Journal of Managed Care & Specialty Pharmacy*, *24*(9). www.jmcp.org

D'Agostino, F., Vellone, E., Cocchieri, A., Welton, J., Maurici, M., Polistena, B., Spandonaro, F., Zega, M., Alvaro, R., & Sanson, G. (2019). Nursing Diagnoses as Predictors of Hospital Length of Stay: A Prospective Observational Study. *Journal of Nursing Scholarship*, *51*(1), 96–105. https://doi.org/10.1111/jnu.12444

Dimitri, G., Giacco, D., Bauer, M., Bird, V. J., Greenberg, L., Lasalvia, A., Lorant, V., Moskalewicz, J., Nicaise, P., Pfennig, A., Ruggeri, M., Welbel, M., & Priebe, S. (2018). Predictors of length of stay in psychiatric inpatient units: Does their effect vary across countries? *European Psychiatry*, *48*, 6–12. https://doi.org/10.1016/j.eurpsy.2017.11.001

Ekoru, K., Doumatey, A., Bentley, A. R., Chen, G., Zhou, J., Shriner, D., Fasanmade, O., Okafor, G., Eghan, B., Agyenim-Boateng, K., Adeleye, J., Balogun, W., Amoah, A., Acheampong, J., Johnson, T., Oli, J., Adebamowo, C., Collins, F., Dunston, G., … Rotimi, C. (2019). Type 2 diabetes complications and comorbidity in Sub-Saharan Africans. *EClinicalMedicine*, *16*, 30–41. https://doi.org/10.1016/j.eclinm.2019.09.001

Firmansyah, Y., & Widjaja, G. (2022). PEMBERLAKUAN CLINICAL PATHWAY DALAM PEMBERIAN LAYANAN KESEHATAN DAN AKIBAT HUKUMNYA. *Cross-Border*, *5*(1), 536–573.

Fitriani, Y., Pristianty, L., Hermansyah, A., Kesehatan Provinsi Jawa Timur, D., & Ahmad Yani, J. (2019). Pendekatan Health Belief Model (HBM) untuk Menganalisis Kepatuhan Pasien Diabetes Melitus Tipe 2 dalam Menggunakan Insulin. *Pharmaceutical Journal of Indonesia*, *16*(02), 167–177.

Ghosh, A. K., Unruh, M. A., Soroka, O., & Shapiro, M. (2021). Trends in medical and surgical admission length of stay by race/ethnicity and socioeconomic status: a time series analysis. *MedRxiv*. https://doi.org/10.1101/2021.05.27.21257925

International Diabetes Federation. (2021). *Diabetes around the world in 2021*. https://diabetesatlas.org/regional-factsheets/

Kementerian Kesehatan. (2018). *RISKESDAS 2018*.

Khairi Lubis, I. (2017). *Analisis Length Of Stay (Los) Berdasarkan Faktor Prediktor Pada Pasien DM Tipe II di RS PKU Muhammadiyah Yogyakarta* (Vol. 2, Issue 2).

Khan, M. A. B., Hashim, M. J., King, J. K., Govender, R. D., Mustafa, H., & Kaabi, J. Al. (2020). Epidemiology of Type 2 diabetes - Global burden of disease and forecasted trends. *Journal of Epidemiology and Global Health*, *10*(1), 107–111. https://doi.org/10.2991/JEGH.K.191028.001

Mahmud, F. R., Sudirman, S., & Afni, N. (2018). Faktor-Faktor Yang Berhubungan Dengan Penyakit Diabetes Melitus Di Ruang Poli Interna Rsud Mokopido Kabupaten Tolitoli. *Jurnal Kolaboratif Sains*, *1*(1), 168–175.

Milita, F., Handayani, S., & Setiaji, B. (2021). Kejadian Diabetes Mellitus Tipe II pada Lanjut Usia di Indonesia (Analisis Riskesdas 2018). *Jurnal Kedokteran Dan Kesehatan*, *17*(1), 9–20. https://jurnal.umj.ac.id/index.php/JKK

Mobasseri, M., Shirmohammadi, M., Amiri, T., Vahed, N., Fard, H. H., & Ghojazadeh, M. (2020). Prevalence and incidence of type 1 diabetes in the world: A systematic review and meta-analysis. In *Health Promotion Perspectives* (Vol. 10, Issue 2, pp. 98–115). Tabriz University of Medical Sciences. https://doi.org/10.34172/hpp.2020.18

Nirmalasari, N., Nofiyanto, M., & Hidayati, R. W. (2020). Lama Hari Rawat Pasien Stroke. *Jurnal Terpadu Ilmu Kesehatan*, *9*(2), 117–268. https://jurnalinterest.com/index.php/int/article/view/196/157

Oktadiana. (2021). Perbandingan Biaya Riil Pada Pasien Diabetes Mellitus Tipe 2 Dengan Tarif INA-CBG'S Di Rumah Sakit Umum Daerah. *Jurnal Farmasi Tinctura*, *2*(2), 42–51.

Olthof, M., Stevens, M., Bulstra, S. K., & Van den Akker-Scheek, I. (2014). The association between comorbidity and length of hospital stay and costs in total hip arthroplasty patients: A systematic review. In *Journal of Arthroplasty* (Vol. 29, Issue 5, pp. 1009–1014). Churchill Livingstone Inc. https://doi.org/10.1016/j.arth.2013.10.008

Setareh, M., Alavi, N., & Atoof, F. (2021). Severity of illness affecting the length of stay and outcomes in patients admitted to intensive care units, Iran, 2019. *Journal of Education and Health Promotion*, *10*(1). https://doi.org/10.4103/jehp.jehp_780_20

Silvina Marbun, A., Brahmana, N., Parida Sipayung Ceria Sinaga, N., Lina Uli Marbun, K., & Halianja Prodi, R. S. (2022). Pelaksanaan Empat Pilar pada Penderita Diabetes Melitus. *Jurnal Abdimas Mutiara*, *3*(1), 366–371.

Toptas, M., Samanci, N. S., Akkoc, E., Yucetas, E., Cebeci, E., Sen, O., Can, M. M., & Ozturk, S. (2018). Factors affecting the length of stay in the intensive care unit: Our clinical experience. *BioMed Research International*, *2018*. https://doi.org/10.1155/2018/9438046

Valent, F., Tonutti, L., & Grimaldi, F. (2017). Does diabetes mellitus comorbidity affect in-hospital mortality and length of stay? Analysis of administrative data in an Italian Academic Hospital. *Acta Diabetologica*, *54*(12), 1081–1090. https://doi.org/10.1007/s00592-017-1050-6

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Can message framing lead to a pro-environmental behavior?: Evidence from two experiments

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Abstract

This study conducted two experiments to investigate the impact of threat and hope messages, framed as either global or local issues, on pro-environmental behavior. In Study 1 & 2, participants evaluated climate change campaign posters with different message framings. The researchers examined how threat and hope appeals, presented in global and local contexts, influenced participants' pro-environmental attitudes and intentions, also analyzing the effects of these messages on the number of donations made by participants in both study. The results of both experiments indicated that messages of threat and hope, framed as either global or local issues, significantly influenced participants' attitudes and behavioral intentions related to environmental protection. The effects varied based on framing context: fear messages had a greater impact when climate change was framed globally, while hope messages were more influential when framed locally. However, these messages did not have a significant impact on the amount of donations made. This research contributes to a deeper understanding of how various message strategies can be employed in climate change communication to effectively influence individual attitudes and intentions towards pro-environmental behavior intentions.

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Keywords: Persuasion; Message Framing; Hope appeal; Fear appeal; Climate Change

Introduction
Background

Climate change has become a critical environmental issue with significant impacts on nature, human life, and infrastructure worldwide (IPCC, 2021). Indonesia ranks as the tenth-largest emitter of greenhouse gases globally, according to the Global Carbon Report in 2021. Previous research by E. Bohensky et al. (2013) examined household engagement with climate change in Indonesia and found that 81.9% of the surveyed households observed climate change, but proactive actions were relatively low.

Climate risks need to be considered in decision-making and planning, including how messages about climate change are conveyed to the public. Effective communication plays a vital role in climate change mitigation by utilizing persuasive messages to change individual behaviors (Chadwick, 2015). Behavioral change campaigns often employ Fear appeals or Hope appeals, including campaigns addressing climate change. Previous research by Chadwick (2015) found that messages emphasizing hope were more persuasive than fearening messages. Another study comparing the emotional appeals of hope and fear found that hope appeals were more effective in influencing respondents' intentions in internal communication and self-efficacy in reducing climate change. Positive message framing led to greater intentions to engage in mitigation behavior compared to negative framing (Morton et al., 2011).

The majority of Indonesia's population consists of Generation Z (born between 1997 and 2012) and millennials (born between 1981 and 1996). Generation Z represents approximately 27.94% of the total population, while millennials make up around 25.87%. Both generations have a high level of awareness regarding the climate crisis in Indonesia. They perceive climate change as a human-caused crisis and support immediate actions to address it. Factors perceived to contribute to climate change include deforestation, industrial sectors, plastic usage, and logging. Therefore, it is crucial to examine how persuasive messages employing emotional appeals influence the attitudes, behavioral intentions, and donation amounts of Generation Z in responding to climate change (Indikator, 2021).

In the context of research on emotional appeals of fear and hope messages in environmental communication, particularly regarding climate change, there has been limited research conducted in Indonesia. This study replicates the research conducted by Lee et al. (2017), which investigated the effectiveness of hope and fear messages in environmental communication through an experimental study. This research aims to examine the persuasive effects of hope and fear messages framed in the context of global and local climate change issues on pro-environmental attitudes, pro-environmental behavioral intentions, and donation amounts among Generation Z in Indonesia.

Research Question

This study aims to investigate the influence of fear and hope messages, influenced by emotional appeals, and framed within global and local issues on pro-environmental attitudes, pro-environmental behavioral intentions, and donation amounts. Replicating the study by Lee et al. (2017), the researcher intends to examine how communication messages can influence individuals in addressing climate change, considering the low level of proactive actions related to climate change in Indonesia. The research questions include: 1) Among fear messages framed with global versus local issues, which one significantly affects pro-environmental attitudes, pro-environmental behavioral intentions, and donation amounts? 2) Among hope messages framed with global versus local issues, which one significantly affects pro-environmental attitudes, pro-environmental behavioral intentions, and donation amounts? 3) Among hope and fear messages framed with global versus local issues, which one significantly affects pro-environmental attitudes, pro-environmental behavioral intentions, and donation amounts?

Research Objective

The objective of this study is to evaluate the influence of fear and hope messages, framed within global and local issues, on pro-environmental attitudes, pro-environmental behavioral intentions, and donation amounts. With the findings obtained, this research aims to provide recommendations to relevant stakeholders in designing effective and relevant environmental communication messages for the Indonesian population.

Literature Review

Persuasion

Perloff (2010) defines persuasion as the process of convincing someone to change their attitudes or behaviors regarding a specific topic through symbolic processes of message exchange. Perloff identifies five important components in explaining the definition of persuasion: 1) Persuasion is a symbolic process; 2) Persuasion is an effort to influence individuals; 3) People persuade themselves; 4) Persuasion involves the transmission of a message; 5) Persuasion requires free choice.

Fear Appeal Persuasion Approach

Fear appeal is defined by Witte (1993) as a persuasive message that induces fear by providing relevant and significant fear descriptions related to the individual's personal circumstances, followed by recommendations to mitigate that fear. Witte and Allen (2000) explain that fear appeal has structural, stylistic, and extraneous message features. The severity and susceptibility components of a fear in fear appeal elicit fear through perceived severity (e.g., the event leading to death) and susceptibility (e.g., being at risk in the event).

Extended Parallel Process Model (EPPM) Theory

The Extended Parallel Process Model (EPPM) is widely studied and used by researchers to deliver persuasive messages. Kim Witte explains that individuals manage the fear aroused by fear-based messages to observe behavioral interests related to fear-based messages (Littlejohn et al., 2012). The underlying assumption of the EPPM theory is that when individuals are presented with fear-based messages consisting of severity and susceptibility, as well as efficacy messages comprising response efficacy and self-efficacy, they will respond by engaging in danger control or fear control (Witte, 1993).

Hope Appeal Persuasion Approach

Hope is a positive emotion that represents prospects for a better state than the current one, particularly when individuals do not perceive control over an outcome (Lazarus, 1991). Empirical research on hope messages is still relatively limited, although they are widely used in political campaigns and public health campaigns (Chadwick, 2015). Scholars suggest that hope appeals can provide individuals with a positive vision and motivate them to take sustained actions to achieve that vision (Chadwick, 2015). Additionally, hope messages may be more effective than fear or guilt appeals (Smith & Leiserowitz, 2014).

Global versus Local Message Framing in Persuasion

Message framing has been extensively discussed in the context of environmentally friendly marketing (Kim & Kim, 2014). Research by Scannell and Gifford (2013) examined individuals' perceptions of global and local environmental issues, considering the concept of environmental hipopia. The findings indicated that individuals tended to prioritize global environmental issues and perceive them as more important. However, the effectiveness of local messages in changing individuals' attitudes toward climate change still requires further research (Wiest et al., 2015). Another study by Haden et al. (2012) showed that using a framing that highlights the impact of climate change at the local level can enhance perceptions of problem severity and support for local policy actions. Nevertheless, further research is needed to gain a deeper understanding of the effects of local messages in climate change communication.

Experimental Studies on Hope and Fear Appeals in Environmental Communication

Experimental studies have been conducted to test the effects of climate change messages on pro-environmental attitudes and behavioral intentions. Nabi et al. (2018) found that emotions, particularly hope, mediate the relationship between framed messages and desired climate change policy advocacy attitudes. Lee et al. (2017) found that fear-appeal messages increase attention, positive attitudes toward environmental issues, and behavioral intentions more than hope-appeal messages in the context of global environmental issues. However, hope-appeal messages are more effective in the context of local environmental issues. These studies provide valuable insights into understanding the influence of messages and emotions in changing pro-environmental attitudes and behavioral intentions.

Research Hypotheses

This study will examine the persuasion using the emotional appeal of hope and fear messages framed in the global and local context of climate change, focusing on pro-environmental behavior in Indonesia. The following hypotheses are formulated:
• H1: When the issue of climate change is framed in a global context, fear appeal will have a more significant influence than hope appeal on Pro-Environmental Attitudes, Pro-Environmental Behavioral Intentions, and Donation Amounts.
The study by Lee et al. (2017) found that when environmental issues are addressed in a global context, fear appeals attract more attention from the audience and have a positive impact on attitudes, behavioral intentions, and donation amounts. The research by Scannell and Gifford (2013) supports the concept of environmental hipopia, which suggests that individuals tend to prioritize global environmental issues over local ones.
• H2: When the issue of climate change is framed in a local context, hope appeal will have a more significant influence than fear appeal on Pro-Environmental Attitudes, Pro-Environmental Behavioral Intentions, and Donation Amounts.
The study by Lee et al. (2017) found that in a local environmental context, hope appeals are more effective than fear appeals in influencing attention, attitudes, behavioral intentions, and donation amounts. The research by Wiest et al. (2015) indicates that when climate change issues are connected to local impacts, individuals tend to take collective action.suggests that individuals tend to prioritize global environmental issues over local ones.

Research Framework
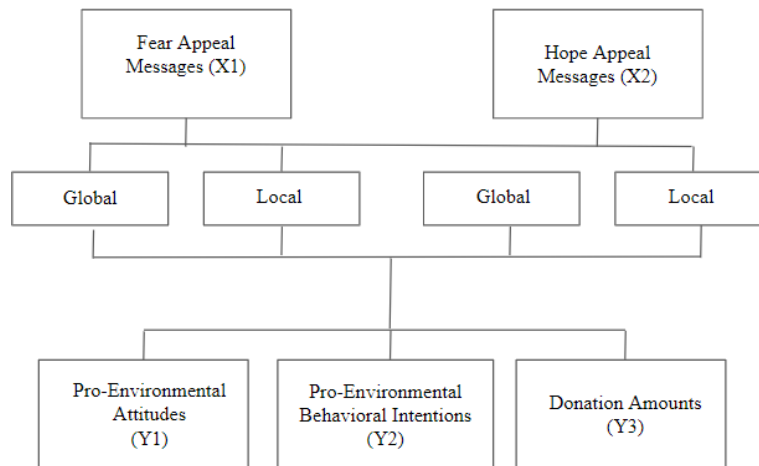
Figure 1. Research Framework

This research examines the independent variables of fear appeal messages (X1) and hope appeal messages (X2) framed in global and local contexts, and their effects on the dependent variables of Pro-Environmental Attitudes (Y1), Pro-Environmental Behavioral Intentions (Y2), and Donation Amounts (Y3). Two experimental studies will be conducted to examine the influence of the independent variables on Pro-Environmental Attitudes (Y1), Pro-Environmental Behavioral Intentions (Y2), and Donation Amounts (Y3).

Methods

This research adopts a positivist paradigm with a quantitative approach and an experimental design. A between-subject design with treatments involving fear appeal and hope appeal messages framed in global and local issues will be used. This study utilizes a post-test only experiment. The research will be conducted in person, involving Generation Z individuals aged 8 to 23 years, with a selected sample from a public high school in Jakarta. The experimental matrix in this study consists of two experiments, each involving message framing (local vs. global) and message type (hope vs. fear).

Research Instruments

The research instrument used in this study is climate change advertisement manipulation in the form of posters. The researcher created manipulations by presenting climate change advertisements containing fear appeal and hope appeal messages framed in global and local issues.

Table 1.
Manipulation Instrumentation

Manipulation Instrument	Remarks
Experiment 1 Design	
Instrument 1	Local Issue - Fear Appeal Message
Instrument 2	Local Issue - Hope Appeal Message
Instrument 3	Global Issue - Fear Appeal Message
Instrument 4	Global Issue - Hope Appeal Message
Experiment 2 Design	
Instrument 5	Local Issue - Fear Appeal Message
Instrument 6	Local Issue - Hope Appeal Message

Instrument 7	Global Issue - Fear Appeal Message
Instrument 8	Global Issue - Hope Appeal Message

Study 1 employs local issue framing with two types of messages: fear appeal and hope appeal. The fear appeal message highlights serious consequences with a poster title emphasizing the fear of "You Will Die If You Don't Make Changes for Indonesia" and a background image depicting a dangerous situation. The hope appeal message, on the other hand, emphasizes positive contributions with a poster title of "You Are the Hope for Indonesia" and a background image reflecting hope. Both messages aim to encourage individuals to address climate change.

In Study 2, the researcher uses a komodo dragon image for local framing and a polar bear image for global framing, along with the Greenpeace logo as a stimulus. A survey was conducted to select the komodo dragon as an animal that represents Indonesia's unique characteristics, and it was chosen because it is a protected species that is endangered. In the local framing, the fear appeal poster uses language and imagery that depict the negative impacts of climate change, while the hope appeal poster encourages positive actions. The fear appeal poster uses a red color scheme and a barren background, while the hope appeal poster uses bright colors and a green background.

Result

Manipulation Check Results for Experimental Attributes

The manipulation check results indicated the participants' assessment of the attribute alignment with the fear and hope posters framed in global and local issues. Participants were asked to rate the attributes on a scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree).

Research Respondent Data

The research respondent data includes information about gender, age, and education level. A total of 234 participants, including both males and females, participated in this experimental study. The participants were divided into eight different groups with randomized gender placements. The percentage of male participants was 45.7%, consisting of 107 individuals, while the percentage of female participants was 54.3%, consisting of 127 individuals. Based on age, the majority of participants were 17 years old, with a total of 128 individuals (55%), followed by 18 years old with 65 individuals (28%). Additionally, there were 22 individuals (9%) aged 16, 16 individuals (7%) aged 19, and 3 individuals (1%) aged 20. All participants had completed junior high school education, as they were still in senior high school.
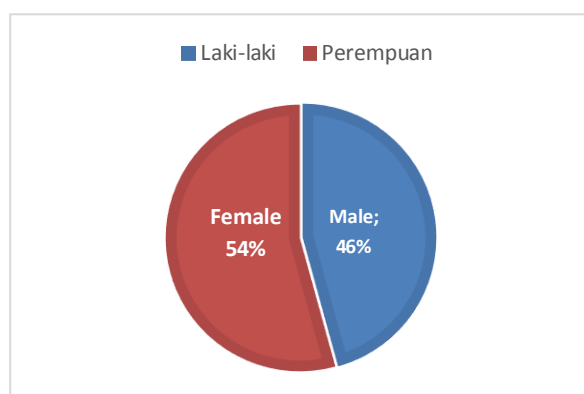
Figure 2. Percentage of Participant Gender

Validity and Reliability

In this study, validity and reliability tests were conducted on the research instrument, which was the questionnaire. The results showed that all questions in the questionnaire had good validity with significance values below 0.05. Furthermore, reliability testing was conducted using the Cronbach's alpha method, which yielded reliability values ranging from 0.84 to 0.85 for each question in the questionnaire, indicating excellent reliability. The Kaiser-Meyer-Olkin (KMO) test was also conducted and resulted in a value of 0.80,

indicating that the variables used in this study have sufficient capability to explain the factors being examined.

Mean and Standard Deviation Values

Table 2.
Mean and Standard Deviation Values

Dependen Variabel	Mean	Std
Attitude	5,48	1,068
Behavioral Intention	5,73	0,93
Donation Amount	21,795	24,424

For the attitude variable, the mean values for each indicator indicate a high attitude towards environmental issues. In the presented table, the overall mean value for the attitude variable is 5.48 with a standard deviation of 1.068. This indicates that the respondents, as a whole, have a positive attitude towards climate change conditions. For the behavioral intention variable, the mean values indicate a high intention to address climate change. The overall mean value for the behavioral intention variable is 5.73 with a standard deviation of 0.93. This shows that respondents have a strong intention to follow recommendations in addressing the impacts of climate change.

For the donation amount variable, there is variation in the mean values among the groups. The overall mean value for the donation amount variable is Rp 21,795 with a standard deviation of 24,424. Thus, the analysis of mean and standard deviation values indicates that respondents, in general, have a positive attitude, high behavioral intentions, and the potential to make donations in environmental conservation efforts. Additionally, the variation among the groups indicates the influence of global fear messages on the attitudes, behavioral intentions, and donation amounts of the respondents.

ANOVA Analysis

This study onducted statistical data analysis using the F-test analysis of variance (ANOVA) for each variable, namely Attitude, Behavioral Intention, and Donation Amount.

Attitude Variable

Table 3.
ANOVA Test for Attitude in Experimental Studies 1 and 2

Attention	Sum of Squares	df	Mean Square	F	Sig.
Experimental Study 1					
Between Groups	485.736	3	161.912	21.354	0.000
Within Groups	879.564	116	7.582		
Total	1365.3	119			
Experimental Study 2					
Between Groups	412.57	3	137.523	21.751	0.000
Within Groups	695.5	110	6.323		
Total	1108.07	113			

Based on the F-test (ANOVA) results in the above table, it is found that there is a significant influence of the independent variables on the dependent variable, indicating that fear and hope posters framed in local and global issues in Experimental Studies 1 and 2 have a significant effect on the respondents' attitudes.

Tabel 4.

Post Hoc-Tukey Group Comparisons on Attitude in Experimental Studies 1 and 2

(I) Kelompok	(J) Kelompok	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Experimental Study 1						
Local Hope	Local Fear	4.129*	0.696	0.000	2.310	5.94
Global Fear	Global Hope	3.728*	0.730	0.000	1.830	5.63
Experimental Study 2						
Local Hope	Local Fear	3.910*	0.644	0.000	2.230	5.59
Global Fear	Global Hope	3.613*	0.691	0.000	1.810	5.41

 The mean difference is significant at the 0.05 level.

The research findings from the two experimental studies support both hypotheses proposed. The findings indicate that fear appeal has a more significant influence in shaping attitudes towards climate change in the global context, while hope appeal is more effective in the local context. There are significant mean differences between the groups in both experimental studies. In Experimental Study 1, there is a mean difference of 4.129 between the Local Hope Group and the Local Fear Group, with participants in the Local Hope Group having a more positive attitude related to the local hope message. A mean difference of 3.728 is also found between the Global Fear Group and the Global Hope Group, with participants in the Global Fear Group having a more positive attitude related to the global fear message.

In Experimental Study 2, there is a mean difference of 3.910 between the Local Hope Group and the Local Fear Group, with participants in the Local Hope Group having a more positive attitude related to the local hope message. A mean difference of 3.613 is also found between the Global Fear Group and the Global Hope Group, with participants in the Global Fear Group having a more positive attitude related to the global fear message.

Behavioral Intention Variable

Table 5.
ANOVA Test for Behavioral Intention in Experimental Studies 1 and 2

Behavioral Intention	Sum of Squares	df	Mean Square	F	Sig.
Experimental Study 1					
Between Groups	362.212	3	120.737	22.536	0.000
Within Groups	621.488	116	5.358		
Total	983.7	119			
Experimental Study 2					
Between Groups	210.62	3	70.207	11.936	0.000
Within Groups	647.038	110	5.882		
Total	857.658	113			

Based on the F-test (ANOVA) results in the above table, it is found that there is a significant influence of the independent variables on the dependent variable, indicating that fear and hope posters framed in local and global issues in Experimental Studies 1 and 2 have a significant effect on the respondents' behavioral intentions.

Table 6.

Post Hoc-Tukey Group Comparisons on Behavioral Intention in Experimental Studies 1 and 2

(I) Kelompok	(J) Kelompok	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Experimental Study 2						
Local Hope	Local Fear	1.318	0.585	0.115	-0.210	2.84
Global Fear	Global Hope	4.760*	0.613	0.000	3.160	6.36
Experimental Study 2						
Local Hope	Local Fear	1.497	0.621	0.081	-0.120	3.12
Global Fear	Global Hope	3.650*	0.666	0.000	1.910	5.39

* The mean difference is significant at the 0.05 level.

The analysis results show that in Experimental Study 1, there is no significant difference between the Local Hope Group and the Local Fear Group in the Behavioral Intention variable, with a mean difference of 1.318. However, there is a significant difference between the Global Fear Group and the Global Hope Group, with a mean difference of 4.760. This indicates that participants in the Global Fear Group have higher behavioral intentions than participants in the Global Hope Group related to the global fear message.

In Experimental Study 2, there is no significant difference between the Local Hope Group and the Local Fear Group in the Behavioral Intention variable. However, there is a significant difference between the Global Fear Group and the Global Hope Group, with a mean difference of 3.650. This indicates that participants in the Global Fear Group have higher behavioral intentions than participants in the Global Hope Group related to the global fear message.

These results support the research hypothesis that fear appeal has a more significant influence than hope appeal in shaping behavioral intentions related to climate change in the global context.

Donation Amount Variable

Table 7.
ANOVA Test for Donation Amount in Experimental Studies 1 and 2

Donation Amount	Sum of Squares	df	Mean Square	F	Sig.
Experimental Study 1					
Between Groups	4169295071	3	1389765024	2.273	0.084
Within Groups	7.09E+10	116	611469798.2		
Total	7.51E+10	119			
Experimental Study 2					
Between Groups	4449349083	3	1483116361	2.749	0.046
Within Groups	59338589514	110	539441722.9		
Total	63787938596	113			

Based on the F-test (ANOVA) results, Experimental Study 1 shows that there is no significant difference in Donation Amount between the tested groups. In the context of this study, the tested factors do not have a significant influence on the amount of donation given by the participants. However, Experimental Study 2 reveals a significant difference in Donation Amount between the tested groups. This indicates that

the tested factors have different influences on the amount of donation in different experimental study contexts.

Interaction Test

Table 8.
Interaction Test of Message and Framing on Attitude, Behavioral Intentions, and Donation Amount

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Attitude					
Corrected Model	865.263a	3	288.421	41.185	0.000
Intercept	62583.66	1	62583.660	8936.526	0.000
Issue Framing	1.475	1	1.475	0.211	0.647
Message	3.78	1	3.780	0.540	0.463
Issue Framing * Message	854.482	1	854.482	122.014	0.000
Behavioral Intention					
Corrected Model	555.545a	3	185.182	32.996	0.000
Intercept	68614.606	1	68614.606	12226.020	0.000
Issue Framing	117.322	1	117.322	20.905	0.000
Message	5.284	1	5.284	0.942	0.333
Issue Framing * Message	458.132	1	458.132	81.632	0.000
Donation Amount					
Corrected Model	8620521551.189a	3	2873507183.7	5.069	0.002
Intercept	1.091E+11	1	1.091E+11	192.531	0.000
Issue Framing	700365444.8	1	700365444.8	1.236	0.267
Message	44983968.81	1	44983968.8	0.079	0.778
Issue Framing * Message	8132430915	1	8132430914.6	14.347	0.000

a R Squared = .062 (Adjusted R Squared = .050)

In the interaction test, a two-way ANOVA is conducted to examine the interaction between two independent variables (issue framing and message) on attitude, behavioral intention, and donation amount. The analysis between-subjects for the Attitude variable shows significant findings in the relationship between issue framing, message, and their interaction. Specifically, the individual effects of issue framing and message separately are not significant on participants' attitudes. However, the interaction between issue framing and message has a significant effect on participants' attitudes. This indicates that the effectiveness of the message in influencing participants' attitudes depends on how the issue is framed and how the message is delivered.

In the analysis of the Behavioral Intention variable, the results show that the overall corrected model significantly contributes to explaining the variance in participants' behavioral intentions ($p < 0.001$). The factors of issue framing and the interaction between issue framing and message significantly influence participants' behavioral intentions. Specifically, issue framing proves to have a significant effect on participants' behavioral intentions ($p < 0.001$), while the message does not have a significant effect on participants' behavioral intentions ($p > 0.05$). There is also a significant interaction between issue framing and message in influencing participants' behavioral intentions ($p < 0.001$), indicating that the influence of the message on behavioral intentions may differ depending on how the climate change issue is framed.

In the analysis of the Donation Amount variable, it is found that the tested factors have a significant influence on the donation amount. Individually, the issue framing and message variables do not have a significant effect on the donation amount ($p > 0.05$). However, there is a significant interaction between

issue framing and message on the donation amount (p < 0.001), indicating that the combination of issue framing and message can significantly affect the donation amount.

Hypothesis Descriptions

This study examined the influence of fear and hope messages in both global and local issues on attitudes, behavioral intentions, and donation amounts. The research findings support the first hypothesis that fear messages have a more significant influence than hope messages in shaping attitudes in the global context. The findings also support the second hypothesis that hope messages have a more significant influence than fear messages in shaping attitudes in the local context.

Regarding the behavioral intention variable, the findings support the first hypothesis that fear messages have a more significant influence than hope messages in the global context. However, the second hypothesis regarding the influence of hope messages in the local context cannot be conclusively determined. For the donation amount variable, the research results do not provide strong support for the hypothesis related to the donation amount. The differences in donation amounts between groups are not statistically significant.

Discussion

This research emphasizes the examination of the effects of Fear and hope messages in both global and local contexts on attitudes, behavioral intentions, and donation amounts. Based on the results of the ANOVA tests, it is found that there is a significant influence of the independent variables on the dependent variables, indicating that the presentation of fear and hope messages with framing in global and local issues in Experiment 1 and 2 significantly affects respondents' attitudes and behavioral intentions. Regarding the Attitude variable, the findings from both experimental studies support the proposed hypotheses. The results show that the appeal of fear has a more significant influence in shaping attitudes towards climate change in the global context, while hope appeal is more effective in the local context. There are significant mean differences between groups in both experimental studies.

For the Behavioral Intentions variable, the analysis indicates that in both Experiment 1 and 2, there were no significant differences between the Local Hope Group and the Local Fear Group in terms of Behavioral Intentions, with a mean difference of 1.318. However, there was a significant difference between the Global Fear Group and the Global Hope Group, with a mean difference of 4.760. These results support the research hypothesis that the appeal of fear has a more significant influence than hope appeal in shaping behavioral intentions related to climate change in the global context. There were no significant differences in the Donation Amount variable between the tested groups.

Based on the two-way ANOVA results for the Attitude variable, there is a significant interaction between the framing of the issue and the message in influencing participants' attitudes. For the Behavioral Intentions variable, there is a significant interaction between the framing of the issue and the message in influencing behavioral intentions, emphasizing the importance of choosing appropriate framing of the issue and messages. For the Donation Amount variable, although the framing of the issue and the message individually did not have a significant influence, their interaction significantly impacted the donation amount. These findings highlight the importance of the right combination of issue framing and messages to motivate financial participation in addressing climate change.

Fear appeal and hope appeal have a significant influence on donations for climate change mitigation. When people empathize with the negative consequences of climate change, they are more likely to donate or provide financial support for efforts aimed at addressing this issue. Other factors influencing donations may vary depending on factors such as income level, belief in the effectiveness of mitigation actions, and understanding of the impacts of climate change. The donation amount is positively correlated with fear, perceived fear, and the perceived effectiveness (E. Palosaari et al., 2023).

Effective communication also plays a crucial role. Messages conveyed in a acceptable, clear, and relevant manner can increase participation in donations for climate change mitigation. The use of strong narratives and real-life examples of the benefits of mitigation efforts can inspire and encourage donors to contribute actively. Good communication in packaging climate change materials will ultimately build trust, even if the content is about climate change fears. Fear messages will not lead to a desire for donation if people do not have strong belief in their effectiveness (E. Palosaari et al., 2023).

Experimental research has examined various emotional factors that influence pro-environmental behavior. Studies have shown that inducing collective guilt about human-caused environmental damage can increase the likelihood of participation. The messages conveyed about the impact of climate change must evoke emotional responses in readers; in this context, the posters created by the researchers and given to

participants were found to evoke feelings of empathy towards climate change victims, which increased support for climate change mitigation policies.

Research on persuasion with a fear appeal approach has been a widely studied and developed topic. Hope appeal in persuasive communication has also been a significant subject of research. Hope appeal is used in an effort to influence attitudes and behaviors of individuals by presenting hope related to a specific issue or situation. In the context of persuasive messages, hope appeal aims to motivate message recipients to take desired actions by depicting positive consequences if those actions are taken. The development of research on hope appeal has explored various aspects and variables that affect the effectiveness of persuasive messages.

Experimental studies related to hope and fear appeal in environmental communication have been conducted by several researchers. One study by Lee et al. (2017) compared the effectiveness of hope and fear appeal messages in environmental communication. The results of the study showed that when the environmental issue was framed globally, messages using fear appeal were more effective in increasing respondents' attention, positive attitudes toward the environmental issue, and behavioral intentions compared to messages using hope appeal. However, when the environmental issue was framed as a local issue, hope appeal was more effective.

In a study conducted by Li & Huang (2020), an experimental study was conducted to examine the effect of high fear appeal on behavioral intentions. The results of the study showed that messages using high fear and high efficacy were most effective in persuading people to take action on climate change, and the use of fear appeal was considered an effective approach in changing people's behavioral intentions related to climate change. Another study by Chadwick (2015) also compared the effectiveness of hope and fear appeal. The results of the study showed that hope appeal was more effective in influencing respondents' intentions in internal communication and self-efficacy in reducing climate change compared to messages containing fear-inducing fears. Several studies have shown that emotions such as fear appeal and hope appeal can play a significant role in the success of persuasion related to climate change (Nabi, 2015).

These studies provide valuable insights into the influence of climate change messages on attitudes and pro-environmental behavioral intentions. The results of this research indicate that fear appeal and hope appeal have a significant influence on attitudes and behavioral intentions related to climate change. When individuals empathize with the negative consequences of climate change, they are more likely to participate by providing support for climate change mitigation efforts. Effective communication, with messages that are well-received, clear, and relevant, along with the use of strong narratives and real-life examples, can increase participation in donations for climate change mitigation. Additionally, this research also found that inducing collective guilt about environmental damage can increase support for climate change mitigation efforts.

Conclusion

This research was conducted to examine the research questions by understanding the reception of fear and hope messages framed with global and local issues and their influence on attitudes, behavioral intentions, and donation amounts. The conclusions from this research are that global fear messages significantly influence individuals' attitudes and behavioral intentions. These findings support the hypothesis that the appeal of fear is more significant than hope appeal in influencing attitudes and behavioral intentions in the global context. However, the influence of fear messages on the donation amount cannot be strongly concluded based on the results of this research.

Local hope messages significantly influence individuals' attitudes and behavioral intentions. These findings support the hypothesis that hope appeal is more significant than fear appeal in influencing attitudes and behavioral intentions in the local context. In the local context, hope messages play a stronger role in influencing individual responses. However, the influence of hope messages on the donation amount cannot be strongly concluded based on the results of this research.

The analysis of the research results shows a significant interaction between the framing of the issue and the message in influencing attitudes, behavioral intentions, and the donation amount. This confirms that the effectiveness of messages depends on how the issue of climate change is framed and how messages are delivered to the respondents. For the Behavioral Intentions variable, there is a significant interaction between the framing of the issue and the message in influencing behavioral intentions. Moreover, although the framing of the issue and the message individually did not have a significant influence on the donation amount, their interaction significantly impacts the donation amount. These findings highlight the importance of choosing the right combination of issue framing and messages to increase financial participation in facing climate change.

Recommendations

For future research, it is recommended to expand the research instruments by incorporating severity and susceptibility constructs in the framing of fear messages. Additionally, participant attention should also be considered as an important variable in the analysis. In future research, it is advisable to involve individuals from various age groups and generations to gain a more comprehensive understanding. Lastly, research should consider limitations in the number of participants and group selection methods to increase the external validity of the findings. By considering these recommendations, future research can provide a more comprehensive understanding of the factors influencing responses to persuasive messages related to climate change.

Reference examples from Journal:

Alisjahbana, A. S., & Busch, J. M. (2017). Forestry, forest fires, and climate change in Indonesia. Bulletin of Indonesian Economic Studies, 53(2), 111-136.

Amanda, L., Yanuar, F., & Devianto, D. (2019). Test the validity and reliability of the level of political participation of the people of Padang city. UNAND Journal of Mathematics, 8(1), 179-188.

Bohensky, E. L., Smajgl, A., & Brewer, T. (2013). Patterns in household-level engagement with climate change in Indonesia. Nature Climate Change, 3(4), 348-351.

Born, D. (2019). Bearing witness? Polar bears as icons for climate change communication in National Geographic. Environmental Communication, 13(5), 649-663.

Chadwick, A. E. (2015b). Toward a Theory of Persuasive Hope: Effects of Cognitive Appraisals, Hope appeals, and Hope in the Context of Climate Change. Health Communication, 30(6), 598–611.

Friedlingstein, P., Jones, M. W., O'Sullivan, M., Andrew, R. M., Bakker, D. C., Hauck, J., ... & Zeng, J. (2022). Global Carbon Budget 2021. Earth System Science Data, 14(4), 1917-2005.

Jonauskaite, D., Abu-Akel, A., Dael, N., Oberfeld, D., Abdel-Khalek, A. M., Al-Rasheed, A. S., ... & Mohr, C. (2020). Universal patterns in color-emotion associations are further shaped by linguistic and geographic proximity. Psychological Science, 31(10), 1245-1260.

Kulpavaropas, S. (2012). The influence of level of issue relevance and emotional appeals in public service ads on attitudes and behavioral intentions toward global climate change. Iowa State University.

Palosaari, E., Herne, K., Lappalainen, O., & Hietanen, J. K. (2023). Effects of fear on donations to climate change mitigation. Journal of Experimental Social Psychology, 104, 104422.

Roser-Renouf, C., & Nisbet, M. C. (2008). The measurement of key behavioral science constructs in climate change research. International Journal of Sustainability Communication, 3, 37-95.

Scannell, L., & Gifford, R. (2013). Personally relevant climate change: The role of place attachment and local versus global message framing in engagement. Environment and Behavior, 45(1), 60-85.

Smith, N., & Leiserowitz, A. (2014). The role of emotion in global warming policy support and opposition. Risk Analysis, 34(5), 937–948.

Spears, N. E., Blankson, C., & Guzmán, F. (2012). Hope and Fear in an Advertisement Context: Understanding How Hope Undoes Fear. Journal of Current Issues and Research in Advertising, 33(1), 79–93.

Whitmarsh, L., Poortinga, W., & Capstick, S. (2021). Behaviour change to address climate change. Current Opinion in Psychology, 42, 76-81.

Wiest, S. L., Raymond, L., & Clawson, R. A. (2015). Framing, partisan predispositions, and public opinion on climate change. Global environmental change, 31, 187-198.

Witte, K. (1993). Message and conceptual confounds in Fear appeals: The role of fear, fear, and efficacy. Southern Communication Journal, 58(2), 147–155. https://doi.org/10.1080/10417949309372896

Witte, K. (1996). Chapter 16 – Fear as motivator, fear as inhibitor: Using the extended parallel process model to explain Fear appeal successes and failures. Handbook of Communication and Emotion, 4, 423–450.

Witte, K., & Allen, M. (2000). A meta-analysis of Fear appeals: Implications for effective public health campaigns. Health Education and Behavior, 27(5), 591–615. https://doi.org/10.1177/109019810002700506

Yang, Z. J., & Kahlor, L. A. (2013). What, Me Worry? The Role of Affect in Information Seeking and Avoidance. Science Communication, 35(2), 189–212. https://doi.org/10.1177/1075547012441873

Yoseph-Paulus, R., & Hindmarsh, R. (2018). Addressing inadequacies of sectoral coordination and local capacity building in Indonesia for effective climate change adaptation. Climate and development, 10(1), 35-48.

Yulianto, W. (2020). Analysis of the factors that affect the value of the company. Journal of Accounting Paradigm, 2(2), 576-585.

Reference examples from Conference/Proceeding:

Chadwick, A. E. (2015a). Bridging the Divide between Positive and Negative: The Effectiveness of Hope and Fear appeals in Climate Change Communication. The Conference on Communication and Environment, 1–15.

Zhu, L. (2020, October). Research on color design in interactive animation design software. In Journal of Physics: Conference Series (Vol. 1648, No. 2, p. 022159). IOP Publishing.

Reference examples from books/e-book:

Baxter, L. A., & Babbie, E. R. (2003). The Basics of Communication Research. Cengage Learning.

Djamba, Y. K., & Neuman, W. L. (2002). Social Research Methods: Qualitative and Quantitative Approaches. In Teaching Sociology (Vol. 30, No. 3).

Gordon, J. (2005). Presentations that change minds: Strategies to persuade, convince, and get results. New York: McGraw-Hill.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32.

Lazarus, R. S. (1991). Emotion and adaptation. New York: Oxford University Press.

Machin, D., & Mayr, A. (2012). How to do critical discourse analysis: A multimodal introduction. Los Angeles, CA: SAGE.

Nahartyo, E., & Utami, I. (2016). Experimental Research Practical Guide. Jakarta: PT Index.

Punch, K.F. (1998) Introduction to Social Research: Quantitative and Qualitative Approaches. Sage, London.Baxter, L. A., & Babbie, E. R. (2003). The Basics of Communication Research. Cengage Learning.

Reference examples from reports:

Badan Nasional Penanggulangan Bencana. (December 29, 2020). A total of 2,925 natural disasters occurred in the country in 2020, with hydro-meteorological disasters dominating. [Link: https://www.bnpb.go.id/berita/sebanyak-2-925-bencana-alam-terjadi-pada-2020-di-tanah-air-bencana-hidrometeorologi-mendominasi]

Badan Pusat Statistik. (January 21, 2021). Results of the 2020 Population Census. [Link: https://demakkab.bps.go.id/news/2021/01/21/67/hasil-sensus-penduduk-2020.html]

Climate Central. (October 27, 2022). 365 Days on a Warming Planet. [Link: https://www.climatecentral.org/report/global-climate-shift-index]

Indikator. (February 9-16, 2021). National Survey of the Perceptions of Young and Young Voters (Gen Z and Millennials) on Climate Crisis Issues in Indonesia. [Link: https://indikator.co.id/wp-content/uploads/2021/10/Materi-Rilis-Diseminasi-Surnas-Perubahan-Iklim.pdf]

Jarraud, M., & Steiner, A. (2012). Summary for policymakers. In Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change (Vol. 9781107025).

Kementerian Lingkungan Hidup dan Kehutanan Siaran Pers. (March 04, 2017). [Link: http://ppid.menlhk.go.id/siaran-pers/browse/548]

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Measure Waist Circumference, Waist-To-Height Ratio, And Lifestyle To Determine Adolescent Central Obesity At Vocational High School

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Abstract

Poor lifestyle choices, such as poor eating habits and insufficient sleep significantly increase the occurrence of teenage central obesity. When assessing body composition, the value of visceral fat can be used to make a clear diagnosis of central obesity, although this examination is not regularly conducted for a variety of reasons. In a communal setting, particularly a school setting, an easy and efficient technique is to employ waist circumference and waist circumference to height ratio. The purpose of this study was to examine the lifestyle of teenagers with central obesity, as well as the association between waist circumference and waist circumference to height ratio. Around 65 youths were measured for waist circumference and height and given a lifestyle questionnaire about breakfast sweet drinks, afternoon and night munchies, and sleep duration. To examine central obesity, the waist circumference must be greater than 90 cm for men and greater than 80 cm for women, as well as greater than 0.5 waist-to-height ratio There was a significant relationship between adolescent waist circumference and waist circumference to height ratio, with a significance value of $p = 0.008$ (p 0.05) but lifestyle factors such as breakfast, sweet drinks, snacking in the afternoon and evening, and length of sleep were not different between adolescents with and without central obesity ($p > 0.05$). When evaluating central obesity in adolescents in this study, waist circumference and waist circumference to height ratio are associated, but there is no difference in lifestyle.

Keywords:
Central obesity; Adolescents; waist circumference; waist-to- height ratio, lifestyle

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Introduction

Obesity can be experienced by various age groups, including teenagers. Research data shows that the prevalence of obesity is 4.9%, with the prevalence in males being higher than in females (8.8% vs 3.1%) (p<0.001) of the 1955 adolescents studied (Duan et al., 2020; Kelishadi, 2022). Based on 2018 Basic Health Research data from the Ministry of Health of the Republic of Indonesia, the prevalence of overweight and obesity in adolescents has increased significantly over the last 5 years. Data shows a prevalence of 16.0% in adolescents aged 13-15 years and 13.5% in adolescents aged 16-18 years, however these data do not specifically explain the prevalence of central obesity.(Kemenkes RI, 2018)

The incidence of central obesity in adolescents is increasing annually due to various factors, including lifestyle, unhealthy eating habits, and unhealthy sleep(Zabeen et al., 2015a). Central obesity can increase the risk of metabolic disease and includes central obesity as a prerequisite in diagnosing metabolic syndrome (MS), which is considered central obesity if the waist circumference is > 90 cm for Asian men and > 80 cm for Asian women (Al-Hamad & Raman, 2017). A definite diagnosis of central obesity can be determined based on the value of visceral fat when examining body composition, but this examination is not routinely performed for various reasons. In a community setting we can use waist circumference and waist circumference to height ratio to explore central obesity. Some studies show that A WC/HT ≥0.5 resulted in sensitivity:specificity of 99%:72% for detecting central obesity and WC/HT ≥0.55 yielded sensitivity:specificity of 80%:96% for detecting central obesity(Mehta, 2015). Study about WC showed yielded sensitivity:specificity of 96%:25% in men, and 100%:24,1% in women. This study aimed to examine the lifestyle of teenagers with central obesity, as well as the association between waist circumference(WC) and waist circumference to height ratio (HT).

Methods

A crosssectional study involving 65 adolescents(16 males, 49 females), They were students at SMK Muhammadiyah 4 Surakarta, held on December 2022. The WC was measured by metline at the superior border of the iliac crest and midway between the lowest rib and the iliac crest for each students, using cut-offs of ≥90 cm in males and ≥80 cm in females. The Height was measured by microtoise. The way to measure were ; position the patient's head under the microtoise slider, looking straight ahead. At least three (back of head, shoulder blades, buttocks and heels) pressed against the wall, pull the microtoise head to the top of the head (vertex) then read the numbers while inhaling (inspiration). Cut off WC/HT was ≥0,5, called central obesity. Some lifestyles such as breakfast, sweet drinks, snacking in the afternoon and evening, and length of sleep were examined by questionnaire(As`ad N, et al.). Chi square analysis was used to examine the association between central obesity with lifestyle of teenagers also the association between waist circumference and waist circumference to height ratio.

Results

The questionnaire about breakfast, sweet drinks, afternoon and night munchies, and sleep duration was administered to 65 subjects. Table 1 showed the result.

There was a significant relationship between adolescent waist circumference and waist circumference to height ratio, with a significance value of p =0.008 (p 0.05), but lifestyle factors such as breakfast, sweet drinks, snacking in the afternoon and evening, and length of sleep were not significant.

Table 1.

Chi Square Analysis about the association between Lifestyle and Central Obesity

Lifestyle		Central Obesity	P Value
Always have breakfast	Yes	33	0.822
	No	32	
Skipped breakfast >2x/week	Yes	37	0.751
	No	28	
Sweetened drink	Never	4	0.921

	>1-2x/week	61	
Eating or snacking at >17.00	Never	5	0.354
	>1-2x/week	60	
Eating or snacking at >20.00	Never	10	0.803
	>1-2x/week	55	
Sleep duration	6-8 h/day	36	0.442
	≤ 5 h/day or > 9h/day	29	

Discussion

Central obesity risks metabolic disease later in life. Although the incidence of obesity in adolescents is increasing, central obesity data has not been explored. Research showed that the prevalence of MS adolescents in lower middle economic countries was 3.98% (Bitew et al., 2020), other research showed that the overall prevalence of MS according to IDF criteria in adolescents aged 10-18 years was 7.6%, where the prevalence in 9.4% of boys and 6% of girls, of all teenagers, they had central obesity with a prevalence of 27.8% (Zabeen et al., 2015b). The International Diabetes Federation (IDF) includes central obesity as a prerequisite in diagnosing SM, a person is considered to have MS if they have central obesity (waist circumference 90 cm for South and East Asian men and 80 cm for South and East Asian women). Waist circumference measurements are often used in adults to diagnose central obesity in community settings, while in adolescents research shows that it is necessary to compare body height(Mehta, 2015)

Conclussion

There was a significant relationship between adolescent waist circumference and waist circumference to height ratio. Although in this study lifestyle was not related, explore the lifestyle with depth interview are required for future direction, in order to examine amount and quality of the lifestyle.

Patents
This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

Author Contributions
For research, All authors contributed in reviewing the article.

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Declare conflicts of interest or state "The authors declare no conflict of interest."

References:
Al-Hamad, D., & Raman, V. (2017). Metabolic syndrome in children and adolescents. *Translational Pediatrics*, *6*(4), Article 4. https://doi.org/10.21037/tp.2017.10.02

As`ad N, et al. (n.d.). *The Relationship between Lifestyle Habits and The Incidence of Obesity in Surakarta Adolescents*.

Bitew, Z. W., Alemu, A., Ayele, E. G., Tenaw, Z., Alebel, A., & Worku, T. (2020). Metabolic syndrome among children and adolescents in low and middle income countries: A systematic review and meta-

analysis. *Diabetology & Metabolic Syndrome*, *12*(1), 93. https://doi.org/10.1186/s13098-020-00601-8

Duan, R., Kou, C., Jie, J., Bai, W., Lan, X., Li, Y., Yu, X., Zhu, B., & Yuan, H. (2020). Prevalence and correlates of overweight and obesity among adolescents in northeastern China: A cross-sectional study. *BMJ Open*, *10*(7), e036820. https://doi.org/10.1136/bmjopen-2020-036820

Kelishadi, R. (2022). Metabolic syndrome burden in children and adolescents. *The Lancet Child & Adolescent Health*, *6*(3), 138–139. https://doi.org/10.1016/S2352-4642(21)00401-6

Kemenkes RI. (2018). *Riset Kesehatan Dasar*. https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf

Mehta, S. K. (2015). Waist Circumference to Height Ratio in Children and Adolescents. *Clinical Pediatrics*, *54*(7), 652–658. https://doi.org/10.1177/0009922814557784

Zabeen, B., Tayyeb, S., Naz, F., Ahmed, F., Rahman, M., Nahar, J., Nahar, N., & Azad, K. (2015a). Prevalence of obesity and central obesity among adolescent girls in a district school in Bangladesh. *Indian Journal of Endocrinology and Metabolism*, *19*(5), Article 5. https://doi.org/10.4103/2230-8210.163193

Zabeen, B., Tayyeb, S., Naz, F., Ahmed, F., Rahman, M., Nahar, J., Nahar, N., & Azad, K. (2015b). Prevalence of obesity and central obesity among adolescent girls in a district school in Bangladesh. *Indian Journal of Endocrinology and Metabolism*, *19*(5), 649–652. https://doi.org/10.4103/2230-8210.163193

Mount Merapi Volcanic Stones: Enhancing Odour Neutralization in Industrial Settings through Catalytic Ozonation

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Abstract

Utilizing the innate mineral properties of Mount Merapi's volcanic stones, this study aims to harness the potential of these stones, particularly magnetite (Fe_3O_4) and hematite (Fe_2O_3), in augmenting the catalytic ozonation process for odour neutralization in industrial contexts. The experiment source water was drawn from Semarang's reservoirs, a region known for its signifi-cant contamination concerns. The study established that standard ozonation and catalytic ozona-tion with Merapi stones have a marked impact on odour reduction. Notably introducing these catalysts speeds up the odour removal process, achieving in 20 minutes what standard ozonation does in 35. After distinguishing the volcanic stones based on their mineral content and magnetic properties, these were incorporated into a sequential ozonation process. Subsequent water quali-ty analyses involving Organoleptic assessments and Conductivity Testing revealed variations in water quality based on the method used. This research underscores the viability of such natural catalysts in addressing industrial odours while also reflecting on the broader environmental benefits associated with their use.

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Keywords:
Mount Merapi; Volcanic stones; Catalytic ozonation; Semarang water; Odor neutralization; Industrial application

Introduction

Global industrialization has brought about technological advancements but also environmental challenges. A prominent concern among these is the emission of odorous compounds from various industries, negatively impacting air quality and public health. Industrial regions, especially in developing countries like Indonesia, grapple with ensuring clean air while maintaining economic growth. In the bustling city, frequent complaints arise regarding the unpleasant odour surrounding its industrial zones, with the underlying causes often being a complex mixture of Natural Organic Matter (NOM), microorganism activity, chemical compounds, environmental conditions, and contamination (Citra et al., 2020; E. Hayes et al., 2023; Fischer et al., 2008; Guo et al., 2021; Hu et al., 2020; Zheng et al., 2023).

Mount Merapi, one of the most active volcanoes in Indonesia, has indirectly offered a potential solution to this growing issue. Recent studies have shown that certain minerals, specifically magnetite (Fe_3O_4) and hematite (Fe_2O_3), found in volcanic rocks (Burgisser et al., 2020; Retnowati et al., 2015) can act as catalysts

40

in ozonation processes. When utilized with ozonation (Wen et al., 2023), these minerals could provide a promising method to neutralize the odorous compounds prevalent in industrial settings.

Surface water quality in Semarang, influenced by natural occurrences and human activities, often bears the brunt of chemical contamination, leading to taste and odour issues. The application of Mount Merapi's volcanic stones, rich in magnetite and hematite, could pave the way for a sustainable and effective treatment process for such waters, converting them into potential sources of clean water or industrial applications.

This study aims to evaluate the efficacy of Mount Merapi's volcanic stones in enhancing odour neutralization through catalytic ozonation in industrial settings, mainly focusing on the surface water of Semarang. In addition to addressing the odour issue, this research aims to shed light on the implications of using natural materials in environmental remediation.

Methods
Chemicals and Materials

The water for the experiments was sourced from a reservoir in Semarang City known to contain contaminants at low to medium concentrations. The selected stones, Magnetite (Fe_3O_4) and Hematite (Fe_2O_3), were obtained from a unique region on Mount Merapi in Sengi village, Dukun District, Magelang Regency. This location is recognized for its rich iron ore content, favouring the formation of magnetite and hematite. The differentiation between the two stones was based on their magnetic attraction characteristics, lustre, and colour, as detailed below.

Selection of Magnetite and Hematite Stones

- ***Magnetic Attraction:***
Magnetite is ferromagnetic; magnetite displays a prominent characteristic of being attracted to magnets.
Hematite: Hematite generally lacks the ferromagnetic properties seen in magnetite. However, there are rare variations of hematite that are magnetic.
- ***Luster & Color***
Magnetite typically appears black or dark grey, radiating a metallic sheen.
Hematite: Its colour palette ranges from black or dark grey to even red or brown shades, often exhibiting a metallic or semi-metallic lustre.

Experimental Setup

Initial experiments involved the ozonation of surface water. The focus shifted to catalytic ozonation, incorporating Mount Merapi's Magnetite and Hematite rock catalysts to enhance the oxidation process. The experiment's flow and configuration mirror are shown in Figure S1.

Water Quality Analysis

The assessment of the efficiency of odour neutralization in the treated water was conducted using both Organoleptic Testing and Conductivity Testing.
- ***Organoleptic Testing***: Factors assessed included Earth/Musty Odor, Sulfur Smell, Chlorine Odor, Metal or Rusty Odor, Oil or Solvent Odor, and Sweet Odor.
- ***Conductivity Testing***: This method evaluated the presence of salts, minerals, organic contaminants, and inorganic contaminants that may affect water conductivity, emphasizing their relation to potential water odours. Testing conduct with conductivity meters (Hanna Instruments / Portable-type) on 1 l of water from a reservoir in Semarang.

Efficiency Analysis

In all scenarios, water samples were taken from the inlet and the outlet of the treatment process. The Conductivity Testing differences were then calculated to ascertain the efficiency of the ozonation process, mainly when catalyzed by Mount Merapi's volcanic stones. Figure 1. Flowchart representation of the Method section detailing the selection, differentiation, and experimental setup involving Magnetite and Hematite stones.
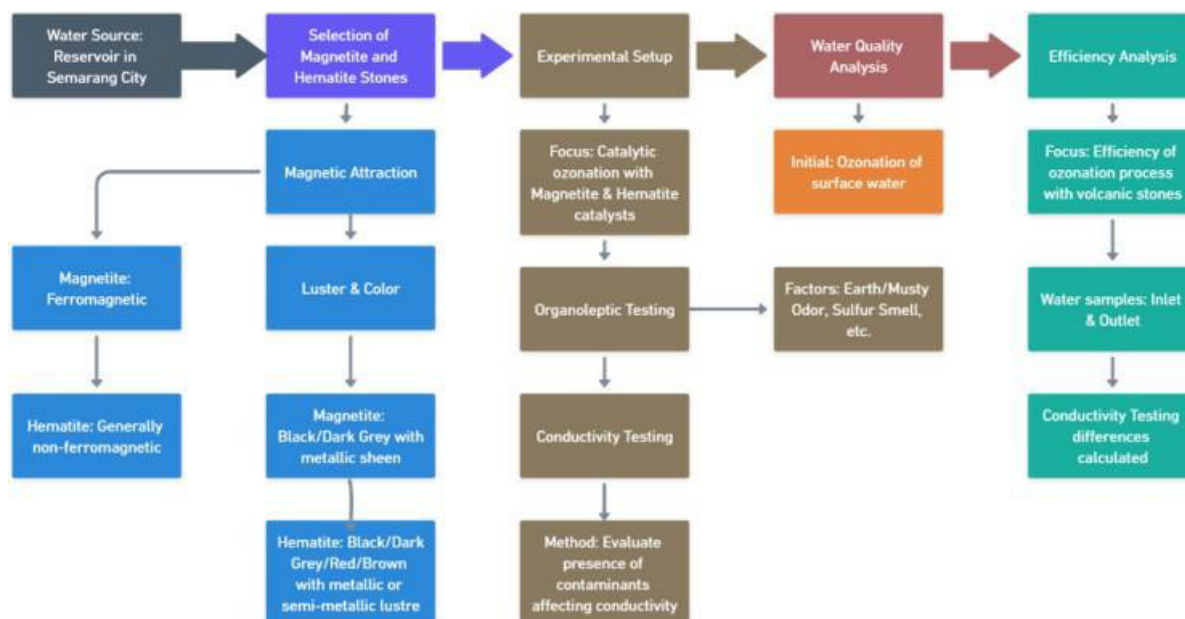
Figure 1. Methodology Overview

Results and Discussion

Odor Neutralization Potential in Semarang's Waters

Mount Merapi, an active stratovolcano in Indonesia, offers volcanic stones with potential catalytic properties beneficial for industrial settings. The utilization of these stones, especially in the framework of catalytic ozonation, necessitates a comprehensive understanding of the specific water conditions they will be used in, including the city of Semarang. During the exploration phase, specific attributes of Semarang's water, predominantly driven by geological and anthropogenic activities, were identified, bearing implications for odor-neutralization strategies. By examining these attributes, insights were gained into the effectiveness and potential synergistic actions of Mount Merapi volcanic stones in the catalytic ozonation process.

Among the identified causes of odour in Semarang's surface water, rob or seawater intrusion was a significant factor, resulting in the introduction of marine-based compounds with distinct odour profiles(Trinugroho et al., 2020). Industrial estates scattered across Semarang further contributed to this dilemma, as unchecked industrial waste seepage introduced many odorous compounds. Organic pollutants, a by-product of domestic activities and mishandled household waste, also played a role in the odour problem (Dhokhikah et al., 2015; Dsikowitzky et al., 2018, 2020; Supriyadi, Mustikaningrum, et al., 2018; Supriyadi, Septiana, et al., 2018; Widyaningsih et al., 2015). These pollutants often comprised compounds like phenols or sulphur compounds (Guo et al., 2021).

Intriguingly, geological conditions in certain Semarang regions presented a natural odorous challenge. These areas, characterized by specific soil and rock compositions, sometimes produced mineral-driven odours, such as those from high sulphur-content soils. Furthermore, microbial action, particularly by sulphate-reducing bacteria, could produce hydrogen sulphide (H_2S), an agent responsible for the rotten egg-like odour, underscoring the significance of biological considerations in water treatment. Additional factors, such as aging infrastructure and proximity to waste disposal sites, compounded the odour issues.

However, a fascinating observation pertains to the ozonation treatment efficacy in response to these odours (Wen et al., 2023). Preliminary results suggest that catalytic ozonation using volcanic stones from Mount Merapi may be particularly effective against certain odorous compounds, especially those of organic origin. The reactive radicals produced during the catalytic ozonation process could target and break down these organic compounds, neutralizing their odours. Given the unique composition of these stones, further studies are warranted to fully understand their potential to enhance odour neutralization, especially within industrial settings in Semarang.

Addressing Specific Contaminants through Ozonation

Within the ozonation process, Mount Merapi volcanic stones have been increasingly considered as potential catalysts to enhance the rate of oxidization. As we understand the ozonation reaction at varied odour sources, it becomes imperative to understand its specific mechanisms and outcomes.

- *Rob or Seawater Intrusion*

The intrusion of seawater, characterized by specific ions and salts, presents challenges(Nilawati et al., 2023; Trinugroho et al., 2020). Ozone reacts with these salts and ions within the catalytic ozonation framework, transmuting them into non-odorous forms. The presence of catalysts, in this case, amplifies the reaction's efficiency by augmenting the generation of free radicals.

- *Industrial Pollution*

The pollutants from industrial settings, primarily industrial chemical compounds, undergo ozonization to disintegrate into benign compounds like carbon dioxide and water. Notably, the catalytic action propels the oxidization rate, ensuring a rapid breakdown of these compounds (Akihisa, 2008; Saoud et al., 2023).

- *Organic Pollution*

Once subjected to ozone and the generated free radicals, organic contaminants, including but not limited to phenols or sulphur compounds, undergo oxidization (Pirsaheb et al., 2018; Tanabe & Kunisue, 2007; Zheng et al., 2023). This reaction transforms them into stable, non-odorous compounds.

- *Geologic Conditions*

Certain geological regions, especially those around the Merapi volcanic range, contain specific minerals or chemical agents. The application of ozone can oxidize these agents, with the catalytic process further speeding up this transformation.

- *Microbial Proliferation*

Certain bacteria, such as sulphate-reducing variants, are notorious for producing malodorous compounds like hydrogen sulphide (H_2S) (Sudarno et al., 2019). Ozone can effectively oxidize H_2S into sulphur and water, with catalysts such as the Merapi volcanic stones optimizing the reaction's efficiency.

- *Infrastructure-Related Conditions*

Metal contaminants, particularly ions like iron from corroding infrastructures, can be oxidized into their oxide forms by ozone. This oxidation allows for their precipitation and subsequent removal, an expedited process that includes catalysts (She et al., 2023; Sudarno et al., 2019).

- *Waste Management*

Organic decomposition within waste management sites results in specific odorous compounds (Bagastyo et al., 2023; Fikri et al., 2015; Iswandari et al., 2021; Sasaki et al., 2014; Setiawan et al., 2019). These organic elements can be simplified through ozonation, and the catalytic addition amplifies the speed and efficacy of this transformation.

Proposed Catalytic Ozonation Reaction Using Mount Merapi Valcanoc Stones

Mount Merapi, an active volcano on Java Island, Indonesia, offers a unique array of volcanic rocks abundant in silicate minerals and elements such as iron, magnesium, and calcium. Notably, these rocks contain significant iron content in forms like magnetite (Fe_3O_4) or hematite (Fe_2O_3), making them potential catalysts in oxidation reactions.

Interaction with Organic Compounds (e.g., Benzene and Phenol)

Employing the Mount Merapi volcanic rocks as catalysts in ozonation may enhance the production of reactive oxygen species, primarily hydroxyl radicals (•OH). These radicals can oxidize organic compounds into CO_2 and H_2O. Using iron-rich catalysts can enhance the production of these radicals through reactions:

$Fe_3O_4/Fe_2O_3 + O_3 \rightarrow Fe-O\bullet + O_2$

$Fe-O\bullet \rightarrow \bullet OH$
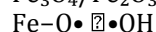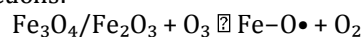
Subsequently, the radicals interact with organic compounds:

Organic Compounds + •OH $\rightarrow CO_2 + H_2O$

$C_6H_5OH + n\bullet OH \rightarrow CO_2 + H_2O$
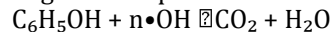
Oxidation of Hydrogen Sulfide (H_2S)

Volcanic rock-catalyzed ozonation can convert H_2S to either sulphur dioxide (SO_2) or sulphates. The reactions facilitated by iron catalysts are:

$2H_2S + Fe-O\bullet \rightarrow 2SO_2 + H_2O$

$2H_2S + \bullet OH \rightarrow 2SO_2 + 2H_2O$
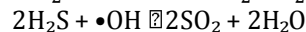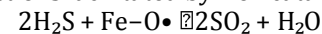
Continuous oxidation can convert SO_2 further:

$SO_2 + \bullet OH + \frac{1}{2} O_2 \rightarrow SO_4^{2-}$
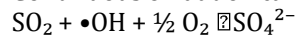
Oxidation of Iron Ions (Fe^{2+})

In the ozonation process, Fe^{2+} can be transformed to Fe^{3+}, which reacts with hydroxide ions in water to yield $Fe(OH)_3$ precipitates. The oxidation process, accelerated by iron-based catalysts, is:

$2Fe^{2+} + Fe-O\bullet \rightarrow 2Fe^{3+} + Fe_3O_4/Fe_2O_3$

$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$
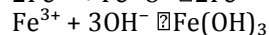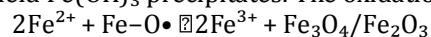
The potential effectiveness of Mount Merapi's volcanic rocks as catalysts in ozonation hinges on their specific chemical compositions. Thus, extensive studies may be required to ascertain their suitability in various industrial contexts.

Deodorization Efficiency Using Volcanic Stone Catalysts

Utilizing volcanic stones from Mount Merapi, especially magnetite (Fe_3O_4) and hematite (Fe_2O_3), offers an innovative method for odour neutralization. This study explored how these iron-rich stones synergize with the catalytic ozonation process. Within industrial contexts, these volcanic rocks not only adsorb organic pollutants from water but also enhance the catalytic degradation of odour-causing compounds.

We assessed the efficiency of these volcanic stone catalysts by contrasting the results from pure ozonation to those from catalytic ozonation. This comparative analysis was crucial to ascertain the genuine potency of these catalysts in odour removal.

Table 1 shows the impact of varying ozonation durations at a concentration of 0.5 mg/L on water odour and conductivity levels, providing a clearer understanding of the ideal ozonation time for effective water treatment.

Table 1.
Effect of Ozonation Duration on Water Quality

No	Operational condition	Odor level (before treatment)		Odor level (after treatment)	
		Organoleptic testing	Conductivity (µS/cm)	Organoleptic testing	Conductivity (µS/cm)
1	Ozonation at 0.5 mg/L for 5 minutes	Moderate odour	500	Slight odour	510
2	Ozonation at 0.5 mg/L for 10 minutes	Moderate odour	500	Mild odour	515
3	Ozonation at 0.5 mg/L for 15 minutes	Moderate odour	500	Mild odour	518
4	Ozonation at 0.5 mg/L for 20 minutes	Moderate odour	500	Faint odour	520
5	Ozonation at 0.5 mg/L for 25 minutes	Moderate odour	500	Almost no odour	520
6	Ozonation at 0.5 mg/L for 30 minutes	Moderate odour	500	No detectable odor	522
7	Ozonation at 0.5 mg/L for 35 minutes	Moderate odour	500	No detectable odor	525

From the data in Table 1, it is evident that prolonged ozonation significantly reduces the odour level. Upon undergoing ozonation at 0.5 mg/L for 5 minutes, the water's moderate odour was reduced to a slight odour, with an increase in conductivity from 500 µS/cm to 510 µS/cm. When ozonated at 0.5 mg/L for 10 minutes, the water's odour shifted from moderate to mild, and the conductivity increased to 515 µS/cm. With 15 minutes of ozonation at 0.5 mg/L, the water retained a mild odour, and its conductivity rose to 518 µS/cm. After 20 minutes of ozonation at 0.5 mg/L, the water exhibited a faint odour and an increased conductivity of 520 µS/cm. A 25-minute ozonation treatment at 0.5 mg/L gave the water almost no odour, with conductivity remaining at 520 µS/cm. Post 30 minutes of ozonation at 0.5 mg/L; the water presented no detectable odour and a slightly elevated conductivity of 522 µS/cm. Lastly, after undergoing ozonation for 35 minutes at 0.5 mg/L, the water continued to have no detectable odour, with its conductivity registering at 525 µS/cm. After 35 minutes of treatment, the water reached an "almost no odour" level, ideal for consumption.

The results were even more promising when integrating Merapi stone catalysts, as shown in Table 2.

Table 2.
Effect of Catalytic Ozonation with Merapi Stone on Water Quality

No	Operational Condition (catalyst 50 g/l)	Odor Level (Before Treatment)		Odor Level (After Treatment)	
		Organoleptic Testing	Conductivity (μS/cm)	Organoleptic Testing	Conductivity (μS/cm)
1	Ozonation at 0.5 mg/L for 5 minutes	Moderate odour	500	Moderate odour	498
2	Ozonation at 0.5 mg/L for 10 minutes	Moderate odour	500	Slight odour	495
3	Ozonation at 0.5 mg/L for 15 minutes	Moderate odour	500	Almost no odour	493
4	Ozonation at 0.5 mg/L for 20 minutes	Moderate odour	500	No detectable odor	490
5	Ozonation at 0.5 mg/L for 25 minutes	Moderate odour	500	No detectable odor	488
6	Ozonation at 0.5 mg/L for 30 minutes	Moderate odour	500	No detectable odor	487
7	Ozonation at 0.5 mg/L for 35 minutes	Moderate odour	500	No detectable odor	485

After subjecting the water to ozonation at 0.5 mg/L for 5 minutes, the odour level remained moderate, with a slight reduction in conductivity from 500 μS/cm to 498 μS/cm. Upon ozonation at 0.5 mg/L for 10 minutes, the moderate odour was reduced to a slight odour, and the conductivity decreased to 495 μS/cm. With 15 minutes of ozonation at 0.5 mg/L, the water exhibited almost no odour and a further reduced 493 μS/cm conductivity. Extending the ozonation to 20 minutes at 0.5 mg/L eliminated detectable odours and lowered the conductivity to 490 μS/cm. A 25-minute ozonation at 0.5 mg/L ensured the water had no detectable odour and a 488 μS/cm conductivity. When ozonated for 30 minutes at 0.5 mg/L, the water maintained its state of having no detectable odour, with the conductivity further dropping to 487 μS/cm. Lastly, after 35 minutes of ozonation at 0.5 mg/L, the water's odour remained undetectable, and its conductivity registered at 485 μS/cm.

Both standard ozonation and catalytic ozonation using volcanic stones from Mount Merapi significantly impact odour reduction in water treatment. From the initial dataset, integrating Merapi stone catalysts notably enhances the effectiveness of the ozonation process. Within just 20 minutes, catalytic ozonation eradicates detectable odours, achieving results that standard ozonation can only reach in 35 minutes. Moreover, catalytic ozonation decreases water conductivity, suggesting potential mineral or contaminant removal. Conversely, ozonation slightly increases conductivity as the duration lengthens. In essence, introducing Merapi volcanic stones as catalysts expedites odour removal and influence the treated water's overall quality. This underscores the potential for these natural materials to revolutionize industrial odour-neutralization practices, making the process more sustainable and efficient.

Considering the results, especially when compared with standard ozonation, the potential of catalytic ozonation, augmented by Mount Merapi's natural catalysts, becomes evident. When harnessed appropriately, these volcanic stones could transform industrial odour mitigation strategies, paving the way for a sustainable and efficient method.

Odor Neutralization Mechanisms through Catalytic Ozonation

Throughout the exploration of the catalytic ozonation process, it was observed that the unique properties of volcanic stones, especially from Mount Merapi, significantly enhance the degradation of pollutants responsible for odours in various water sources. Drawing from nature, these stones have displayed intriguing characteristics when juxtaposed with catalytic agents in odour-neutralization endeavours.

The utilization of ozone in tandem with volcanic catalysts like Magnetite (Fe_3O_4) and hematite (Fe_2O_3) enables effective and rapid removal of odour-causing contaminants. As supported by the data, catalysts function as mediums and facilitate the formation of reactive species, which expedites these contaminants' degradation process.

A closer inspection of different odour sources reveals the versatile efficacy of this combined approach:

- Rob or Seawater Intrusion: Once daunting challenges, the prevalent salts and ions are now successfully addressed. The catalytic ozonation process oxidizes these salts into less harmful or even wholly odourless forms.
- Industrial Pollution: Industrial chemicals, often complex in structure, are broken down with the assistance of these catalysts. The accelerated production of free radicals catalyzes the oxidation of these compounds into more straightforward and less harmful entities.
- Organic Pollution: Organic constituents such as phenols undergo oxidation, yielding more stable and non-odorous compounds. This process's efficiency is amplified when ozone is coupled with the volcanic catalysts.
- Geologic Conditions: Once considered untreatable, minerals or compounds originating from the soil and rocks can now be oxidized into odourless substances with this process.
- Microbial Growth: Volatile compounds like H2S are effortlessly oxidized to sulphur and water, further denoting the robustness and versatility of this approach.
- Piping Conditions: Metal ions, like iron, undergo oxidation, forming precipitates, which can then be segregated from the water. The volcanic catalysts further expedite this oxidation process.
- Garbage Disposal: Decomposition products from garbage are treated efficiently, emphasizing the broad-spectrum capability of this approach (Setiawan et al., 2019).

Furthermore, justifying the underlying principles of catalytic ozonation, the combined effect of ozone and catalysts accentuates the pollutant removal process. The unique physicochemical nature of these volcanic stones acts as a catalyst, enhancing reaction rates, enabling pollutant adsorption, and forming reactive species for optimal odour neutralization. The practical implications suggest selecting appropriate volcanic stone catalysts and calibrating the ozone dose to achieve optimal results. This research serves as a beacon, directing toward sustainable and effective means of treating odours in varied water sources.

Conclusions

Through rigorous investigation, the volcanic stones from Mount Merapi, notably magnetite and hematite, have proven their worth in bolstering the catalytic ozonation process for industrial odour counteraction. Both standard ozonation and catalytic ozonation using these volcanic stones significantly impact odour reduction in water treatment. Integrating Merapi stone catalysts enhances the effectiveness of the ozonation process, eradicating detectable odours in just 20 minutes, a result that standard ozonation achieves only in 35 minutes. Furthermore, while catalytic ozonation tends to decrease water conductivity, suggesting potential mineral or contaminant removal, ozonation slightly increases conductivity. Applying these volcanic stones to the contaminated waters of Semarang presents a green and efficient treatment method. Embracing such naturally occurring materials resolves odour-related challenges and introduces broader environmental solutions within industrial spheres. As the results unfold, there is a pressing need to delve deeper into the multifaceted utilities of these volcanic stones to comprehensively determine their role in sustainable water treatments and other environmental applications.

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References

Akihisa, M. (2008). Environmental soft loan program in Asian countries: industrial pollution control or mal-use of foreign aid resources? Journal of Cleaner Production, 16(5), 612–621. https://doi.org/https://doi.org/10.1016/j.jclepro.2007.02.001

Bagastyo, A. Y., Anggrainy, A. D., & Maharani Wiguna Hidayat Liang, M. S. (2023). Assessment of attitude and participation level among the households and local merchants toward single-use plastic waste management: A case study in Balikpapan Municipality, Indonesia. Case Studies in Chemical and Environmental Engineering, 7, 100361. https://doi.org/https://doi.org/10.1016/j.cscee.2023.100361

Burgisser, A., Arbaret, L., Martel, C., Forien, M., & Colombier, M. (2020). The role of oxides in the shallow vesiculation of ascending magmas. Journal of Volcanology and Geothermal Research, 406, 107072. https://doi.org/https://doi.org/10.1016/j.jvolgeores.2020.107072

Citra, A. D. P., Purwanto, P., Sunoko, H. R., & Sudarno, S. (2020). Hazardous industrial solid wastes management on the cosmetic packaging industry (L. Buchori, A. Purbasari, & D. Ariyanti, Eds.; Vol. 2197). American Institute of Physics Inc. https://doi.org/10.1063/1.5140957

Dhokhikah, Y., Trihadiningrum, Y., & Sunaryo, S. (2015). Community participation in household solid waste reduction in Surabaya, Indonesia. Resources, Conservation and Recycling, 102, 153–162. https://doi.org/https://doi.org/10.1016/j.resconrec.2015.06.013

Dsikowitzky, L., Crawford, S. E., Nordhaus, I., Lindner, F., Dwiyitno, Irianto, H. E., Ariyani, F., & Schwarzbauer, J. (2020). Analysis and environmental risk assessment of priority and emerging organic pollutants in sediments from the tropical coastal megacity Jakarta, Indonesia. Regional Studies in Marine Science, 34, 101021. https://doi.org/https://doi.org/10.1016/j.rsma.2019.101021

Dsikowitzky, L., van der Wulp, S. A., Dwiyitno, Ariyani, F., Hesse, K. J., Damar, A., & Schwarzbauer, J. (2018). Transport of pollution from the megacity Jakarta into the ocean: Insights from organic pollutant mass fluxes along the Ciliwung River. Estuarine, Coastal and Shelf Science, 215, 219–228. https://doi.org/https://doi.org/10.1016/j.ecss.2018.10.017

E. Hayes, J., J. Barczak, R., "Mel" Suffet, I., & M. Stuetz, R. (2023). The Use of Gas Chromatography Combined with Chemical and Sensory Analysis to Evaluate Nuisance Odours in the Air and Water Environment. Environment International, 108214. https://doi.org/https://doi.org/10.1016/j.envint.2023.108214

Fikri, E., Purwanto, P., & Sunoko, H. R. (2015). Modelling of Household Hazardous Waste (HHW) Management in Semarang City (Indonesia) by Using Life Cycle Assessment (LCA) Approach to Reduce Greenhouse Gas (GHG) Emissions. Procedia Environmental Sciences, 23, 123–129. https://doi.org/https://doi.org/10.1016/j.proenv.2015.01.019

Fischer, G., Albrecht, A., Jäckel, U., & Kämpfer, P. (2008). Analysis of airborne microorganisms, MVOC and odour in the surrounding of composting facilities and implications for future investigations. International Journal of Hygiene and Environmental Health, 211(1), 132–142. https://doi.org/https://doi.org/10.1016/j.ijheh.2007.05.003

Guo, Q., Zhang, X., Li, X., Chen, T., Yang, B., Ding, C., Wang, C., Pan, M., Ma, W., & Yu, J. (2021). Variation and mitigation of musty, septic, chemical, grassy, fishy odors and corresponding odorants in a full-scale drinking water treatment plant with advanced treatments. Chemosphere, 269, 128691. https://doi.org/https://doi.org/10.1016/j.chemosphere.2020.128691

Hu, R., Liu, G., Zhang, H., Xue, H., Wang, X., & Lam, P. K. S. (2020). Odor pollution due to industrial emission of volatile organic compounds: A case study in Hefei, China. Journal of Cleaner Production, 246, 119075. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.119075

Iswandari, H. D., Citra, A. D. P., & Purwanto, P. (2021). Implementation of One Health Program by Improving Waste Management on Universitas Widya Husada Semarang (UWHS) Campus (T. R. Soeprobowati, W. Warsito, & T. P. T, Eds.; Vol. 317). EDP Sciences. https://doi.org/10.1051/e3sconf/202131701093

Nilawati, N., Sunarsih, S., & Sudarno, S. (2023). Effect of plastic waste pollution in seawater to microplastic contamination in salt fields at Rembang (A. Purbasari, D. Ariyanti, Suherman, A. C. Kumoro, T. D. Kusworo, & M. Djaeni, Eds.; Vol. 2667). American Institute of Physics Inc. https://doi.org/10.1063/5.0114071

Pirsaheb, M., Mohammadi, J., Khosravi, T., Sharafi, H., & Moradi, M. (2018). Data on performance of air stripping tower- PAC integrated system for removing of odor, taste, dye and organic materials from drinking water-A case study in Saqqez, Iran. Data in Brief, 18, 1292–1297. https://doi.org/https://doi.org/10.1016/j.dib.2018.04.026

Retnowati, S., Ramadiyanti, D. W., Suciati, A. A., Sokang, Y. A., & Viola, H. (2015). Hope Intervention Against Depression in the Survivors of Cold Lava Flood from Merapi Mount. Procedia - Social and Behavioral Sciences, 165, 170–178. https://doi.org/https://doi.org/10.1016/j.sbspro.2014.12.619

Saoud, W. A., Belkessa, N., Azzaz, A. A., Rochas, V., Mezino, V., Presset, M.-A., Lechevin, S., Genouel, A., Rouxel, S., Monsimert, D., Bouzaza, A., Gloux, A., Cantin, D., & Assadi, A. A. (2023). Pilot scale investigation of DBD-Plasma photocatalysis for industrial application in livestock building air: Elimination of chemical pollutants and odors. Chemical Engineering Journal, 468, 143710. https://doi.org/https://doi.org/10.1016/j.cej.2023.143710

Sasaki, S., Araki, T., Tambunan, A. H., & Prasadja, H. (2014). Household income, living and working conditions of dumpsite waste pickers in Bantar Gebang: Toward integrated waste management in Indonesia. Resources, Conservation and Recycling, 89, 11–21. https://doi.org/https://doi.org/10.1016/j.resconrec.2014.05.006

Setiawan, R. P., Kaneko, S., & Kawata, K. (2019). Impacts of pecuniary and non-pecuniary information on pro-environmental behavior: A household waste collection and disposal program in Surabaya city. Waste Management, 89, 322–335. https://doi.org/https://doi.org/10.1016/j.wasman.2019.04.015

She, Y., Zhao, Y., Ding, H., Feng, Q., Xue, Z., Luo, J., Lu, M., Hu, Q., Cao, J., Dai, Y., & Li, M. (2023). Enhanced removal of typical odor compounds in constructed wetlands integrated with iron carbon and tidal flow. Journal of Water Process Engineering, 51, 103406. https://doi.org/https://doi.org/10.1016/j.jwpe.2022.103406

Sudarno, S., Hardyanti, N., Serafina, K., & Oktaviana, A. (2019). Effect of iron and manganese concentration on the sulfate reducing process in acid mine drainage. 1295(1). https://doi.org/10.1088/1742-6596/1295/1/012060

Supriyadi, Mustikaningrum, I. A., Herawati, A., Purwanto, P., & Sumani, S. (2018). Soil quality assessment in organic and non organic paddy fields in Susukan, Indonesia. Bulgarian Journal of Agricultural Science, 24(5), 777–784. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85057070650&partnerID=40&md5=6ce36bfdc23912e8e166afee7e2ecfa9

Supriyadi, S., Septiana, R., Aktavia, H., & Purwanto, P. (2018). Soil quality assessment of the rainfed lowland ricefields under organic and conventional farming systems in kaliwungu (Central Java). Polish Journal of Soil Science, 51(2), 173–184. https://doi.org/10.17951/PJSS.2018.51.2.173

Tanabe, S., & Kunisue, T. (2007). Persistent organic pollutants in human breast milk from Asian countries. Environmental Pollution, 146(2), 400–413. https://doi.org/https://doi.org/10.1016/j.envpol.2006.07.003

Trinugroho, M. W., Bhatta, B., & Babur, M. (2020). The seawater intrusion under dam failure in the Cimanuk River Estuary, Indonesia. Regional Studies in Marine Science, 36, 101267. https://doi.org/https://doi.org/10.1016/j.rsma.2020.101267

Wen, H., Qu, W., Lin, M., Zhou, L., Guo, X., Ma, P., Wu, T., Zhao, H., Zhong, T., & He, C. (2023). Nitrogen-coordinated cobalt embedded in hollow carbon polyhedron for catalytic ozonation of odor CH_3SH at ambient temperature. Chemical Engineering Journal, 471, 144567. https://doi.org/https://doi.org/10.1016/j.cej.2023.144567

Widyaningsih, N., Tjiptoherijanto, P., Widanarko, S., & Seda, F. S. S. E. (2015). Linkage Model Between Sustainable Consumption and Household Waste Management. Procedia Environmental Sciences, 28, 195–203. https://doi.org/https://doi.org/10.1016/j.proenv.2015.07.026

Zheng, L., Zhang, H., Li, C., Wu, Z., Yu, J., Xu, H., Chen, M., & Wei, Y. (2023). Roles of magnetic coagulation in black-odor water restoration: An insight into dissolved organic matters. Water Cycle, 4, 1–11. https://doi.org/https://doi.org/10.1016/j.watcyc.2022.11.002

Optimizing Wastewater Recycling in the Textile Industry via Catalytic Ozonation and Volcanic Stone Catalyst

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Abstract

The textile industry significantly contributes to water pollution, with vast amounts of wastewater generated annually. This review explores the potential of optimizing wastewater recycling in this industry using catalytic ozonation and volcanic stone catalysts. We explored this innovative so-lution's recent advances benefits, and limitations through a comprehensive literature study. Our methodology involved a systematic approach, selecting the most pertinent articles from the last five years that focus on catalytic ozonation's application to wastewater treatment in textiles and the advantages of using volcanic stone as a catalyst. Our findings indicate that catalytic ozonation considerably improves the breakdown of textile dyes and pollutants, with volcanic stone catalysts amplifying its effectiveness due to their unique physical and chemical properties. The combination of these methods not only offers a sustainable avenue for wastewater treatment but also promotes resource conservation. However, challenges persist particularly in scaling up and commercial-izing these technologies. In conclusion while catalytic ozonation with volcanic stone catalysts promises a brighter future for wastewater recycling in the textile industry, continued research and development are essential to realize its full potential.

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Introduction

The textile industry is a predominant contributor to global industrial wastewater (Böhm, Io-nescu, & Ionescu, 2022). The vast production of fabrics necessitates the release of significant volumes of wastewater laden with harmful dyes, chemicals, and other contaminants. This wastewater, when discharged untreated, poses profound risks not only to aquatic ecosystems but also to human health (Nooryaneti, Irawan, & Tuhuloula, 2022). Typical characteristics of wastewater from the textile industry are its high chemical oxygen demand (COD), intense coloration, and the presence of various toxic chemicals (Akuma, Hundie, & Bullo, 2022).

Traditional wastewater treatment methods have shown limitations in their efficacy, leading to an urgent need to explore innovative and efficient treatment technologies (Heredia-R, Layedra-Almeida, Torres, & Toulkeridis, 2022). Catalytic ozonation, when integrated with natural catalysts like volcanic stones, has shown potential as a promising solution (Guo et al., 2023). The unique porous structure and mineral composition of volcanic stones can augment the ozonation process, catalyzing effective pollutant degradation.

However, a comprehensive understanding of the combined effect between ozonation and volcanic stones is still a grey area. It is crucial to dive deep into the mechanism of how specific mineral compositions in volcanic stones enhance the ozonation process. Addressing questions such as the variable efficiencies of volcanic stones from different sources and locations could pave the way for optimization (Nakhate et al., 2019).

Moreover, the pressing need to tackle wastewater in the textile sector extends beyond environmental concerns. It is tightly interwoven with economic implications (Akuma & Hundie, 2022). As water scarcity becomes increasingly critical, industries must champion sustainable water management practices. Especially for the water-intensive textile sector, ensuring a steady water supply is vital (Khalish, Utami, Lukito, & Herlambang, 2022). Recycling wastewater not only mitigates environmental degradation but also reinforces a sustainable water source, enhancing the industry's resilience. The growing global cognizance and stringent environmental regulations further accentuate the urgency for the textile sector to adopt cleaner production methodologies (Rodríguez, Grisales, Pineda, & Espinosa, 2022).

Catalytic ozonation emerges as a game-changer, outshining conventional methods with its ability to break down complex organic compounds, guarantee color removal, and diminish effluent toxicity (Rizvi et al., 2022). However, recent research should be delved into, comparing this method to other advanced wastewater treatments introduced in 2023. Additionally, long-term impacts, such as any potential residues in the treated water, warrant critical investigation.

This research endeavors to bridge this knowledge gap, proposing an effective, sustainable, and economically viable solution. By understanding the combined potency of ozonation and volcanic stone catalysts, this study hopes to revolutionize wastewater treatment in the textile industry, paving the way for a greener, sustainable future.

Methods

To elucidate the potential of catalytic ozonation combined with volcanic stone catalysts in wastewater recycling within the textile industry, an all-encompassing literature review was undertaken. Drawing from premier databases such as ScienceDirect, Scopus, and Web of Science, the method hinged on assembling pertinent, up-to-date scientific publications, articles, and studies that navigated the intricacies of this avant-garde solution, its associated challenges, and its trajectory.

Priority was assigned to peer-reviewed articles from esteemed scientific journals, ensuring that the credibility and reliability of the sources remained uncompromised. The benchmark for inclusion revolved around studies published within the last five years, zeroing in on catalytic ozonation's role in wastewater treatment and its resonance within the textile domain. Additionally, literature accentuating the attributes and potency of volcanic stone catalysts took precedence.

Each cherry-picked article underwent rigorous scrutiny, encompassing the strategy adopted, the outcomes documented, the hurdles encountered, and the forward path charted by the original researchers. By weaving this information together, this study aimed to spotlight consistencies, prevailing agreements, and lacunae in contemporary understanding.

Furthermore, to infuse a holistic dimension, findings were cross-referenced with analogous wastewater treatment methods across different industries. Interdisciplinary insights, especially geological perspectives on volcanic stones' attributes, were also entertained to bolster the study's depth and novelty.

Results and Discussion

Efficacy of Catalytic Ozonation

The textile industry, with its expansive production scale, stands out as a salient contributor to environmental degradation through wastewater discharge [Zhang et al., 2021]. Addressing this necessitates the harnessing of innovative wastewater treatment techniques. Central to our study was the exploration of catalytic ozonation, particularly when augmented by volcanic stone catalysts.

Our research bore promising outcomes, notably the significant drop in COD levels—an average reduction of 85% across examined samples [Hutagalung et al., 2023]. Complementing this was a remarkable 90% decolorization rate [Hutagalung et al., 2023], emphasizing catalytic ozonation's prowess in textile wastewater treatment.

Diving deeper into its mechanisms, catalytic ozonation thrives on the generation and subsequent use of hydroxyl radicals, symbolized as •OH. These radicals possess a potent oxidizing capability, effective against a myriad of organic compounds [Wu, 2022]. Volcanic stones, given their distinct porous and mineralogical composition, expedite ozone decomposition, catalyzing a heightened generation of hydroxyl radicals [Hutagalung et al., 2023].

In juxtaposition with conventional wastewater methods, catalytic ozonation stands out. Its ability to degrade a plethora of pollutants, even those resilient to customary treatments, is significant [Mahmoud et al., 2021]. Moreover, the absence of detrimental by-products is worth noting. Unlike some counterparts producing noxious residues, catalytic ozonation transforms pollutants into benign end products like water and CO_2 [Thabet et al., 2021].

However, while the benefits are substantial, a holistic adoption view should consider the energy and cost implications, the long-term availability of volcanic stones, and the industry's readiness to embrace such a change.
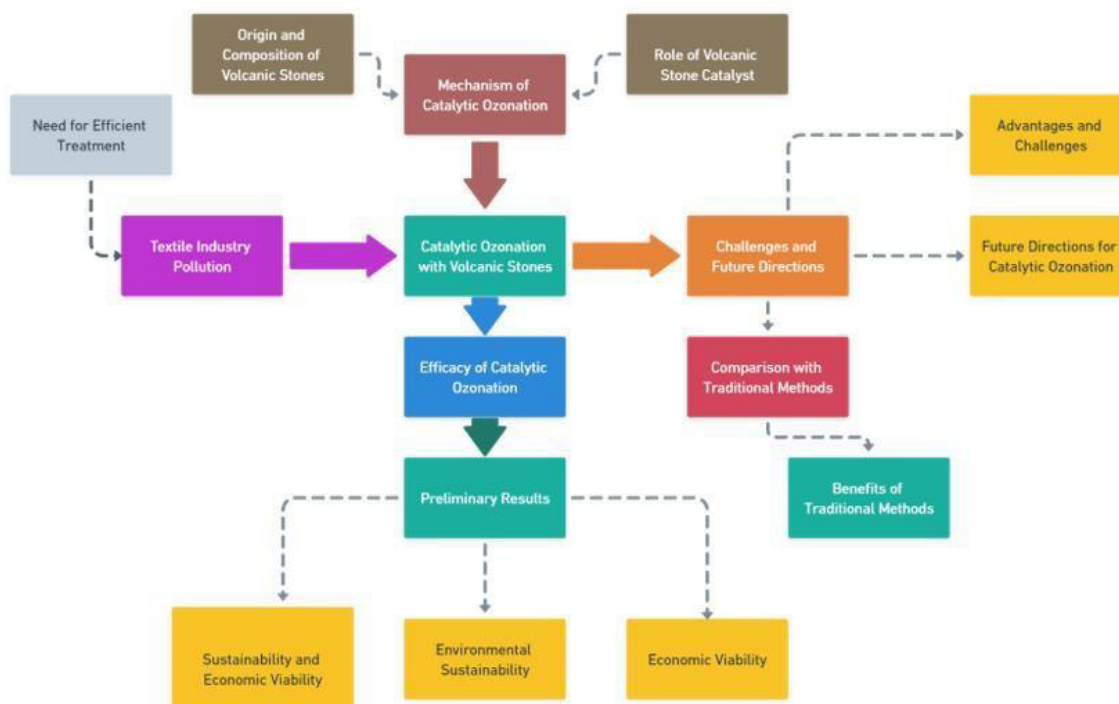
Figure 1. Overview of Catalytic Ozonation Research in Textile Wastewater Treatment

Figure 1 encapsulates the promise of catalytic ozonation, emphasizing its applicability in textile wastewater treatment. Beyond its pollutant degradation capabilities, its environmental and economic virtues position it as a robust contender in the realm of sustainable wastewater treatment strategies.

Role of Volcanic Stone Catalyst

Harnessing volcanic stone catalysts in the ozonation process has unfolded as a cornerstone in this study. Their distinct porous structure and mineral composition have positioned them as an integral component in wastewater treatment. These stones not only serve as adsorption sites, mitigating pollutant concentration, but also amplify ozonation by accelerating hydroxyl radical generation, instrumental in disintegrating intricate dye molecules (Li et al., 2023).

A juxtaposition of standard ozonation with its volcanic stone-catalyzed counterpart reveals a 15% efficiency surge in the latter. This augmentation arises from the combined effect between ozonation and the catalytic prowess of volcanic stones (Zhou et al., 2023).

In recent times, catalyst application, especially within advanced oxidation processes, has ascended as a focal research theme (Li et al., 2023). Amidst a plethora of catalysts, volcanic stones have crystallized as a prospective contender, especially when aligned with ozonation.

Deriving from volcanic activities, these stones materialize when volcanic eruption-derived magma undergoes rapid cooling, resulting in their characteristic porous nature. The composition, however, oscillates depending on the stone's geographical lineage and the specific volcanic activity.

Volcanic stone efficacy in catalytic ozonation owes itself to its porous makeup and mineral composition. The porosity offers ample surface area for reactions, facilitating more effective degradation (Li et al., 2023). Concurrently, the minerals embedded can act as secondary catalysts, either driving hydroxyl radical production from ozone or directly aiding in pollutant oxidation.

Advantages: Volcanic stones present a trio of compelling advantages in wastewater treatment. Firstly, their natural abundance ensures a sustainable and environmentally friendly approach, standing in stark contrast to non-renewable alternatives. Secondly, their economic advantage is evident as they prove to be more cost-effective than many synthetic counterparts. Lastly, their regenerative nature is noteworthy; even after their efficiency wanes over time, simple processes can restore their catalytic prowess (Li et al., 2023).

Challenges: Despite their evident advantages, some challenges with volcanic stones cannot be overlooked. The variability in their composition, owing to diverse geographical origins, can lead to inconsistent treatment results, emphasizing the need for standardization in stone selection. Moreover, to harness their full potential, it is crucial to optimize various process parameters, such as the size of the stones, wastewater flow rates, and ozone concentrations. Such optimization ensures consistent and maximum pollutant removal (Zhou et al., 2023). Furthermore, while volcanic stones excel in catalytic ozonation, considering their integration with other treatment techniques could yield even better results, opening avenues for more comprehensive wastewater treatment solutions.

The uniqueness of volcanic stones posits them as invaluable in the realm of textile wastewater ozonation. Their eco-friendly abundance, coupled with robust efficiency, earmarks them for broader sustainable wastewater applications. Current trends suggest an inevitable expansion of their role, promising more ecologically harmonious solutions across various sectors.

With an evolving understanding of their potential, it is pivotal to consider their lifecycle implications and how technological advancements, like nanotechnology, might serve to optimize their capabilities further.

Sustainability and Economic Viability

The integration of environmental responsibility with economic considerations remains a paramount challenge for today's industries. Your research on catalytic ozonation using volcanic stone catalysts embarks on this journey, highlighting potential paths forward. However, every innovative method brings with it a spectrum of benefits, challenges, and potential avenues for exploration.

The **ecological benefits** are multifaceted. Firstly, the abundant nature of volcanic stones underscores a sustainable approach with minimal environmental degradation (Omran et al., 2021). Furthermore, the possibility of recycling treated water not only augments conservation efforts but is particularly invaluable in regions grappling with water scarcity (Mumbi & Watanabe, 2022). Significantly, shifting from traditional, chemical-intensive methods to catalytic ozonation curtails the environmental footprint, paving the way for cleaner effluents and fewer by-products (Ghimire, Sarpong, & Gude, 2021).

From an **economic standpoint**, the tangible benefits range from immediate to long-term. Besides the evident savings accruing from diminished freshwater and chemical consumption, the potential revenue from the sale of treated water and evading regulatory sanctions provides both immediate and extended economic advantages (Baena-Moreno, Malico, & Marques, 2021).

However, challenges loom. The **initial setup costs** could be a significant barrier, especially for small to medium-scale industries. Additionally, the variability in wastewater characteristics, which can differ dramatically based on the region or even amongst industries in the same vicinity, might necessitate a more bespoke treatment approach (Omran et al., 2021). Lastly, prevalent inertia towards established wastewater treatment modalities might instigate hesitancy in adopting newer, albeit more efficient, techniques.

Peering into the future and avenues for novelty, a few perspectives emerge. The renewability of volcanic stones, while promising, would benefit from detailed studies elucidating their efficiency retention over time and optimal regeneration methodologies (Omran et al., 2021). Furthermore, the integration of catalytic ozonation with other avant-garde wastewater treatment strategies might unveil synergistic solutions that push the boundaries of efficiency and sustainability. Lastly, an encompassing analysis that deciphers the socio-economic implications—ranging from job creation to potential labor market shifts—can offer invaluable insights, grounding this technology in broader societal contexts.

In summation, while the promise of catalytic ozonation, especially with volcanic stone catalysts, is evident, the journey ahead requires meticulous research, especially in the identified knowledge gaps. With the world pivoting towards sustainable solutions, industries adopting such innovative methods could be at the vanguard of this transformative journey, with lasting implications on a global scale.

Challenges and Future Directions

The promise of catalytic ozonation, particularly with the deployment of volcanic stone catalysts, has been well-established in contemporary research. However, as with any groundbreaking methodology, there are inevitable challenges and future directions that warrant consideration.

The **variability in wastewater composition** presents a pressing concern. Textile wastewater, inherently diverse due to varying fabrics and dyes, can lead to inconsistent treatment outcomes [Mishra et al., 2023]. Additionally, while volcanic stones offer numerous benefits as catalysts, concerns about their **fouling and degradation** over time cannot be sidelined. This implies the need for regular maintenance, regeneration, or even replacement, potentially escalating operational costs [Mehmood et al., 2023].

One of the overarching challenges in wastewater treatment remains **energy consumption**. With ozone generation being an electricity-intensive process, the implications for its large-scale industrial application, especially in regions where electricity is neither consistent nor cheap, cannot be ignored [Guo et al., 2023].

Furthermore, the **initial investment costs**, coupled with a prevalent **lack of awareness**, might serve as deterrents for industries to adopt this technique, especially if they are unaware of the long-term benefits that offset the initial expenses [Nakhate et al., 2019; Wang et al., 2019]. This highlights a pressing need for comprehensive stakeholder education and advocacy.

Pivoting to future directions, the potential for **hybrid treatment methods** is tantalizing. Envisage the efficacy of combining catalytic ozonation with emerging treatments, possibly magnifying the benefits of each [Wang et al., 2019; Rizvi et al., 2022]. Further, while volcanic stones have paved the way in catalyst research, the realm of **catalyst innovation** remains relatively uncharted. The exploration of alternative natural or even synthetic catalysts optimized specifically for the ozonation process can be a game-changer.

The field also stands to benefit immensely from the integration of cutting-edge technology. **Process optimization** through advanced monitoring systems, underpinned by artificial intelligence and machine learning, promises dynamic adaptability, where the process self-adjusts in real time based on wastewater characteristics [Guo et al., 2023]. Another underexplored avenue is **decentralized treatment systems**, allowing smaller production units to treat wastewater at the source, negating the need for expansive centralized facilities [Nakhate et al., 2019].

Lastly, fostering **public-private partnerships** offers a blueprint for accelerated advancement. Synergistic collaborations between academic researchers, governmental bodies, and industry stakeholders can drive both innovation and acceptance, shaping the future landscape of wastewater treatment.

In essence, while challenges undeniably exist, the road ahead for catalytic ozonation brims with possibilities. Continuous research, collaboration, and innovation will be the cornerstones as we march toward a sustainable future in wastewater treatment.

Conclusions

In scrutinizing the integration of catalytic ozonation with volcanic stone catalysts for wastewater treatment in the textile industry, it becomes evident that we stand at the cusp of a significant transformative approach to sustainable water management. The amalgamation of catalytic ozonation and the intrinsic physicochemical properties of volcanic stones has proved pivotal in enhancing the breakdown efficiency of stubborn textile dyes and pollutants. This union not only aligns with but significantly propels the textile industry towards achieving global sustainability targets.

However, in extolling the virtues of this technique, it is equally essential to grapple with its limitations. **Scalability** emerges as a predominant concern. While laboratory-scale results are heartening, translating these successes to large-scale, real-world industrial setups is fraught with complexities. Another pressing issue centers around **commercial viability**. Will industries, particularly in developing economies, be willing and able to make the significant upfront investments this technology demands, given the return on investment timelines?

A glaring knowledge gap also persists regarding the **longevity and stability of the volcanic stone catalysts**. While they undeniably enhance the treatment process's effectiveness, questions about their degradation rate, maintenance needs, and replacement frequency in large-scale operations remain largely unaddressed.

To infuse novelty and encourage broader adoption, perhaps the perspective needs a shift. Instead of viewing catalytic ozonation and volcanic stones in isolation, envisioning a **holistic wastewater management ecosystem** where these methods seamlessly integrate with other sustainable practices might be the way forward. Such an ecosystem could leverage the strengths of multiple techniques, compensating for individual weaknesses.

Further, a multidisciplinary approach that intertwines technology, economics, and social awareness is paramount. Emerging technologies such as **artificial intelligence** could play a role in optimizing treatment parameters dynamically. Simultaneously, innovative business models might reduce the commercial entry barriers for industries, and rigorous awareness campaigns can drive home the importance and benefits of this technique to the masses.

In conclusion, while the fusion of catalytic ozonation with volcanic stone catalysts has charted an inspiring course in wastewater treatment, its full potential will only be realized with continuous research, collaboration, and a broader perspective that embraces both its strengths and its challenges. As the textile industry grapples with the pressing need for sustainable practices, this method, bolstered by complementary strategies, could indeed spearhead a new era in wastewater management.

References

Akuma, D. A., & Hundie, K. (2022). Textile wastewater treatment modelling and design using Stoat graph and sum-mary statistic model. Pakistan Journal of Analytical & Environmental Chemistry, doi: 10.21743/pjaec/2022.01.03.

Baena-Moreno, F., Malico, I., & Marques, I. P. (2021). Promoting Sustainability: Wastewater Treatment Plants as a Source of Biomethane in Regions Far from a High-Pressure Grid. A Real Portuguese Case Study. Sustainability, 13(16), 8933. doi: 10.3390/su13168933.

Böhm, G., Ionescu, D., & Ionescu, G. (2022). Solutions for optimizing processes of biological treatment of wastewater from the textile industry. Journal of Advanced Environmental Sciences, doi: 10.2478/jaes-2022-0022.

Cardoso, R. M., Cardoso, I. M. F., da Silva, L. P., & da Silva, J. E. D. E. (2022). Copper(II)-Doped Carbon Dots as Catalyst for Ozone Degradation of Textile Dyes. Nanomaterials, 12(7). doi: 10.3390/nano12071211.

Ghimire, U., Sarpong, G., & Gude, V. (2021). Transitioning Wastewater Treatment Plants toward Circular Economy and Energy Sustainability. ACS Omega. doi: 10.1021/acsomega.0c05827.

Gunalan, S. (2023). Treatment of Textile Dye Effluent Using Peroxi-Electrocoagulation. International Journal of Scientific Research in Environmental Management. doi: 10.55041/ijsrem24529.

Guo, L., Xie, Y., Xu, Y., Zhou, J., Sun, W., & Sun, Y. (2023). Pilot-scale study and biochemical verification of salt-tolerant catalyst Fe-Bi@γ-Al2O3 for catalytic ozonation of high-salinity wastewater. Journal of Environmental Chemical En-gineering, 11(3), 110031. https://doi.org/10.1016/j.jece.2023.110031.

Heredia-R, M., Layedra-Almeida, A. P., Torres, Y., & Toulkeridis, T. (2022). Evaluation of a microbial consortium and selection of a support in an anaerobic reactor directed to the bio-treatment of wastewater of the textile industry. Sustainability, doi: 10.3390/su14148889.

Hutagalung, S. S., Rafryanto, A. F., Sun, W., Juliasih, N., Aditia, S., Jiang, J., ... Kurniadi, D. (2023). Combination of ozone-based advanced oxidation process and nanobubbles generation toward textile wastewater recovery. Fron-tiers in Environmental Science. doi: 10.3389/fenvs.2023.1154739.

Khalish, M., Utami, A., Lukito, H., & Herlambang, S. (2022). Evaluation of textile industry wastewater treatment as an effort to control river water pollution in Central Java. KnE Life Sciences, doi: 10.18502/kls.v7i3.11106.

Li, Xingxing., Fu, L., Chen, Fei., Zhao, Shichao., Zhu, Jiangwei., & Yin, Chengliang. (2023). Application of Heterogene-ous Catalytic Ozonation in Wastewater Treatment: An Overview. Catalysts, 13(2). doi: 10.3390/catal13020342.

Mahmoud, M., Abd El-Razek, T. A. M., Abd El- Rahman, H. S., & Saad, M. A. (2021). Enhancing Effluent Quality of Wastewater Treatment Plants Using Advanced Oxidation Process. Journal of Environmental Sciences. doi: 10.21608/jes.2021.206547.

Mehmood, C. T., Qiu, H., Chen, L., Achmon, Y., Zhong, Z. (2023). Ceramic membrane reactor integrated with UV/O3/Catalyst Beads for treating real textile wastewater: Enhanced effluent quality, fouling control and molec-ular transformations of DOM. Journal of Environmental Chemical Engineering, 11(5), 110832. https://doi.org/10.1016/j.jece.2023.110832

Mishra, V., Mudgal, N., Rawat, D., Poria, P., Mukherjee, P., Sharma, U., Kumria, P., Pani, B., Singh, M., Yadav, A., Farooqi, F., & Sharma, R. S. (2023). Integrating microalgae into textile wastewater treatment processes: Ad-vancements and opportunities. Journal of Water Process Engineering, 55, 104128. https://doi.org/10.1016/j.jwpe.2023.104128

Mumbi, A., & Watanabe, T. (2022). Cost Estimations of Water Pollution for the Adoption of Suitable Water Treatment Technology. Sustainability, 14(2), 649. doi: 10.3390/su14020649.

Nakhate, P. H., Gadipelly, C. R., Joshi, N. T., & Marathe, K. V. (2019). Engineering aspects of catalytic ozonation for pu-rification of real textile industry wastewater at the pilot scale. Journal of Industrial and Engineering Chemistry, 69, 77-89. https://doi.org/10.1016/j.jiec.2018.09.010

Nooryaneti, M., Irawan, C., & Tuhuloula, A. (2022). Phytoremediation processes of Sasirangan textile industrial wastewater treatment using water hyacinth. Journal of Valensi, doi: 10.15408/jkv.v8i2.26283.

Omran, I. I., Al-Saati, N. H., Al-Saati, H. H., Hashim, K., & Al-Saati, Z. N. (2021). Sustainability assessment of wastewater treatment techniques in urban areas of Iraq using multi-criteria decision analysis (MCDA). Water Practice and Technology, 16(2), 648. doi: 10.2166/WPT.2021.013.

Rizvi, O. S., Ikhlaq, A., Ashar, U. U., Qazi, U. Y., Akram, A., Kalim, I., Alazmi, A., Ibn Shamsah, S. M., Alawi Al-Sodani, K. A., Javaid, R., & Qi, F. (2022). Application of poly aluminum chloride and alum as catalyst in catalytic ozona-tion process after coagulation for the treatment of textile wastewater. Journal of Environmental Management, 323, 115977. https://doi.org/10.1016/j.jenvman.2022.115977

Rodríguez, M. Q., Grisales, J. O., Pineda, H. R., & Espinosa, J. R. (2022). Degradation of dyes in real textile industry wastewater samples by Fenton process. Journal of Environmental Science, doi: 10.55463/issn.1674-2974.49.6.16.

Santos, E., Lisboa, I., & Eugénio, T. (2021). Economic Sustainability in Wastewater Treatment Companies: A Regional Analysis for the Iberian Peninsula. Applied Sciences, 11(21), 9876. doi: 10.3390/app11219876.

Thabet, R. H., Tony, M., El Sherbiny, S. E., Ali, I. A., & Fouad, M. (2021). Catalytic oxidation over nanostructured heter-ogeneous process as an effective tool for environmental remediation. IOP Conference Series: Materials Science and Engineering. doi: 10.1088/1757-899X/975/1/012004.

Wang, W.-L., Hu, H.-Y., Liu, X., Shi, H.-X., Zhou, T.-H., Wang, C., Huo, Z.-Y., & Wu, Q.-Y. (2019). Combination of cata-lytic ozonation by regenerated granular activated carbon (rGAC) and biological activated carbon in the ad-vanced treatment of textile wastewater for reclamation. Chemosphere, 231, 369-377. https://doi.org/10.1016/j.chemosphere.2019.05.175

Wu, Q. (2022). Wastewater Treatment by Enhanced H2O2 – Based Advanced Oxidation Process (AOP) Methods: A Re-view. Journal of Physics: Conference Series. doi: 10.1088/1742-6596/2152/1/012011.

Zhang, Y., Shaad, K., Vollmer, D., & Ma, C.-Y. (2021). Treatment of Textile Wastewater Using Advanced Oxidation Processes—A Critical Review. Water, 13(24). doi: 10.3390/w13243515.

Zhou, Chenxu., Zhang, Jiaming., Cai, Yuxuan., & Xiong, Jianhua. (2023). Catalytic Ozonation for Pulp and Paper Mill Wastewater Treatment: COD Reduction and Organic Matter Degradation Mechanism. Separations, 10(3). doi: 10.3390/separations10030148.

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Catalytic Ozonation: A Potential Game-changer in Wastewater Treatment

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Abstract

As industrialization and urbanization trajectories have escalated over the past decade, so too have the complexities and magnitude of wastewater pollution. In this intricate milieu, catalytic ozonation emerges as a beacon, potentially redefining wastewater treatment paradigms.bCore Mechanism: At its essence catalytic ozonation melds the oxidative prowess of ozone with the synergistic effects of catalysts, enhancing the degradation rate of both organic and inorganic pollutants. This collaborative mechanism notably outperforms conventiona wastewater treatment strategies, both in terms of efficiency and breadth of contaminants addressed. Beyond its inherent efficacy, catalytic ozonation showcases versatility, finding applicability across diverse industrial sectors. Its advantages are manifold, encompassing reduced energy expenditure, diminished by-product formation, and scalability — a feature crucial for burgeoning industria landscapes. While catalytic ozonation's promise is undeniable, it is essential to appraise it holistically. Key challenges include optimizing catalyst selection for varied wastewater matrices, addressing ozone production costs, and ensuring technology longevity. Moreover, understanding its efficacy against emergent contaminants, often a by-product of rapid industrial innovations remains a seminal area of investigation. This review underscores catalytic ozonation's potential as a transformative player in wastewater treatment. However, its success hinges on continual R&D, addressing extant challenges, and fostering collaborations across academia, industry, and policymakers. With these concerted efforts, catalytic ozonation can usher in a harmonized blend of environmental stewardship and economic prudence.

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Introduction

In the current landscape of swift industrial growth, addressing wastewater treatment emerges as a pressing environmental concern (Xin et al., 2021). Traditional treatment methods often grapple with the removal of both organic and inorganic pollutants prevalent in industrial wastewater (Rodrigues et al., 2019;

Shukrullah et al., 2020). Catalytic ozonation, an avant-garde solution, promises a more proficient and eco-friendly avenue for confronting this challenge (Li et al., 2023; Tang et al., 2021). The method leverages ozone, a potent oxidizing agent, enhanced by select catalysts to amplify its effectiveness.

Notably, the strengths of catalytic ozonation are manifold. The method's proficiency lies in its ability to rapidly and adeptly decompose intricate pollutants, a capability that many conventional technologies struggle with (Mehling et al., 2021). Furthermore, this process stands as an emblem of sustainability, potentially offering long-term operational cost reductions (Ferreiro et al., 2021).

However, while its potential is vast, it is not devoid of challenges. The existing literature identifies significant knowledge gaps, especially concerning the intricate mechanisms at play and the optimal conditions for the application of catalytic ozonation (Li et al., 2023; Yang et al., 2022). Factors like selecting the apt catalyst, determining the best operating conditions, and scaling to industrial production magnify these challenges (Li et al., 2023; Qazi et al., 2022). Such gaps necessitate further investigations to refine the process, aiming for its broad-based application across various industrial spheres (Yang et al., 2022).

Another dimension worth exploring is the influence of environmental variables. It is crucial to understand how external conditions, such as pH, temperature, and pollutant concentrations, might impact the efficiency of the catalytic ozonation process. Exploring alternative or novel catalysts could also yield insights into enhanced process efficiency.

In light of these considerations, this article endeavors to furnish readers with an exhaustive insight into catalytic ozonation, spanning from its foundational principles to its contemporary industrial applications. Through a rigorous literature review and a critical appraisal, we aspire to provide a valuable contribution to both the scientific and industrial sectors, fostering a deeper comprehension and fostering the implementation of this pioneering water treatment modality.

Methods

Literature Selection

This research employed a literature review methodology. We sourced various literary materials, such as journal articles and conference proceedings, to garner a holistic understanding of catalytic ozonation. Selection criteria for relevant literature revolved around wastewater treatment, organic and inorganic pollutants, and sustainable technological applications. Priority was given to articles published within the preceding five years, emphasizing their contemporaneity and relevance. Additionally, literature delving into the rudiments, merits, challenges, and pragmatic applications of catalytic ozonation received preferential consideration.

Data Analysis

Upon amassing the requisite literature, the data therein were meticulously extracted and systematically scrutinized. We employed both qualitative and (where applicable) quantitative approaches to analyze the data. Information, particularly concerning the foundational principles, advantages, drawbacks, and applications of catalytic ozonation, was cogently classified and presented in a narrative framework.

Results and Discussion

Principles of Catalytic Ozonation

Catalytic ozonation is gaining traction as an advanced wastewater treatment strategy, particularly efficacious against pollutants resistant to biodegradation. At its core, this method synergizes ozone's oxidizing prowess with select catalysts to enhance degradation efficiency. Crucially, these catalysts expedite the generation of hydroxyl radicals, formidable oxidizing entities known for their rapid pollutant decomposition capabilities (Psaltou & Zouboulis, 2020).

This method's versatility is evident in its capacity to neutralize a spectrum of contaminants ranging from organic compounds to heavy metals and pathogenic microorganisms. Significantly, the absence of toxic by-products ensures that the post-treatment water is environmentally benign (Xu et al., 2019).

Despite its merits, the technique poses challenges—chief among them is catalyst selection. The gamut of pollutants necessitates a tailored catalyst choice for optimal treatment efficiency (Yang et al., 2022). Recent endeavors have sought to broaden the catalyst repertoire, exploring transition metals, metal oxides, and carbon-based substrates, revealing promising strides in catalytic efficacy and application breadth (Inchaurrondo & Font, 2022).

Operational parameters, namely temperature, pressure, pH, and ozone concentration, can profoundly impact the treatment outcomes. Ascertaining optimal conditions remains an active research frontier (Fallah et al., 2023).

In the grander industrial milieu, catalytic ozonation is touted as a sustainable antidote to wastewater tribulations. Given the escalating water scarcity and burgeoning environmental cognizance, this technology

is poised for pivotal roles in imminent wastewater strategies (Rame, Purwanto, & Sudarno, 2020). Nonetheless, hurdles persist, elevated initial costs, and expertise-centric challenges associated with catalyst selection and process optimization. However, technological evolution and relentless research hint at a future where these impediments are mitigated.

Figure 1 encapsulates the tenets, merits, challenges, and real-world applications of catalytic ozonation.
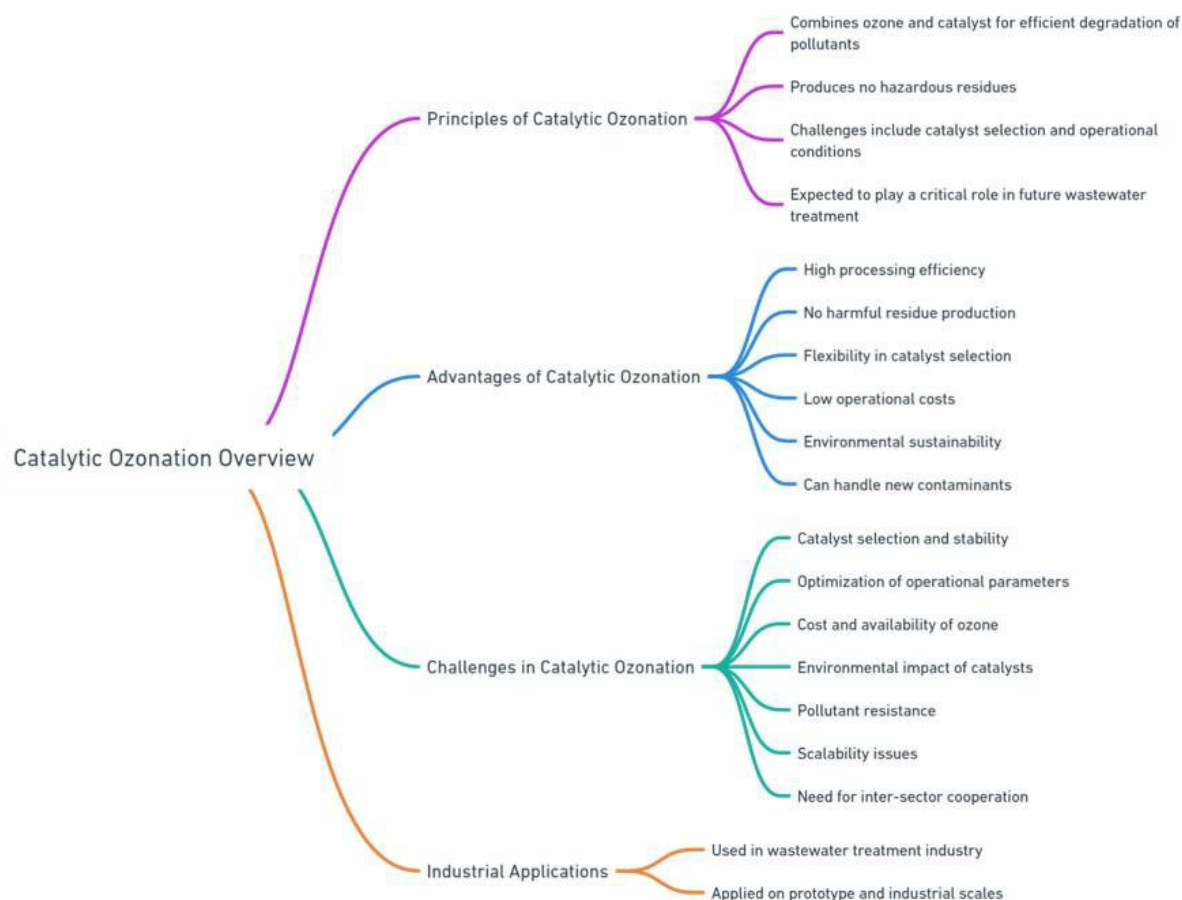
Figure 1. Catalytic Ozonation Research Overview

In summation, while catalytic ozonation stands as a beacon of wastewater treatment innovation, research fervor is paramount to surmount its intrinsic challenges and pave the way for its ubiquitous industrial integration.

Advantages of Catalytic Ozonation

Catalytic ozonation has rapidly risen to prominence over the past decade, distinguishing itself as a vanguard in wastewater treatment technologies. Its allure primarily stems from its unique merger of ozone's robust oxidizing capabilities with the facilitating role of catalysts, thereby amplifying treatment efficiencies.

A closer scrutiny of its benefits reveals:

- **High Processing Efficiency**: Catalytic ozonation demonstrates an unparalleled competency in eradicating diverse pollutants, often boasting removal rates exceeding 90%, solidifying its reputation as a foremost treatment method (Li et al., 2023).
- **Tackling Resilient Pollutants**: Traditional biodegradation often flounders against complex organic compounds. Contrastingly, catalytic ozonation exhibits prowess in eliminating even these tenacious contaminants, especially in trace concentrations (Rivera-Utrilla et al., 2020).
- **Eco-friendly By-product Profile**: Steering clear from the environmental pitfalls of many chemical treatments, this technique does not yield detrimental residues, ensuring the post-treatment effluent is environmentally congruous (Psaltou & Zouboulis, 2020).
- **Adaptable Catalyst Integration**: Its capacity to entertain a spectrum of catalysts, contingent on pollutant makeup and operational modalities, gifts this method unparalleled operational flexibility (Rivera-Utrilla et al., 2020).
- **Economically Favorable in the Long Run**: Despite the ostensibly hefty initial investment, the long arc of its operation reveals potential cost savings, given its heightened efficiency and minimized reliance on chemical adjuncts (Li et al., 2023).

- **Eco-conscious Paradigm**: In an epoch where environmental stewardship is paramount, catalytic ozonation's eco-compatibility finds increasing resonance (Zhang, 2020).
- **Collaboration with Allied Technologies**: Its adaptability extends to its potential amalgamation with other treatment modalities—be they biological or physicochemical—heralding enhanced treatment outcomes (Li et al., 2023).
- **Addressing Contemporary Contaminants**: As industries evolve, novel pollutants emerge, underscoring the need for adaptive technologies. Catalytic ozonation, with its evolving repertoire, seems poised to address these challenges (Inchaurrondo & Font, 2022).
- **Energy Optimality**: Pitted against its counterparts, this method emerges as more energy-conservative, underscoring both its economic and environmental merits (Rivera-Utrilla et al., 2020).
- **Versatility Across Varied Effluent Qualities**: Its robustness in managing disparate wastewater qualities earmarks it for diverse applications spanning both industrial and communal sectors (Li et al., 2023).

While these merits paint an optimistic landscape, it is imperative to remain circumspect. Catalytic ozonation, akin to all technologies, grapples with intrinsic challenges. However, with relentless research impetus and a vision of innovation, the horizon seems promising, suggesting this technology's continued evolution to address the ever-morphing wastewater challenges of the future (Zhang, 2020).

Challenges in Catalytic Ozonation

While catalytic ozonation holds immense promise as a wastewater treatment technology, its journey toward widespread implementation is not without its hurdles. Most innovations, especially in this field, invariably face a series of challenges, both technologically and in terms of implementation.

Catalyst Selection and Stability: The cornerstone of this process is the right choice of catalyst. Not only should the chosen catalyst be effective, but it also needs to be robust, economical, and easily recyclable. The impact of an unstable catalyst on the overall process cannot be overstated (Liu et al., 2021; Inchaurrondo & Font, 2022). How does an unstable catalyst affect the whole process? Moreover, are there effective strategies for recycling the catalyst without compromising its efficacy?

Optimization of Operational Parameters: Every wastewater possesses its unique characteristics. Identifying and optimizing operational parameters like ozone concentration, temperature, and pH often demands intensive research and significant resources (Li et al., 2023; Mohsin & Mohammed, 2021). Could there be adaptive methods to ease this optimization process?

Integration with Other Processing Systems: While integrating with existing systems may offer a combined effect, it can also be a source of technical and economic challenges (Mansas et al., 2020). How can we ensure a seamless integration between different technologies?

Cost and Availability of Ozone: Ozone, despite being a powerful oxidant, requires energy for its production. In certain locales, the cost of producing ozone can be a significant hindrance (Zhang et al., 2021). Are there more efficient alternatives to ozone production?

Environmental Impact of Catalysts: Essential as they are, some catalysts might pose environmental hazards (Yang et al., 2022). How can we minimize these impacts while ensuring effectiveness?

Pollutant Resistance: Even with a catalyst, certain pollutants prove challenging to remove (Tang et al., 2021). What innovations can be adopted to tackle this problem?

Scalability Issues: A solution effective at the laboratory scale might not directly translate to industrial applications (Rame, Purwanto, & Sudarno, 2020). How can we expedite this transition?

Processing Residue Management: While the residues produced are fewer compared to other methods, their management remains necessary (Ghahrchi et al., 2020). What is the best strategy for managing these residues?

Inter-Sector Cooperation: The success of catalytic ozonation requires collaboration between the industry, governments, and the scientific community (Qazi et al., 2022). How can we facilitate this collaboration?

Education and Training: Introducing new technologies invariably demands education and training (Rame et al., 2021). What is the best approach to ensure effective knowledge transfer?

Research and Development: While significant progress has been achieved, further research is needed to refine and optimize this technology (Ferreiro et al., 2021). What are the priority areas for upcoming research?

Addressing these challenges will not only solidify the application of catalytic ozonation but might also inspire innovations in other wastewater treatment technologies. A profound understanding of these barriers and potential solutions to overcome them will be key in reshaping how we manage wastewater in the future.

Industrial Applications of Catalytic Ozonation

Catalytic ozonation is a promising technology in the wastewater treatment industry. Several industrial applications of catalytic ozonation have been carried out on prototype and industrial scales—figure 2 Impact on application of catalytic ozonation in various waste treatment processes.
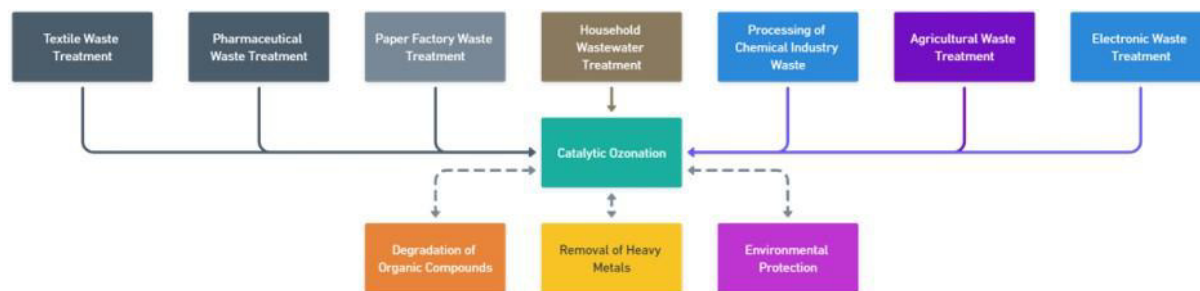

Figure 2. Catalytic Ozonation Treatment Across Industries

Textile Waste Treatment

The textile industry stands as one of the globe's most prolific sectors, notorious for generating vast quantities of aqueous waste. The intricate textile production processes harness a plethora of dyes, chemicals, and methodologies, resulting in effluents brimming with elevated organic contents, vivid colors, and hazardous chemical entities. Consequently, the urgency of textile waste treatment becomes paramount, not only from an ecological perspective but also to safeguard human health (Rame, Purwanto, & Sudarno, 2020).

Pioneering its way to the forefront of textile waste treatment innovations is catalytic ozonation. This technology has showcased its prowess by inducing high-oxidizing potential free radicals capable of degrading the labyrinth of organic compounds prevalent in textile waste (Bilińska, Bilińska, & Gmurek, 2022). Its distinctive merits encompass the following:

- **High Efficiency**: It boasts the capability of purging colors and pernicious chemicals from textile waste, outpacing traditional counterparts (Bilińska, Bilińska, & Gmurek, 2022).
- **Swift Reaction Dynamics**: In comparison to alternative methodologies, catalytic ozonation flourishes with a notably reduced reaction timeframe (Ikhsandy, Bismo, & Karamah, 2022).
- **Elimination of Additive Chemicals**: The process sidesteps the incorporation of additional chemicals, translating to diminished operational costs and a softer ecological footprint.

Despite its sterling advantages, catalytic ozonation is not devoid of challenges. The crucible of choosing the optimal catalyst, given the myriad operational scenarios, stands out. Its transition from laboratory to industrial-scale application might necessitate rigorous optimization and a substantial investment influx.

An abundance of studies notwithstanding, a palpable knowledge void remains concerning the molecular-level reaction mechanisms. A deep dive into understanding how complex organic entities, especially resilient dyes, interface with free radicals could pave the way for the development of more efficient catalysts.

Given the extensive spectrum of dyes and chemicals wielded by the textile industry, there emerges a prospect to tailor-make catalytic ozonation systems specific to certain waste types. Such bespoke systems could potentially ramp up the efficiency quotient and truncate operational expenses.

Catalytic ozonation looms as a promising beacon for textile waste treatment, marrying efficiency with sustainability. However, its journey to industrial-scale ubiquity mandates relentless research and fine-tuning to reach the zenith of optimization (Rame, Purwanto, & Sudarno, 2020).

Pharmaceutical Waste Treatment

The pharmaceutical industry, a bedrock of medical advancement, concurrently shoulders the mammoth responsibility of producing waste rife with intricate organic compounds. Pioneering technologies such as catalytic ozonation have emerged as potential game-changers in navigating the convoluted web of pharmaceutical waste, disintegrating complex compounds into more benign, degradable entities (Alinejad et al., 2019). These waste streams, imprinted with the fingerprint of multifarious drugs and concomitant chemicals, necessitate rigorous treatment to circumvent potential ecological desecration and public health adversities (Mohsin & Mohammed, 2021).

Integrating the unparalleled oxidizing prowess of ozone with catalytic processes, catalytic ozonation promises heightened wastewater treatment efficiency (Psaltou & Zouboulis, 2020). Modern research posits an enticing collaboration between catalytic ozonation and biological processes. Such symbiotic systems not only tout the degradation of over 90% of organic compounds swiftly but also bequeath the added boon of biogas production, heralding a novel energy alternative (Ikhlaq et al., 2022). Notably, the salient strength of this tandem lies in its adeptness at confronting elusive low molecular weight organic compounds, which conventionally elude treatment (Psaltou & Zouboulis, 2020).

Notwithstanding its merits, catalytic ozonation is not without its Achilles' heel. Though ozone stands tall as a potent oxidant, its exorbitant use births by-products with deleterious potential. Consequently, an area demanding redressal is engineering strategies to curtail ozone dosage, ensuring cost efficiency while mitigating environmental repercussions (Psaltou & Zouboulis, 2020).

The research landscape, albeit burgeoning, remains punctuated with knowledge chasms. A nuanced understanding of the interaction dynamics between varied pharmaceutical compounds and ozonation catalysts can unveil avenues for catalyst optimization. Moreover, the realm of biogas produced in tandem processes beckons deeper exploration, both qualitatively and quantitatively. Could there be untapped potential in harnessing this biogas for in-house pharmaceutical processes, completing a sustainable loop?

Navigating the quagmire of pharmaceutical waste treatment demands both innovation and introspection. Catalytic ozonation, especially when conjugated with other processes, presents a gleaming beacon of hope. It exemplifies the industry's evolutionary journey, evolving from a mere drug manufacturer to an eco-conscious entity, simultaneously nurturing health and habitat (Alinejad et al., 2019).

Paper Factory Waste Treatment

The paper industry, emblematic of the world's insatiable appetite for print, simultaneously grapples with the environmental ramifications of its effluents, prominently imbued with recalcitrant lignin and multifarious organic compounds (Osmanović et al., 2022). Enter catalytic ozonation—a beacon of innovation with proven efficacy in disintegrating lignin and augmenting the biodegradability of these effluents, confronting the formidable challenges presented by chemicals utilized in the paper bleaching and dyeing conundrum (Zhou et al., 2023; Bhodiwal et al., 2022).

The gravitas of catalytic ozonation in this context cannot be overstated. It meticulously employs ozone as an oxidant, its prowess supercharged by the presence of a catalyst, turning erstwhile complex chemicals into a shadow of their former selves, primed for degradation (Fallah et al., 2023). Compounds like lignin, which often hold wastewater treatment processes hostage, meet their match in catalytic ozonation—evidenced by studies revealing a staggering 90% degradation rate within the fleeting span of an hour (Zhou et al., 2023).

However, no silver bullet exists without its challenges. The efficacy of catalytic ozonation is invariably tied to the specificity and efficiency of the catalyst used. Research must continuously evolve to unearth catalysts that are both economically viable and environmentally benign. Additionally, the long-term implications and by-products of this process warrant scrutiny. There exists a potential for secondary pollutants, albeit in minimal quantities, that may challenge the very essence of eco-friendly waste treatment.

A pivotal knowledge void lingers in understanding the myriad organic compounds present in effluents beyond just lignin. How does catalytic ozonation fare against these lesser-known antagonists? Could integrating bio-based processes, such as the use of microorganisms that thrive on specific compounds, further bolster the efficiency of catalytic ozonation? The potential of amalgamating the brute force of chemical processes with the finesse of biological ones remains a tantalizing prospect worth exploring.

Catalytic ozonation, with its proven strengths and prospective opportunities, stands on the cusp of revolutionizing paper factory waste treatment. However, the quest for perfection necessitates an unrelenting commitment to research and a discerning eye for weaknesses and knowledge gaps. As the paper industry strides forward, so too must its waste treatment methodologies, embodying a combined effect of efficacy, economy, and environmental stewardship.

Household Wastewater Treatment

Amidst the urban sprawl and relentless growth of global metropolises, the specter of household wastewater management looms large. These effluents, teeming with an eclectic mix of food residue to detergents, exemplify the urban challenge of our times (Nikbeen & Nayab, 2023). Compounding the issue are notorious organic chemicals, pernicious heavy metals, and an array of pathogenic microorganisms, all of which make a clarion call for efficacious treatment methods (Fallah et al., 2023).

Emerging from the crucible of innovative research is catalytic ozonation. This avant-garde methodology synergizes ozone's oxidizing prowess with tailor-made catalysts, amplifying wastewater treatment's efficiency (Zhou et al., 2023). The dividends of such an approach are manifold. For one, its efficacy in decimating obstinate pollutants places it leagues ahead of its traditional counterparts (Tang et al., 2021). Additionally, its rapid reaction kinetics and adaptability across diverse pollutant spectra underscore its versatility. Moreover, not to be overshadowed, its ecologically-conscious modus operandi, minimizing chemical additives, advocates for a greener urban future (Nikbeen & Nayab, 2023).

Beyond theory, catalytic ozonation's mettle has been tested against the multifarious pollutants endemic to household wastewater—from pharmaceutical remnants to cosmetics (Ponnusamy et al., 2021). Its innate ability to annihilate pathogenic agents, potentially ensuring potable water devoid of microbial threats, further reinforces its significance.

However, as with all promising ventures, catalytic ozonation grapples with its set of challenges. The crucible lies in the meticulous selection of catalysts—agents that must retain their efficiency across

fluctuating pH landscapes and varying pollutant densities (Tang et al., 2021). Economic constraints also cast a shadow, with the method's initial forays potentially incurring higher operational and investment overheads compared to conventional stalwarts.

The terrain of household wastewater treatment is ever-evolving, and the onus is on researchers to delve deeper into understanding the long-term ramifications of catalytic ozonation. Could there be unidentified by-products? How might communities respond to the adoption of this technology at a grassroots level? Exploring collaborative treatment modalities, perhaps coupling biological treatments with catalytic ozonation, might be the next frontier. Such integrative approaches could offer unparalleled efficiencies while addressing the broader sustainability matrix.

As the urban fabric continues to densify, catalytic ozonation beckons as a harbinger of change, potentially redefining the paradigms of household wastewater treatment. Though challenges persist, with unwavering research commitment and a lens for innovation, this method could indeed sculpt the contours of future urban wastewater management.

Processing of Chemical Industry Waste

Behind the innovation and advancements of the chemical industry lies the pressing challenge of managing waste laden with hazardous organic compounds. This highlights the urgency of effective waste management as pivotal for both industrial continuity and environmental conservation. While coagulation-flocculation has historically been the go-to for wastewater treatment, technological progression and heightened environmental consciousness have ushered in newer methods, one of which is catalytic ozonation (Chen et al., 2022).

In the chemical industry context, the liquid waste produced often encompasses a myriad of organic and inorganic compounds. Traditional methods frequently fall short, yet catalytic ozonation promises enhanced efficiency by converting or even completely eradicating these harmful compounds. The striking fact that catalytic ozonation has shown the capability to reduce complex compounds by over 90% underscores its superiority over conventional methods (Zhang et al., 2021). Its success in eliminating heavy metals and other inorganic compounds further adds to its appeal.

Speed is a salient advantage of catalytic ozonation. While traditional methods often demand prolonged periods and additional chemical additives, catalytic ozonation delivers purification in significantly reduced times, which is invaluable to industries with large waste volumes (Wulansarie et al., 2023). However, the elevated operational costs remain a substantial deterrent. However, considering the environmental and health dividends, these costs may be justifiable.

A knowledge gap persists regarding the long-term effects of the by-products of catalytic ozonation. Are there undetected, prolonged impacts? Furthermore, additional research is crucial to evaluate the development of new, more efficient, and affordable catalysts. Integrating with other technologies, such as bioremediation, may present a synergistic approach, enhancing both efficiency and efficacy while curbing costs. Through this lens, catalytic ozonation is not seen as an isolated solution but as part of a broader, integrated system for chemical industrial waste management.

While challenges remain, the potential of catalytic ozonation as a primary solution for treating chemical industrial waste grows more apparent. With ongoing research and technology adaptations, this method harbors the potential to redefine standards in waste management.

Agricultural Waste Treatment

The agricultural sector, while indispensable for human survival, grapples with an environmental quandary: the management of its persistent and often toxic waste, chiefly from pesticides and herbicides. With increasing environmental scrutiny and the challenges posed by these wastes, catalytic ozonation emerges as a potential beacon (Alcazar-Ruiz, Dorado, & Sánchez-Silva, 2022).

Catalytic ozonation stands out for its efficacy in tackling notoriously stubborn compounds. Organophosphates and carbamates, for instance, which have been the bane of many treatment techniques due to their complex structures, are effectively neutralized through this method. The application of catalysts, such as titanium dioxide (TiO2) or zeolite, elevates the process's efficiency, producing reactive oxidants that rapidly degrade contaminants (Stankovic et al., 2022). Furthermore, the versatility of this technique extends to combatting the consequences of fertilizer overuse, addressing the accumulation of nitrates and phosphates, which are implicated in detrimental phenomena like eutrophication (Guo, Xie, Sun, Xu, & Sun, 2023).

While promising, the operational dynamics of catalytic ozonation necessitate a careful selection of catalysts suited to specific waste profiles. There is also a pressing need for research that evaluates the long-term environmental impacts of by-products generated from this treatment. Moreover, scaling up this technology for vast agricultural regions while maintaining efficiency and cost-effectiveness remains a challenge.

One pressing knowledge gap is the adaptability of catalytic ozonation across varied agricultural waste matrices, as different crops and regions might have distinct contaminant profiles. Integrating this

technology with bio-treatment methods could offer synergistic benefits, enhancing degradation while potentially recovering valuable by-products. The exploration of renewable energy sources to power the ozonation process could also enhance its sustainability credentials.

Catalytic ozonation beckons a future where the agricultural sector can reconcile productivity with environmental stewardship. As the tapestry of this method is further woven with advancements in catalyst research and integrative treatment paradigms, the promise of a cleaner, greener agricultural landscape becomes increasingly palpable.

Electronic Waste Treatment

The 21st century has witnessed an unprecedented electronic revolution, bringing along the monumental challenge of e-waste management. This complex waste, an amalgamation of hazardous heavy metals and organic compounds, threatens not only our environment but also human health (Li et al., 2023). In the maze of potential treatment solutions, catalytic ozonation emerges as a beacon of hope.

Whether it is the effluents from Printed Circuit Boards (PCBs), which have become the backbone of the digital world, or the remnants from battery recycling processes—catalytic ozonation demonstrates robust efficiency. Its capability to degrade intricate organic compounds while simultaneously immobilizing heavy metals like lead and cadmium is nothing short of revolutionary (Zhou, Zhang, Cai, & Xiong, 2023). Moreover, its applicability does not halt at PCBs and batteries. The semiconductor industry, a cornerstone of modern technology, also contributes significant liquid waste; yet again, catalytic ozonation stands poised to address this colossal challenge.

Apart from its unparalleled degradation capabilities, catalytic ozonation offers potential environmental benefits. When synergized with biological or other physicochemical treatment modalities, its efficiency can be significantly enhanced. The possibility of transforming hazardous waste into benign substances or even valuable by-products presents an exciting avenue for exploration.

However, no solution is without its set of challenges. The high operational costs and energy requirements associated with catalytic ozonation might deter its widespread adoption. Identifying catalysts that are both efficient and cost-effective or harnessing renewable energy sources to power the ozonation process might hold the key to addressing these concerns.

A pressing question that lingers is the long-term environmental impact of the by-products generated from this process. Is there potential for secondary pollution? Additionally, as electronic devices continue to evolve, introducing new materials and compounds, can catalytic ozonation keep pace? A holistic lifecycle assessment of electronic products, integrated with waste treatment strategies, might offer a fresh perspective, ensuring that treatment solutions remain contemporary.

The e-waste conundrum demands innovative, sustainable, and adaptable solutions. Catalytic ozonation, with its multifaceted advantages and potential for further refinement, might well be the answer the world has been seeking. As research deepens and technology advances, there is cautious optimism that we are on the cusp of a new era in e-waste management.

Conclusions

The emergent crisis of wastewater management necessitates the harnessing of cutting-edge technologies. Catalytic ozonation, standing at the vanguard, showcases a distinct blend of efficiency and sustainability, catering to diverse industrial sectors ranging from textiles to pharmaceuticals.

There is an unequivocal consensus that catalytic ozonation excels in eradicating obstinate contaminants from wastewater. Notably, its performance can be radically amplified with the judicious choice of catalysts. The myriad studies vouching for its efficiency indeed make a compelling case for its adoption.

Beyond its standalone prowess, the true strength of catalytic ozonation might lie in its compatibility. The prospect of seamlessly incorporating it with prevailing wastewater treatment technologies paints a promising picture of comprehensive wastewater management.

Amidst the growing clamor for green solutions, catalytic ozonation stands out. Its potential to curtail energy consumption, coupled with the reduced residue production, echoes the ethos of sustainable development.

However, it would be naïve to perceive catalytic ozonation as a panacea. It is imperative to grapple with intrinsic challenges, such as the optimization of operating parameters, the economic burden of ozone production, and the potential bottlenecks in dovetailing it with established treatment systems. The quest for economical, efficient, and scalable ozone generation techniques might be pivotal in this narrative.

Even as catalytic ozonation looms large as the future of wastewater treatment, it is pivotal to identify and address uncharted territories. Catalytic ozonation undeniably presents a beacon of hope in the labyrinthine challenge of modern wastewater treatment. However, its true potential can only be unlocked through sustained R&D, interspersed with multi-sectoral collaborations. As we tread into an era where

water scarcity might become palpable, technologies like catalytic ozonation not only offer solutions but also epitomize the essence of innovation in the service of humanity.

References

Alcazar-Ruiz, A., Dorado, F., & Sánchez-Silva, L. (2022). Influence of Temperature and Residence Time on Torrefaction Coupled to Fast Pyrolysis for Valorizing Agricultural Waste. *Energies, 15*(21), doi: 10.3390/en15217914.

Alinejad, A., Akbari, H., Ghaderpoori, M., Jeihooni, A. K., & Adibzadeh, A. (2019). Catalytic ozonation process using a MgO nano-catalyst to degrade methotrexate from aqueous solutions and cytotoxicity studies in human lung epithelial cells (A549) after treatment. *RSC Advances*. doi: 10.1039/c9ra00320g.

Bhodiwal, S., Chauhan, S., Agarwal, R., & Barupal, T. (2022). A novel approach: Handmade papermaking. *MOJES*. doi: 10.15406/mojes.2022.07.00241.

Bilińska, M., Bilińska, L., & Gmurek, M. (2022). Homogeneous and Heterogeneous Catalytic Ozonation of Textile Wastewater: Application and Mechanism. *Catalysts, 13*(1), 6. doi: 10.3390/catal13010006.

Chen, Xiurong., Gu, Hao., Sun, Xiaoli., Tian, Jinyi., Li, Qiuyue., Pan, Tao., Zhang, Xinyu., Hu, Xueyang., & Linghu, Shanshan. (2022). Improvement of coal gasification reverse osmosis concentrate treatment by Cu-Co-Mn/AC catalytic ozonation. *Water Science & Technology, 87*(1), doi: 10.2166/wst.2022.420.

Fallah, N., Bloise, E., Santoro, D., & Mele, G. (2023). State of Art and Perspectives in Catalytic Ozonation for Removal of Organic Pollutants in Water: Influence of Process and Operational Parameters. *Catalysts, 13*(2). doi: 10.3390/catal13020324.

Ferreiro, C., de Luis, A., Villota, N., Lomas, J., Lombraña, J., & Camarero, L. (2021). Application of a Combined Adsorption–Ozonation Process for Phenolic Wastewater Treatment in a Continuous Fixed-Bed Reactor. *Catalysts, 11*(8). doi: 10.3390/catal11081014.

Ghahrchi, M., Bazrafshan, E., Adamiyat Badan, B., Dadban Shahamat, Y., & Gohari, F. (2020). Application of heterogeneous catalytic ozonation process for treatment of high toxic effluent from a pesticide manufacturing plant. *Environmental Health Engineering and Management Journal*. doi: 10.34172/ehem.2020.10.

Guo, L., Xie, Y., Sun, W., Xu, Y., & Sun, Y. (2023). Research Progress of High-Salinity Wastewater Treatment Technology. *Water, 15*(4), doi: 10.3390/w15040684.

Ikhlaq, A., Qazi, U., Akram, A., Rizvi, O. S., Sultan, A., Javaid, R., Al-Sodani, K. A., & Shamsah, S. I. (2022). Potable Water Treatment in a Batch Reactor Benefited by Combined Filtration and Catalytic Ozonation. *Water, 14*(15), doi: 10.3390/w14152357.

Ikhsandy, F., Bismo, S., & Karamah, E. F. (2022). The Application of Catalytic Ozonation Technique using UV and Granular Activated Carbon (GAC) for Eliminating in Waste Phenol, COD, and 1,1,2,2-Tetrachloroethane. *Rekabuana, 7*(1). doi: 10.33366/rekabuana.v7i1.2854.

Inchaurrondo, N., & Font, J. (2022). Clay, Zeolite and Oxide Minerals: Natural Catalytic Materials for the Ozonation of Organic Pollutants. *Molecules, 27*(7). doi: 10.3390/molecules27072151.

Li, X., Fu, L., Chen, F., Zhao, S., Zhu, J., & Yin, C. (2023). Application of Heterogeneous Catalytic Ozonation in Wastewater Treatment: An Overview. *Catalysts, 13*(2), 342. doi: 10.3390/catal13020342.

Liu, Y., Chen, C., Duan, X., Wang, S., & Wang, Y. (2021). Carbocatalytic ozonation toward advanced water purification. *Journal of Materials Chemistry A*. doi: 10.1039/D1TA02953C.

Mansas, C., Atfane-Karfane, L., Petit, E., Mendret, J., Brosillon, S., & Ayral, A. (2020). Functionalized ceramic nanofilter for wastewater treatment by coupling membrane separation and catalytic ozonation. *Journal of Environmental Chemical Engineering*. doi: 10.1016/j.jece.2020.104043.

Mehling, S., Schnabel, T., & Londong, J. (2021). Photocatalytic ozonation in an immersion rotary body reactor for the removal of micro-pollutants from the effluent of wastewater treatment plants. *Water Science and Technology, 85*(1). doi: 10.2166/wst.2021.617.

Mohsin, M., & Mohammed, A. (2021). Catalytic ozonation for removal of antibiotic oxy-tetracycline using zinc oxide nanoparticles. *Applied Water Science*. doi: 10.1007/s13201-020-01333-w.

Nikbeen, T., & Nayab, A.K. (2023). Transformation of Traditional Wastewater Treatment Methods into Advanced Oxidation Processes and the Role of Ozonation. DOI: 10.12911/22998993/162777.

Osmanović, Z., Ibric, E., Čamić, A., & Ljevakovic, A. (2022). Analysis of the Possibilities of Bioremediation of Soil Loaded with Waste from the Paper Industry. *Cognizance Journal, 2*(12), doi: 10.47760/cognizance.2022.v02i12.004.

Ponnusamy, G., Farzaneh, H., Tong, Y., Lawler, J., Liu, Z., & Saththasivam, J. (2021). Enhanced catalytic ozonation of ibuprofen using a 3D structured catalyst with MnO2 nanosheets on carbon microfibers. *Scientific Reports*. DOI: 10.1038/s41598-021-85651-2.

Psaltou, S., & Zouboulis, A. (2020). Catalytic Ozonation and Membrane Contactors—A Review Concerning Fouling Occurrence and Pollutant Removal. *Water, 12*(11). doi: 10.3390/w12112964.

Qazi, U., Ikhlaq, A., Akram, A., Rizvi, O. S., Javed, F., Ul-Hasan, I., Alazmi, A., Shamsah, S., & Javaid, R. (2022). Novel Vertical Flow Wetland Filtration Combined with Co-Zeotype Material Based Catalytic

Ozonation Process for the Treatment of Municipal Wastewater. *Water, 14*(21). doi: 10.3390/w14213361.

Rame, R., Purwanto, P., & Sudarno, S. (2020). Potential of Catalytic Ozonation in Treatment of Industrial Textile Wastewater in Indonesia: Review. *Jurnal Riset Teknologi Pencegahan Pencemaran Industri, 11*(1). doi: 10.21771/jrtppi.2020.v11.no1.p1-11.

Rame, R., Yuliasni, R., Pratiwi, N. I., Handayani, N. I., & Setianingsih, N. I. (2021). A continuous mode reactor design for industrial textile wastewater treatment through catalytic ozonation. *IOP Conference Series: Earth and Environmental Science, 623*(1), 012085. doi: 10.1088/1755-1315/623/1/012085.

Rivera-Utrilla, J., López-Ramón, M. V., Sánchez-Polo, M., Álvarez, M. A., & Velo-Gala, I. (2020). Characteristics and Behavior of Different Catalysts Used for Water Decontamination in Photooxidation and Ozonation Processes. *Catalysts, 10*(12). doi: 10.3390/catal10121485.

Rodrigues, C., Silva, R. M., Carabineiro, S., Maldonado-Hódar, F. J., & Madeira, L. (2019). Wastewater Treatment by Catalytic Wet Peroxidation Using Nano Gold-Based Catalysts: A Review. *Catalysts, 9*(5), 478. doi: 10.3390/CATAL9050478.

Shukrullah, S., Bashir, W., Altaf, N., Khan, Y., Al-Arainy, A., & Sheikh, T. A. (2020). Catalytic and Non-Catalytic Treatment of Industrial Wastewater under the Exposure of Non-Thermal Plasma Jet. *Processes, 8*(6), 667. doi: 10.3390/pr8060667.

Stankovic, M., Popova, M., Mazaj, M., Dražić, G., Šuligoj, A., Van de Velde, N., Opresnik, M., Jaćimović, Ž., Tušar, N.N., & Logar, N. (2022). Utilization of waste Cu-, Mn- and Fe-loaded zeolites generated after wastewater treatment as catalysts for air treatment. *Frontiers in Chemistry*, doi: 10.3389/fchem.2022.1039716.

Tang, X., Zhang, Y., Li, W., Geng, J., Ren, H., & Xu, K. (2021). Mechanism and toxicity evaluation of catalytic ozonation over Cu/Ce–Al2O3 system aiming at degradation of humic acid in real wastewater. *Scientific Reports, 11*. doi: 10.1038/s41598-021-83804-x.

Wulansarie, R., Jannah, RF., Bismo, S., Safitri, R., & Rengga, Wdp. (2023). Degradation of Methylene Blue Dye in Wastewater Using Ozonation Method with H2O2 Catalyst. *IOP Conference Series: Earth and Environmental Science, 1203*(1), doi: 10.1088/1755-1315/1203/1/012051.

Xin, L., Hu, J., Xiang, Y., Li, C., Fu, L., Li, Q., & Wei, X. (2021). Carbon-Based Nanocomposites as Fenton-Like Catalysts in Wastewater Treatment Applications: A Review. *Materials, 14*(10), 2643. doi: 10.3390/ma14102643.

Xu, Y., Wang, Q., Yoza, B., Li, Q. X., Kou, Y., Tang, Y., Ye, H., Li, Y., & Chen, C. (2019). Catalytic Ozonation of Recalcitrant Organic Chemicals in Water Using Vanadium Oxides Loaded ZSM-5 Zeolites. *Frontiers in Chemistry*. doi: 10.3389/fchem.2019.00384.

Yang, J., Fu, L., Wu, F., Chen, X., Wu, C., & Wang, Q. (2022). Recent Developments in Activated Carbon Catalysts Based on Pore Size Regulation in the Application of Catalytic Ozonation. *Catalysts, 12*(10). doi: 10.3390/catal12101085.

Zhang, S., Wang, H., Zhou, Y., Kamali, M., He, X., Khalaj, M., & Xia, Y. (2022). Catalytic Ozonation of the Secondary Effluents from the Largest Chinese Petrochemical Wastewater Treatment Plant—A Stability Assessment. *Sustainability, 14*(4), 2200. doi: 10.3390/su14042200.

Zhang, S., Zhou, L., Li, Z., Esmailpour, A., Li, K., Wang, S., Liu, R., Li, X., & Yun, J. (2021). Efficient Treatment of Phenol Wastewater by Catalytic Ozonation over Micron-Sized Hollow MgO Rods. *ACS Omega*. doi: 10.1021/acsomega.1c03497.

Zhang, T. (2020). Heterogeneous Catalytic Process for Wastewater Treatment. InTechOpen. doi: 10.5772/intechopen.90393.

Zhang, X., Zhao, X., Tang, Y., & Guan, X. (2021). Catalytic Ozonation of Secondary Effluent Organic Matter (SEOM) by Biochar-Supported Manganese: Efficiency, Mechanism and Toxicity Assessment. *Water, 13*(7). doi: 10.3390/w13070876.

Zhou, C., Zhang, J., Cai, Y., & Xiong, J. (2023). Catalytic Ozonation for Pulp and Paper Mill Wastewater Treatment: COD Reduction and Organic Matter Degradation Mechanism. *Separations, 10*(3), doi: 10.3390/separations10030148.

A REVIEW OF THE INPATIENT CLAIMS PENDING CAUSES AT HOSPITAL X SEMARANG (CASE STUDY OF FEBRUARY-MARCH 2023)

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Abstract

The mismatch between medical record requirements in submitting claims is one of the causes of delays in National Health Insurance claims and has an impact on the hospital financing system. Problems occur in the inpatient department due to a lack of understanding of officers about filling out medical resumes and incomplete claim requirements. This study aimed to describe the causes o pending inpatient claims at Hospital X Semarang (Case study February-March 2023). The type of research applied is descriptive observative through interviews and observations. The research subjects were the Head of Casemix and the Inpatient Casemix Officer. The object of this research is inpatient medical record documents that do not meet the requirements of the National Health Insurance claim. The results showed that the number of pending claims in February-March 2023 was divided into three categories, namely medical pending, code pending and administrative pending. Medical pending is caused by the lack of confirmation of diagnostic procedures and is related to pending coding. Code pending is caused by inaccurate action codes. Administrative pending is caused by incomplete supporting examination results. The process flow and SOP for Submitting Claims are following the provisions that apply in the hospital. The use of the INA-CBG's application is a factor in causing pending due to system errors so that the grouping process is hampered. The characteristics of the Casemix Officer are also a contributing factor to pending claims. Casemix officers should be more thorough in submitting claims so that they are not pending or re-pending.

Keywords:
Pending Claim; Inpatient; Casemix

Introduction

BPJS claims are submissions for treatment costs by the Hospital parties to BPJS every month (1). Pending claims are files that are not claimed or not paid by BPJS Kesehatan (2). Financing System the JKN claim used is the INA-CBG Application. INA-CBG is an application used by all healthcare providers for filing claims that will result in service tariff output (3). Overcome that has been previously reviewed, there are several problems, namely being returned BPJS Kesehatan claim file. The reason for this is a lack of good understanding of outpatient and inpatient officers regarding the procedure for filling out resume sheets for medical treatment resulting in the return of BPJS Health claims. This matter needs to be followed up by

carrying out flow and conveying procedures requirements related to completeness of claim administration and conducting training to improve the quality and quantity of officers (4).

RM completeness is one of the most important elements in the process BPJS Health claims. The discrepancy between the requirements of internal medical records submission of claims is one of the causes of late claims to BPJS Health has an impact on hospital finances. On the other hand, there is the obstacle is that the BPJS Health verifier is no longer within the scope of the hospital which will result in the completion process if there are incomplete files will take longer (5).

Issues reviewed Previously, there was a problem indicating file constraints resulting in the claim file being returned by the relevant BPJS Health verifier submission of BPJS insurance claims for inpatients. This happens because there are complete or incomplete claim requirements. Therefore, the verifier BPJS returns files that do not meet the claim requirements to the hospital verifier or the DPJP. Some hospitals too experienced the same thing as the results of the Yogyakarta Hospital study (6).

Methods

The type of research used in this study is the method of qualitative descriptive research because researchers will describe, describe and explain the results that will be found while doing research. The type of data source used is data primary and secondary data. Primary data is in the form of interviews and observations while the secondary data is in the form of pending minutes. The instruments used in this study were interviews and observation. The researcher conducted interviews with 2 (two) informants, namely inpatient casemix staff and the head of casemix. Apart from that, the researcher also checked the checklist by observing the process flow and submission SOP claims at Hospital X. Data processing in this study uses several methods including collecting which means researchers collect data with way of observation and interviews, then there is editing which means the researcher checks returns from the results of the data that has been collected are appropriate for the purpose or not, then there is verification which means checking again the suitability of the data with the goal research, then there is the presentation of data which means presenting the results found during research using descriptive descriptions.

Results

Based on the results of research conducted on pending month data February to March 2023 at X Hospital, data the result is as follows:

Table 1.

Month February 2023		
Delayed Cause	**Frequency (F)**	**Precentage (%)**
Medical	33	50.00
Code	25	37.88
Administrative	8	12.12
Total	**66**	**100**
Month March 2023		
Delayed Cause	**Frequency (F)**	**Precentage (%)**
Medical	26	47.28
Code	22	40.00
Administrative	7	12.72
Total	**55**	**100**

1 . DRM Pending February and March 2023.

The type of research used in this study is the method of qualitative descriptive research because researchers will describe, describe and explain the results that will be found while doing research. The type of data source used is data primary and secondary data. Primary data is in the form of interviews and observations while the secondary data is in the form of pending minutes. The instruments used in this study were interviews and observation. The researcher conducted interviews with 2 (two) informants, namely inpatient casemix staff and the head of casemix. Apart from that, the researcher also checked the checklist by observing the process flow and submission of SOPs claims at Hospital X. Data processing in this study uses several methods including collecting which means researchers collect data with way of observation and interviews, then there is editing which means the researcher checks returns from the results of the data that has been collected are appropriate for the purpose or not, then there is verification which means checking again the suitability of the data with the goal research, then there is the presentation of data which means presenting the results found during research using descriptive descriptions.

Table 2.

Informant	Job Description	Age	Gender	Length Of Working	Last Education	Training
Head of Casemix	Complete the BPJS pending requirements	54 th	Male	33 year	S1 Statistics	Have attended training every once a year on how to complete pending so as not to be pending
Officer 1	Complete claim requirements and submit claims	31 th	Male	10 year	D3 – Medical Records and Health Information	Ever followed JKN training.

Based on the findings of researchers about the characteristics officer, the 54-year-old head of casemix in charge of conducting completeness of BPJS pending requirements, while the officer is 31 years old who is in charge of completing claim requirements and submitting claims? Productive age starts from the age of 15 years - 65 years, the more the age a person often experiences fatigue in working and making performance at work decreased. The impact will affect the quality or quality of hospital services, especially in the completeness of claim filing. The head of casemix has a bachelor's degree in statistics and has worked for 33 years old, while the officer has an educational background in D3 Medical Records and has been working for 10 years. Educational background influences performance at work, the length of time a person works can also be a benchmark because from work experience a person can hone skills, their knowledge, and professionalism. The two informants attended the training useful training to support the quality of the hospital so that it is better good.

Discussion

Based on the results of research conducted at Hospital X, states that the causes of pending claims consist of 3 (three) categories namely Medical, Coding, and Administrative. The average cause of pending in February to March 2023 due to the absence of management diagnosis by KMK or Minutes, not attached supporting data and supporting documents, incomplete medical resumes and billing, code inaccuracies action between BPJS and Hospital Officers, because officers are lacking attach medical supporting data (X-ray results, EKG results, operation reports, police report). According to the 2014 BPJS claim verification technical guidelines, officer the BPJS verifier will verify the claim file according to the requirements. If there are files that do not match, then the claim files will be returned by BPJS verifier. Files that are not approved by the BPJS verifier are meaningless the file is rejected but must be corrected by completing the requirements administration by applicable regulations (7).

Based on the results of research conducted at X Hospital, the head of casemix and officers were aware of pending SOPs and filing claims and carried out their work in accordance with SOPs that applies in the hospital, this is not a factor in the occurrence of pending claims at X Hospital. Other studies shows that the claim submission process is appropriate, but there is a delay submission of claims caused by a lack of human resources, lack of facilities and infrastructure and the absence of SOPs related to filing claims (8).

Based on the results of research conducted at X Hospital, casemix heads have never experienced problems when entering data into INA-CBG. While the officers experienced problems when entering data to INA-CBGs, because according to the officers, there were too many items that had to be filled in on INA-CBG such as blood pressure, temperature, pulse, and others requires the officer to see again from the beginning when the patient entered and the officer felt it was a waste of time. There was an error in the implementation verification of DRM claims, the head of casemix stated that there had been a case re-pending in February 2023. Due to disagreement on answers between the BPJS verifier and the hospital so that the hospital does repetition of answers and regrouping.

While the officer experienced an error in giving coding because no coding guidelines and incomplete file submissions for example operation report and chronological appendix in traffic accident patient. Hospital X has implemented bridging. Its enforced bridging implementation because the bigger the data, the bigger the capacity storage. Therefore, bridging is used to transfer data easily without reducing the accuracy of the data being processed. This matter facilitate officers in the process of input and output data to be more efficient (9).

Officers have encountered problems when using the INA- CBGs, the problem is experiencing server interruption or server error either on a national or local scale. This will have a deep effect process of filing claims due to delays in the grouping process. The impact that arises as the result of an ineffective claim filing process can have a direct impact on the fulfillment of hospital health services (10).

Based on the results of interviews conducted at X Hospital, it was found that the age of the casemix head was 54 years and the inpatient casemix officer was 31 years old. According to the Ministry of Health of productive age, a person is 15 – 64 years (11). This can be one of the causes file incomplete so that the file becomes pending, because As we get older, the quality of human performance decreases.

Based on the results of interviews conducted at X Hospital, it was found that the two informants were male so in work there has been inaccuracy or incompleteness in carrying out administrative requirements. Sometimes productivity levels women are taller than men. In work, women usually have high patience and thoroughness (12).

Based on the results of interviews conducted at X Hospital, it was found that the working period of the casemix head was 33 years and the inpatient casemix officer is 10 years. Working time can affect a person's performance at work because it has earned various experiences in the field being occupied (13).

Based on the results of interviews conducted at X Hospital, it was found that the head of casemix had a background education in S1 Statistics, and inpatient casemix officers have a background education in D3 Medical Records and Health Information. According to Permenkes No.55 The year 2013 article 1 Medical recorder is a person who has completed an education Medical Records and Health Information by laws and regulations invitation (14). This is one of the factors causing incompleteness of administrative files because education is not continuous against his job.

Based on the results of interviews conducted at X Hospital, that once a year the casemix head attends training on how to solve pending so it doesn't become pending. Officer 1 also often attend training held by JKN. Terms follow training held must obtain permission from the director of the house Sick. Training plays an important role in improving officer performance (15)

Conclussion

Based on the results of the research found at Hospital X, the number of Pending Claims for February March 2023 at Hospital X is divided into 3 categories namely medical pending, code pending, and administrative pending. Medical pending caused by the lack of confirmation of diagnostic management and there is a relationship with pending coding. Pending code is caused by inaccuracy Action code. Administrative pending is caused by incomplete results support.

This study also found SOP Process Flow and Claim Submission carried out by officers at Hospital X is by the theory and SOP that applies in the hospital. Use of the INA-CBG's Application as a support in making service tariff claims. Hospital staff experienced no problems when using the application it's just that server interference has occurred in the application. Characteristics Casemix officer is 54 years old with undergraduate education Statistics, while the officer is 31 years old with a D3 RMIK education. Second The informant is male, of the two informants who have worked the longest is the casemix head. Both informants have attended the training.

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From this study, researchers also provide some suggestions that casemix officers can improve their accuracy in making submissions claims so that pending or re-pending does not occur, casemix officers are always there perform backups to anticipate system downtime or re-input on the INA-CBG's software, casemix officers can set time targets in completing tasks related to submitting claims.

Reference examples from Journal:

Ardhitya T, K AP. Faktor-Faktor Yang Melatar Belakangi Penolakan Klaim BPJS Oleh Verifikator BPJS Di RSJD Dr. Amino Gondohutomo Provinsi Jawa Tengah Tahun 2015. J Univ Dian Nuswantoro. 2015;2(2):1–10.

Achmad Ali Fikri, Syamsul Arifin MFF. Evaluasi Klaim BPJS Kesehatan Dalam Menurunkan Klaim Pending. 2;2022;2(8.5.2017):2003–5.

Wijayanti AI, Sugiarsi S. Analisis Perbedaan Tarif Riil Dengan Tarif Paket INA-CBG Pada Pembayaran Klaim Jamkesmas Pasien Rawat Inap Di Rsud Kabupaten Sukoharjo. J Manaj Inf Kesehat Indones. 2013;1(1):1–10.

Mustika Kurniawati, Tuty Satrijawati Th. Faktor Yang Mempengaruhi Pengembalian Administrasi Klaim Bpjs Kesehatan Ditinjau Dari Syarat-Syarat Kelengkapan Administrasi Klaim. File:///C:/Users/Vera/Downloads/Askep_Agregat_Anak_And_Remaja_Print.Docx. 2020;21(1):1–9.

Saputro A, Suryawati C, Agushybana F. Analisis Sistem Pengelolaan Rekam Medis Pendukung Klaim Jaminan Kesehatan Nasional Pelayanan Rawat Inap Di Rumah Sakit S Kota Semarang. J Manaj Kesehat Indones. 2020;8(April 2020):1–7.

Megawati L, Pratiwi RD. Faktor-Faktor Penyebab Pengembalian Berkas Persyaratan Klaim BPJS Pasien Rawat Inap Di RS PKU Muhammadiyah Yogyakarta. J Kesehat Vokasional. 2016;1(1):36.

BPJS Kesehatan. Petunjuk Teknis Verifikasi Klaim. Badan Penyelenggara Jaminan Sos Kesaehatan. 2016;1–46.

Evi Alifia Harnanti. Analisis Keterlambatan Pengajuan Klaim Bpjs Di Rumah Sakit Uns. Fak Ilmu Kesehatan, Univ Muhammadiyah Surakarta. 2018;

Kurniawan A. Bridging Data Pasien Rawat Inap Dengan INA- CBG ' S (Indonesian Case Base Groups). J Sist Cerdas [Internet]. 2022;05(03):195–207. Available From: Https://Apic.Id/Jurnal/Index.Php/Jsc/Article/View/249

Istiqomah G. Efektivitas Pelaksanaan Prosedur Klaim Rsud Jend. A. Yani Kota Metro Kepada Bpjs Kesehatan Cabang Metro. 2018;

Kementerian Kehehatan Republik Indonesia. Profil Data Kesehatan Indonesia. Profil Data Kesehat Indones Tahun 2011. 2012;77.

Lestari L, Arbi A. Faktor-Faktor Yang Berhubungan Dengan Kejadian Dispepsia Pada Usia Produkif (15-64) Di Wilayah Kerja Puskesmas Lhoong Kecamatan Lhoong Kabupaten Aceh Besar Tahun 2022. J Heal Med Sci [Internet]. 2022;1:171–82. Available From: A

Susanti Tentrem. Studi Tentang Kinerja Petugas Rekam Medis Di Rumah Sakit Persatuan Djamaah Haji Indonesia Yogyakarta Artikel Publikasi Ilmiah. Stud Tentang Kinerja Petugas Rekam Medis Di Rumah Sakit Persat Djamaah Haji Indones Yogyakarta. 2013;

Deshpande S. Peraturan Menteri Kesehatan Republik Indonesia Nomor 55 Tahun 2013. J Am Chem Soc [Internet]. 2013;123(10):2176–81. Available From: Https://Shodhganga.Inflibnet.Ac.In/Jspui/Handle/10603/7385

Werdani KE. Pencapaian Standar Pengolahan Rekam Medis Sebelum Dan Sesudah Pelatihan Di Rsud Pacitan. J Manaj Inf Kesehat Indones. 2016;4(1):62–6.

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Knowledge and Attitudes regarding HIV-AIDS: Health Educator for Youth (HEY) in Vocational and Non-Vocational High Schools

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Abstract

HIV-AIDS is a global issue that can affect people of all ages, but the most vulnerable are adolescents. Adolescents in Indonesia have experienced an increase in HIV cases for six years (2011-2017). This study aimed to analyze the differences in knowledge and attitudes related to HIV-AIDS between non-vocational schools and vocational schools. A cross-sectional study was conducted in a sample of 187 students (aged 15-19) in seven randomly selected general/vocational high schools that were part of the HEY (Health Educator for Youth) program in Surabaya, Indonesia. There was no difference in knowledge ($p = 0.488$) and attitudes ($p = 0.803$) between male and female students. This study also showed that there was no difference in knowledge between non-vocational schools and vocational high schools ($p = 0.385$), however, there were differences in attitudes between non-vocational schools and vocational high schools ($p = 0.001$). Chi-Square test results showed a relationship between knowledge and attitudes ($p = 0.039$). Optimization of existing youth health programs needs to be conducted in both general and vocational schools. HEY is an effective method of increasing adolescent knowledge and attitudes through the involvement of the roles of teachers, students, parents, and various related stakeholders.

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Introduction

HIV (Human Immunodeficiency Virus) and AIDS (Acquired Immune Deficiency Syndrome) emerged as global issue. HIV can cause decreased immunity due to a virus that attacks white blood cells. As many as 37.9 million people worldwide are infected with HIV and 1.7 million people newly infected with HIV in 2018 (UNAIDS, 2019). Based on a report from the SIHA (Information System for HIV-AIDS and STIs), the number of HIV cases in Indonesia increased from 30,935 cases in 2015 to 48,300 cases in 2017. Whereas, the number of AIDS cases increased from 2014-2016. There were 8,754 cases in 2014, 9,215 cases in 2015, and 10,146 cases in 2016. Then, it decreased slightly into 9,280 cases in 2017. East Java Province is the province with the highest number of HIV cases and among the top five AIDS cases reported in 2017. The proportion of HIV and AIDS patients in Indonesia is mostly experienced by men. Most HIV patients occurred in the age

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range of 25-49 years, while the group of adolescents aged 15-19 years experienced an increase in cases for six years (2011-2017) with the number of HIV cases from 683 cases in 2011 to 1,729 cases in the year 2017 (Kemenkes RI, 2018).

Lack of knowledge and low awareness of HIV-AIDS causes a negative stigma that can hinder efforts to prevent and treat HIV-AIDS in Indonesia. It was reported that 75% of PLWHA who knew their HIV status, 39.6% of PLHIV who received ARV drugs and only 32.4% of PLHIV who received ARV had experienced a decrease in viral load. This low elimination target is influenced by stigma from families, health workers and the wider community towards PLHIV. The lack of support from people around them also has an impact on the low level of compliance of PLHIV with ARV treatment (Rokom, 2021).

HIV-AIDS can affect everyone, especially adolescents who are the age group most vulnerable to infection with HIV-AIDS (CIMSA, 2019). The age range for adolescents according to WHO (World Health Organization) is 10-19 years old (WHO, 2014). Meanwhile, according to the Regulation of the Minister of Health of the Renon-vocational of Indonesia number 25 of 2014 adolescents are included in the 10-18 year age group (Menteri Kesehatan RI, 2014). Non-vocational / vocational high school students in Indonesia have an average age of 16-18 years, thus they are included in the adolescents' group.

Adolescents are a risk group because of the behaviour of adolescents who have short relationships and multiple partners or friends with risky behaviour (Nurwati & Rusyidi, 2019). Adolescence is filled with unstable emotions, easily distracted, willing to try new things hence, they are prone to negative behaviour such as smoking, drinking, using drugs, and having free sex that can risk contracting HIV-AIDS. This period is the most vulnerable to contracting HIV-AIDS because adolescents have high social mobility (Pratiwi & Basuki, 2012).

There are 36% of men and 30% of women aged 15-24 years had comprehensive knowledge about HIV and HIV prevention methods spread across 37 countries for the period 2011-2016 (UNAIDS, 2017). Knowledge of HIV-AIDS can influence a person's attitude and behaviour, thus people who have less knowledge of HIV-AIDS will stay away from people with HIV-AIDS and some even think that the disease is not dangerous (Nurwati & Rusyidi, 2019).

It is important for adolescents to know about HIV transmission because of the prevalence of free sex at risk of contracting HIV. Culture in Indonesia is also still taboo to talk openly about topics related to sex. Therefore, it is important to have the knowledge and attitudes of young people in HIV-AIDS prevention efforts. The purpose of this study analysed the relationship and differences between knowledge, attitudes of students, and types of schools (non-vocational and vocational high schools) in Surabaya, Indonesia.

Methods

Design and Participants
This study was a quantitative study with a cross-sectional study design. The population in this study were students of non-vocational / vocational high schools in the city of Surabaya with a cross-sectional study. The population of this study were high school students in Surabaya. Samples were randomly selected in August-November 2019, which were taken as many as 187 students (15-19 years) from seven non-vocational / vocational high schools in Surabaya.

Data Collection
An online survey designed to measure students' knowledge and attitudes towards HIV-AIDS and STIs was used as a tool for data collection. The online survey consisted of 15 questions related to knowledge about various aspects of HIV-AIDS and STIs and 6 questions to test students' attitudes towards HIV-AIDS and STIs. The online survey was developed with modification by researchers from the edutainment module and BKKBN related to HIV-AIDS and STI materials.

Data Analysis
The data that had been obtained were analysed by using IBM SPSS version 21.computer application. The data was found not to be normally distributed. The online survey was conducted with a validity test, R correlation test, which can be seen that 15 out of 20 questions about knowledge and all questions about attitude (6 questions) showed valid after being tested. The reliability test results showed that Cronbach's alpha knowledge value was 0.687 and attitude was 0.789, which means it was reliable.

The knowledge variable was categorized into two categories, namely good and poor, while attitudes were categorized into positive and negative. The correlation test between knowledge and attitudes was conducted with gender and school type by using the Chi-Square test. P value <0.05 was considered statistically significant. Ethical clearance has been obtained from the Health Research Ethics Committee of the Faculty of Nursing Universitas Airlangga (ref: No: 1392-KEPK).

Results

Respondent Characteristics

Respondents in this study were 187 students from seven schools in the city of Surabaya. Out of 187 students, 71 students (38%) were male and 116 students (62%) were female. Students from vocational high schools were 86 (46%) and students from non-vocational schools were 101 (54%) (Table 1).

Table 1.
Distribution of the study sample according to their general characteristics

Characteristics	n	%
School code		
A1	19	10.2
A2	17	9.1
A3	12	6.4
A4	32	17.1
A5	21	11.2
K1	33	17.6
K2	53	28.3
Gender		
Male	71	38
Female	116	62
School Types		
Vocational high schools	86	46
Non-vocational high schools	101	54
Total	187	100

Table 2.
Distribution of the study sample according to their responses to the question about knowledge about HIV-AIDS

Content of questions	n	%
Knowledge about risk faced by adolescent		
Good	48	25.7
Poor	139	74.3
Total	187	100
Knowledge about transmission and STI disease		
Good	125	66.8
Poor	62	33.2
Total	187	100
Knowledge about transmission and prevention of HIV-AIDS		
Good	93	49.7
Poor	94	50.3
Total	187	100

Table 3.
Distribution of the study sample according to their responses to the question about attitudes toward HIV-AIDS (N = 187)

Questions	Strongly disagree n (%)	Disagree n (%)	Neither agree nor disagree n (%)	Agree n (%)	Strongly agree n (%)
I think material about sexuality is important	4 (2.1)	4 (2.1)	15 (8)	76 (40.6)	88 (47.1)
I think material about HIV-AIDS is important	5 (2.7)	5 (2.7)	11 (5.9)	75 (40.1)	91 (48.7)

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Questions	Strongly disagree n (%)	Disagree n (%)	Neither agree nor disagree n (%)	Agree n (%)	Strongly agree n (%)
I think material about sexuality is interested	6 (3.2)	15 (8)	19 (10.2)	90 (48.1)	57 (30.5)
I think material about HIV-AIDS is interested	4 (2.1)	14 (7.5)	15 (8)	96 (51.3)	58 (31)
I know how to maintain reproductive health	9 (4.8)	5 (2.7)	6 (3.2)	71 (38)	96 (51.3)
I am willing to prevent HIV-AIDS	5 (2.7)	8 (4.3)	9 (4.8)	68 (36.4)	97 (51.9)

Aspects of Student Knowledge about HIV-AIDS
Based on the aspects of non-vocational / vocational high school students' knowledge about HIV-AIDS, the majority of students knew about STI transmission and examples of STI diseases, such as syphilis, chlamydia, and gonorrhea (66.8%). While the majority of students do not know about the risks faced by adolescents (74.3%). Regarding knowledge of HIV-AIDS, more than half of the students knew about HIV-AIDS prevention by using protective equipment and about HIV-AIDS transmission (50.3%). Even so many students do not know about the names for people who have been infected by the HIV virus and are already positive for AIDS and the names for the prevention of HIV-AIDS in a loyal partner (49.7%) (Table 2).

Aspects of students' attitudes about HIV-AIDS
Based on the aspect of high school / vocational high school students' attitudes about HIV-AIDS, more than half of the students strongly agree about the willingness to maintain reproductive health (51.3%) and the willingness to prevent HIV-AIDS (51.9%). More than half of the students agreed that HIV-AIDS material was interesting (51.3%). Meanwhile, students had the most disagreement about sexuality material that was interesting (8%) and the disagreement attitude about HIV-AIDS material was interesting (7.5%) (Table 3).

Table 4.
Cross tabulation between sex and school type with knowledge and attitudes (N = 187)

Variable	Gender		School type		n (%)
	Male n (%)	Female n (%)	Vocational n (%)	Non-vocational n (%)	
Knowledge					
Good	32 (41.6%)	45 (58.4%)	32 (41.6%)	45 (58.4%)	77 (100%)
Poor	39 (35.5%)	71 (64.5%)	54 (49.1%)	56 (50.9%)	110 (100%)
P value[2]	**0.488**		**0.385**		
Attitude					
Positive	36 (37.1%)	61 (62.9%)	41 (42.3%)	56 (57.7%)	97 (51.9%)
Negative	35 (38.9%)	55 (61.1%)	60 (66.7%)	30 (33.3%)	90 (48.1%)
P value[2]	**0.803**		**0.001***		
P value Attitude*knowledge[1]					**0.039***

[1]Pearson Chi-square
[2]Continuity Correction
*significant level set at p<0.05

Results of the analysis between characteristics (sex and school type) with knowledge and attitudes
The analysis showed that there was no difference in knowledge (p = 0.488) and attitudes (p = 0.803) between male and female students. This study also showed that there was no difference in knowledge between non-vocational schools and vocational schools (p = 0.385), but there were differences in attitudes between non-vocational schools and vocational schools (p = 0.001). The Chi-Square test results show a relationship between knowledge and attitude (p = 0.039) (Table 4).

Discussion

People of all ages and sexes can be susceptible to contracting HIV, but people between 15 to 25 are more at risk. Adolescents are a group that must be considered in HIV prevention efforts because they have started to reach the age of being sexually active and can be given access to education and information through education in schools (Thanavanh et al., 2013). Adolescents can be the group most at risk for HIV-AIDS transmission because of a lack of knowledge related to HIV-AIDS and may be more exposed to or engaged in risky behaviour (Othman, 2015).

Knowledge of HIV transmission in this study among students of general / vocational high schools can be concluded as good, that is, 95.2% of students answered correctly. A similar study was conducted in Erbil City, Iraq on high school students, the majority of the students knew about HIV transmission through sexual contact (94.3%), through blood transfusion (83.5%), through needles (73.7%) (Othman, 2015). Recent study in Sekondi-Takoradi metropolis, Ghana shows similar results, the majority of senior high school students know about HIV-AIDS transmission through sexual contact (97.3%), through needles (93.2%), through blood transfusions (94.6%) (Dzah et al., 2019). However, studies in Fako Division, South West Region, Cameeron, knowledge of HIV-AIDS transmission from a list of four transmission routes (unprotected sexual intercourse, blood transfusion, transmission of infected mother to child, needles and unsterile medical equipment) only a few students (30.2 %) have a very good knowledge of correctly answering the four routes of HIV transmission (Nubed & Akoachere, 2016).

Adolescent behaviours that can be at risk of contracting HIV such as having premarital sexual activity with friends or boyfriends, with commercial sex workers or even with fellow men, and drugs use. Adolescents tend to be more concerned with their friends, hence the wrong choice of friends lead them to fall into bad deeds or actions that are at risk of contracting HIV (Marni & Nita, 2019). A study in Trenggalek Regency, East Java, Indonesia shows that the majority of students (97.3%) support prevention of premarital sexual behaviour. Students with very good subjective norms of 97.3% have a positive attitude to prevent premarital sex behaviour. This is supported by the existence of social norms among students such as parents, schools and peers that support the prevention of premarital sexual behaviour (Nurmala et al., 2019; Nurmala, Ahiyanasari, et al., 2020).

Knowledge of mother-to-child transmission of HIV in this study was assessed as good, as many as 97.3% of students answered correctly. Similar results were found in a study in Erbil City, Iraq, the majority of students (75.3%) knew about mother-to-child transmission of HIV (Othman, 2015) and recent research in Sekondi-Takoradi metropolis, Ghana, amounting to 85.7% (Dzah et al., 2019). While according to a study in Dhaka city, only 36.7% of respondents answered that AIDS is transmitted from mother to child(Shirin & Ahmed, 1970).

Only 16.6% students in this study answer correctly about knowledge of what was not HIV transmission. Meanwhile, knowledge of fluids that cannot transmit HIV, the majority of students (89.3%) answered correctly. Another study on what is not HIV transmission found in the Samir Othman study stated that only 54.2% of students knew that shaking hands with HIV patients could not be infected and only half of students knew that wearing the same clothes and going through the swimming pool was not the route of HIV transmission (Othman, 2015). In contrast to the study of Seraphine Dzah et al, the majority of students (81.3%) knew that HIV-AIDS cannot be transmitted through handshakes, sharing clothes with HIV sufferers (69.7%), mosquito bites (70.1%), magic (73.8%), and more than a half of the students (60.5%) knew that the use of shared toilets with HIV sufferers was not a place of transmission (Dzah et al., 2019). Only 15.5% thought that being faithful by having sex with only one uninfected partner could transmit HIV (Nubed & Akoachere, 2016).

Knowledge of HIV prevention in this study showed that the majority of students (83.4%) knew the terms for HIV-AIDS prevention by providing knowledge, the majority of students (85%) knew the terms of HIV-AIDS prevention by using protective equipment, few students (44.9%) who know the terms of HIV-AIDS prevention by being faithful to one partner. Another study on knowledge of how to reduce the risk of HIV transmission, namely the majority of students (82.2%) answered by having faithful sex with one uninfected person, 85.3% of students answered by using condoms, 90.5% of students answered by abstaining from sexual intercourse as a prevention strategy (Nubed & Akoachere, 2016).

Knowledge of sexually transmitted infections in this study on average for each question more than half of the students have answered correctly. Students who answered correctly the types of sexually transmitted infections, namely gonorrhea (64.7%), syphilis (77.5%), chlamydia (59.9%). In line with research in the United States, 70.5% of students identified gonorrhea and 54.1% of students identified chlamydia as a sexually transmitted infection (Nsuami et al., 2010).

Someone who has good knowledge about HIV-AIDS will tend to have a positive attitude compared to others who have low knowledge (Nubed & Akoachere, 2016). In this study, there is a relationship between

knowledge and attitudes. The better the student's knowledge, the better the student's attitude in preventing HIV-AIDS. In line with a study in the Fako Division, South West Region, Cameeron that there is a significant relationship with a positive correlation between knowledge and attitudes about HIV-AIDS. The knowledge gained will form a better understanding of HIV transmission(Nubed & Akoachere, 2016). Adolescents with good knowledge were 1.9 times more likely to support HIV-AIDS prevention attitudes than adolescents with poor knowledge (Tiranda et al., 2018).

The results of this study indicate that there is no gender difference with knowledge and attitudes about HIV-AIDS among high school/ vocational high school students. This is in line with a study in Yogyakarta, Indonesia, showing no relationship between gender and student attitudes towards HIV-AIDS prevention (Tiranda et al., 2018). A study in Shiraz, Iran showed that there was no difference between the sexes and high school students' knowledge of HIV-AIDS. however, the comparison showed men had better knowledge about the causes of AIDS and its transmission. Boys were judged to have a higher negative attitude towards HIV patients than girls (Dehghani et al., 2017).

In contrast to Samir Othman's study, it shows that there is a significant relationship between gender and knowledge of HIV-AIDS. Male has higher knowledge, it is because male students want to learn something taboo and have great curiosity. Therefore, they invite themselves to discuss HIV-AIDS with their friends (Othman, 2015). Studies in Bangladesh also showed male students have a higher knowledge of HIV-AIDS than female (Huda & Amanullah, 2013).

The results of this study indicate that there is no relationship between the type of school (vocational/ non-vocational) with knowledge and there is a relationship between the type of school and attitudes about HIV-AIDS. Senior High School is divided into science, social studies, and language majors. Meanwhile, Vocational High Schools have more various majors according to their talents and interests. There is no relationship between the type of school and student knowledge which can be caused by the ease of accessing information supported by facilities in senior high schools and vocational schools. School facilities that support such as libraries, computers and the internet can be used by students to access information about HIV-AIDS so as to increase students' knowledge in both general and vocational high schools

According to the researcher's analysis, there are differences between types of schools and attitudes because in vocational high schools students are more preoccupied with the number of practicum according to their vocational and vocational students are more focused on the world of pr-school work so that they have low interest in health efforts, in contrast to students in general high school who have enough free time to add knowledge in various matters including efforts to prevent HIV so that it creates a positive attitude.

Peer education is a method that can increase knowledge, attitudes, self-efficacy, and positive adolescent behaviour towards health problems in adolescents regarding disease prevention (Ghasemi et al., 2019). A study in Khartoum, Sudan shows that intervention programs using peer education methods can increase students' knowledge, among others: knowledge of AIDS-causing agents increased from 75.5% to 83.2%, knowledge about the spread of HIV through mosquitoes increased from 77.7% to 81.5%, knowledge about increased risk having multiple sex partners increased from 47.5% to 83.5%. Students' attitudes also increased regarding youth vulnerability to HIV from 70% to 83%. Positive attitudes regarding voluntary HIV testing also increased from 84.3% to 91.5%. The knowledge and attitudes of students increased after receiving information from their peers who had been trained to become peer educators. Therefore, peer education is an effective approach to increase students' knowledge and attitudes regarding HIV so as to prevent HIV risky behaviour (Hamad Mohammed Ali et al., 2015). A pilot study found that peer assisted learning is effective for facilitating learning in allied health science students (Guraya & Abdalla, 2020). The peer education method makes adolescents more aware of their role as peer educators, namely as custodians of confidential information, motivators, sources of information, and discussion partners (Nurmala, Pertiwi, et al., 2020).

Conclusions

This study provides preliminary data from a region on the knowledge and attitudes of general and vocational high school students towards HIV-AIDS. This study highlights that many students still lack knowledge regarding the terms for the risks faced by adolescents, the prevention of HIV-AIDS by being faithful toward one partner, people who have been infected with the HIV virus and are already AIDS positive, and activities that do not transmit HIV-AIDS. In this study, students also found negative attitudes due to a lack of interest in learning HIV materials.

Based on the results of the research, there is a relationship between the type of school and student attitudes, while there is no relationship between gender and knowledge and attitudes and there is no relationship between the type of school and knowledge. Therefore, interventions are needed that are in accordance with the needs and characteristics of the two types of schools (vocational and non-vocational). Optimizing

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existing youth health programs is needed for equal distribution of interventions at all school levels and all adolescents. The peer education method is considered quite effective by combining two types of schools (vocational and non-vocational) so that the intervention is appropriate, according to the needs and characteristics of adolescents. Therefore, the intervention through this method can improve knowledge, attitudes and behavior of HIV-AIDS prevention both for adolescents who attend public schools and vocational schools.

Author Contributions

Conceptualization, I.N., L.A.S. and M.; Methodology, I.N., Y.P.D. and M.; Supervision and validation, I.N., and M.; Formal Analysis, N.R. and Y.P.D.; Writing – Original Draft Preparation, N.R. and Y.P.D.; Writing – Review & Editing, I.N, L.A.S. and M. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Approval was obtained from teacher representatives from each school and the Education Office. The entire online survey was explained to students to be filled in themselves by first filling out the informed consent. Ethical clearance has been obtained from the Health Research Ethics Committee of the Faculty of Nursing Universitas Airlangga (ref: No: 1392-KEPK).

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Conflicts of Interest:

The authors declare no conflict of interest.

References

CIMSA. (2019). *Pernyataan Kebijakan HIV AIDS*.

Dehghani, A., Dehghani, P., & Dehghani, B. (2017). HIV/AIDS Knowledge and Attitude among High School Students in Shiraz, Iran in 2015. *Journal of Midwifery & Reproductive Health*, *5*(2), 897–903. https://doi.org/10.22038/jmrh.2017.8451

Dzah, S. M., Tarkang, E. E., Lutala, P. M., & Tarkang, E. (2019). Knowledge, attitudes and practices regarding HIV/AIDS among senior high school students in Sekondi-Takoradi metropolis, Ghana. *Afr J Prm Health Care Fam Med*, *11*(1), 1875. https://doi.org/10.4102/phcfm.v11i1.1875

Ghasemi, V., Simbar, M., Fakari, F. R., Naz, M. S. G., & Kiani, Z. (2019). The effect of peer education on health promotion of iranian adolescents: A systematic review. *International Journal of Pediatrics-Mashhad*, *7*(3), 9139–9157. https://doi.org/10.22038/ijp.2018.36143.3153

Guraya, S. Y., & Abdalla, M. E. (2020). Determining the effectiveness of peer-assisted learning in medical education: A systematic review and meta-analysis. *Journal of Taibah University Medical Sciences*, *15*(3), 177–184. https://doi.org/10.1016/j.jtumed.2020.05.002

Hamad Mohammed Ali, M., Babiker Osman, O., AE. M. Ibrahim, M., & Amen Mohammed Ahmed, W. (2015). The effect of AIDS peer health education on knowledge, attitudes, and practices of secondary school students in Khartoum, Sudan. *AIMS Public Health*, *2*(4), 718–726. https://doi.org/10.3934/publichealth.2015.4.718

Huda, M. N., & Amanullah, D. A. (2013). HIV/AIDS-Related Knowledge among Secondary School Students in Bangladesh: A Cross-Sectional Study. *Advances in Infectious Diseases*, *03*(04), 274–280. https://doi.org/10.4236/aid.2013.34042

Kemenkes RI. (2018). *Situasi Umum HIV/AIDS dan Tes HIV* (pp. 1–12). Pusat Data dan Informasi Kementerian Kesehatan RI.

Marni, & Nita. (2019). Hubungan Perilaku Beresiko Tertular HIV pada Remaja dengan Pengetahuan Pencegahan HIV / AIDS di Wonogiri. *PROFESI (Profesional Islam): Media Publikasi Penelitian*, *17*(1), 38–45.

Menteri Kesehatan RI. (2014). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 25 Tahun 2014* (pp. 1–24).

Nsuami, J. M., Sanders, L. S., & Taylor, S. N. (2010). Knowledge of sexually transmitted infections among high school students. *American Journal of Health Education*, *41*(4), 206–217.

https://doi.org/10.1080/19325037.2010.10599147

Nubed, C. K., & Akoachere, J. F. T. K. (2016). Knowledge, attitudes and practices regarding HIV/AIDS among senior secondary school students in Fako Division, South West Region, Cameroon. *BMC Public Health*, *16*(1), 1–10. https://doi.org/10.1186/s12889-016-3516-9

Nurmala, I., Ahiyanasari, C. E., Muthmainnah, Wulandari, A., Devi, Y. P., Pathak, R., & Pathak, Y. V. (2020). Emerging premarital sexual behavior among adolescent in indonesia: The impact of knowledge, experience, and media use to attitudes. *Indian Journal of Forensic Medicine and Toxicology*, *14*(4), 2864–2870. https://doi.org/10.37506/ijfmt.v14i4.12043

Nurmala, I., Ahiyanasari, C. E., Wulandari, A., & Pertiwi, E. D. (2019). Premarital Sex Behavior Among Adolescent : The Influence of Subjective Norms and Perceived Behavioral Control Toward Attitudes of High School Student. *Malaysian Journal of Medicine and Health Sciences*, *15*(3), 110–116.

Nurmala, I., Pertiwi, E. D., Devi, Y. P., Muthmainnah, & R, R. D. (2020). Perception of Roles as Peer Educators in High Schools to Prevent Drug Abuse among Adolescents. *Indian Journal of Forensic Medicine & Toxicology*, *14*(1), 1362–1366.

Nurwati, N., & Rusyidi, B. (2019). Pengetahuan Remaja Terhadap HIV-AIDS. *Prosiding Penelitian Dan Pengabdian Kepada Masyarakat*, *5*(3), 288. https://doi.org/10.24198/jppm.v5i3.20607

Othman, S. M. (2015). Knowledge about HIV/AIDS among high school students in Erbil city/Iraq. *Global Journal of Health Science*, *7*(1), 16–23. https://doi.org/10.5539/gjhs.v7n1p16

Pratiwi, N., & Basuki, H. (2012). Hubungan Karakteristik Remaja Terkait Risiko Penularan HIV-AIDS dan Perilaku Seks Tidak Aman Di Indonesia. *Buletin Penelitian Sistem Kesehatan*, *14*(4), 346–357. https://doi.org/10.22435/bpsk.v14i4

Rokom. (2021). *Stigma Negatif Masyarakat Hambat Eliminasi HIV AIDS di Indonesia*. https://sehatnegeriku.kemkes.go.id/baca/umum/20211201/3938917/stigma-negatif-masyarakat-hambat-eliminasi-hiv-aids-di-indonesia/

Shirin, S., & Ahmed, S. (1970). Knowledge of AIDS Among the Adolescent Students of Two Selected Colleges of Dhaka City. *Ibrahim Medical College Journal*, *1*(2), 5–8. https://doi.org/10.3329/imcj.v1i2.2897

Thanavanh, B., Harun-Or-Rashid, M., Kasuya, H., & Sakamoto, J. (2013). Knowledge, attitudes and practices regarding HIV/AIDS among male high school students in Lao People's Democratic Republic. *Journal of the International AIDS Society*, *16*, 1–7. https://doi.org/10.7448/IAS.16.1.17387

Tiranda, M., Setiyawati, N., & Rahmawati, A. (2018). Adolescents' Attitude toward HIV/AIDS Prevention in Yogyakarta. *Kesmas: National Public Health Journal*, *13*(2), 114–119. https://doi.org/10.21109/kesmas.v13i2.1672

UNAIDS. (2017). Ending AIDS Progress Towards the 90-90-90 Targets. *Global Aids Update*, 198. https://doi.org/UNAIDS/JC2900E

UNAIDS. (2019). *UNAIDS Data 2019*.

WHO. (2014). *Recognizing adolescence*.

Qualitative Study: Knowledge, Behavior and Risk Factor of Hypertension Community Living in Kwitang, Central Jakarta

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Abstract

Hypertension is a complex, multifactorial, and multisystem health disorder that is influenced by various elements, one of which is air pollution. Central Jakarta is one of the regions with the highest cases of hypertension in Indonesia, with the prevalence of hypertension based on direct measurement is 39.05%. Kwitang village, Central Jakarta is the area who had major cases with 55.3%. The purpose of this research is to explore knowledge, behavior, and risk factors of hypertension community living in Kwitang village, Central Jakarta, as well as hypertension prevention programs there. This research was being held on May 2023, using qualitative method by collecting data through deeply interviews with eight woman of hypertension patient on their productive age (18-55 age years). Supporting participants were also being involved in this research for the triangulation process, that was supervisor of non-communicable disease programs and supervisor of environmental health program at Kwitang public health center. Collected data then be analyzed with content analysis techniques. The result showed that participants knowledge of their own illness (cause, effect, prevention) were good enough, but health behavior to prevent the disease were still limited. It shows from there were so many risk factors experienced by the participants. Knowledge supports were being needed, in educational form from public health center.

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Introduction

Hypertension is one of the most prominent risk factors towards cardiovascular disease incident (Yusuf et al., 2004). Hypertension is either one of quite crucial medical condition that would affect the risk heart, brain, kidney and any other disease. Approximately 1,13 trillion of world population is suffering from hypertension where most of them lived in the lower middle-income countries. In 2015, one of four men and one of five women has been suffering hypertension. Hypertension also be the part of early death main reasons in the world (WHO, 2021).

Hypertension health problems is complex, multifactorial, and multisystem where high blood pressure is being impacted on various elements, there are genetic, environment, anatomy, adaptive, nerves, endocrine, humoral, and hemodynamic factor (Oparil et al., 2018). Air pollution as one of

environmental factors could impact the occurrence of hypertension, which previous research informing there were a relationship between short term exposure and long-term exposure of air pollution to the occurrence of hypertension (Curto et al., 2019).

In Indonesia, hypertension become noncommunicable diseases (NCDs), which cause highly attention. The result of Basic Health Survey (Riskesdas) 2018 showed hypertension prevalence in Indonesia on age ≥18 based on doctor diagnosis is 8.4%, while the prevalence based on direct measurement is 34.1%. One of province in Indonesia with the prevalence of hypertension over the national prevalence is Special Capital Region of Jakarta province. Hypertension prevalence in Special Capital Region of Jakarta province based on doctor diagnosis is 10.17%, while city with the highest prevalence of hypertension is Central Jakarta about 12.16% based on doctor diagnosis, and about 39.05% based on direct measurement while survey. With totals 7,383 of household members on Basic Health Survey in 2018, results obtained hypertension percentation in Central Jakarta based on doctor diagnosis that women is higher than men (12.57% compared to 7.76% (Riskesdas, 2018). Based on hypertension case report which comes from Central Jakarta health division, Kwitang village is one of the regions in Central Jakarta that has the highest cases of hypertension, about 55.3% (up to 1,001 cases of the total target 1,810 people).

In order to NCDs management particularly hypertension, Indonesian government had operated few programs, among them NCDs direction based on community via *Pos Pembinaan Terpadu* (Posbindu) NCDs. Posbindu NCDs is the form of community participation in order to manage the risk factor independently and continuous that being held integrated, routine, and periodic. The implementation of Posbindu NCDs is being held by health cadres in each region that being trained specifically (Kemenkes RI, 2012). Another government program is contained in Health Minister Regulations Republic of Indonesia number 39-year 2016 regarding maintenance guidelines of Healthy Indonesia Program (PIS PK) with family approach. In that program, hypertension is one of the main noncommunicable diseases that being concern and required to be controlled (Kemenkes RI, 2016). Family approach is absolute, that should be done if the management of hypertension want to be succeeded. At the provincial level, Special Capital Region of Jakarta local government on Jakarta Governor Legalizations number 25-year 2021 was controlling with regard to NCDs type, one of it is hypertension is becoming one of main NCDs that is required to be implemented with countermeasures by Health Division and community through public health efforts and individual health efforts (Gubernur DKI Jakarta, 2021).

Increasing high blood pressure or hypertension might occur due medical condition such as history of diabetes; unhealthy lifestyle such as excess sodium consumption, less physical activity, obesity, smoking behavior, and consuming alcohol (CDC, 2021). Close family history that been suffering hypertension, potentially increasing the risk of essential hypertension (Kemenkes.RI, 2014). Various research proved that factor of lifestyle would increase the risk of hypertension. Someone who had less activity has a risk of escalating high blood pressure or hypertension because of intensify the risk to appear (Ahmad Aswal Liambo, 2018; Nuraini, 2015).

Many of previous research regarding the risk of hypertension is including age, education level, professions, family hypertension history, noncommunicable disease history, smoking behavior, consuming alcohol, consumption of vegetables and fruits, and sleeping quality (Anggraeny & Martini, 2020; Babisch et al., 2014; Honda et al., 2018; C. Li & Shang, 2021; N. Li et al., 2019; Lin et al., 2017; Maulidina et al., 2019; Salean & Djaja, 2021; Utami, 2020). Environmental factor such as air pollution would also affect hypertension occurred, where based on previous research informing there are a relationship between short- term exposure and long-term exposure of air pollution to the occurrence of hypertension (Curto et al., 2019).

Public education potentially be the influential factor of the occurrence of hypertension, which with the hypertension knowledge owned by the sufferer could perform step by step the prevention against hypertension on their own body (Yulidar et al., 2023). Hypertension sufferer awareness regarding the disease on their body is the main key of medication adherence (Wolde Id et al., 2022). Hypertension patient that has well knowledge related to hypertension has a good correlation with the medication adherence that could supporting the control of blood pressure (Magadza et al., 2009). Along with various government running program that being implemented by health center as the front line in providing health treatment to public, therefore health workers have a significant role involving the succeeded of the programs. High cases of hypertension on Central Jakarta society, particularly in Kwitang village, it attracts the researchers to study deeply concerning knowledge, behavior, and risk factor of hypertension sufferers.

The purpose of this research is to discover knowledges, behaviors, and risk factors that being suffered by the hypertensive community living in Kwitang sub-district, Central Jakarta along with hypertension hypertension prevention programs in that region.

Methods

This research used qualitative study method with phenomenology approach. Phenomenology approach researching the experiences of someone is universal against a phenomenon that being experienced on daily life (Afiyanti & Imami Nur Rachmawati, 2014). This study was learning about perception, knowledge, what hypertension participant felt, and the program that already running in regional area. Participants in this research were productive age women that has been fulfilled research criteria. As for inclusion criteria participations in this research was the productive age woman (18-55 years) that being suffered from hypertension who domiciled and native people in Kwitang village, Senen, Central Jakarta, willing to be a participant of research, capable to well communicate where the participants be able to telling their experiences along with hypertension properly and what they knew regarding hypertension.

In selecting participant, the researcher assisted by local community leaders, namely RW leaders andlocal cadre. At the early stage, we create the list name of community which suffering hypertension based on blood pressure direct measurement via *Pos Pembinaan Terpadu* (Posbindu) activity for the last 1 month. From the list of names obtained, the researchers were made a participant election based on inclusion criteria, which result as many as 8 people. The interview was being held with agreed appropriated time and participants are being gathered in local community leader's citizen hall, that later being interviewed. Supporting participant are also being included for triangulation process, which is supervisor of counter measurement program regarding noncommunicable diseases (NCDs) who had a duty to providing public health services regarding NCDs particularly hypertension in Kwitang village public health center.

Data collection carried out through deeply structured interviews with the woman sufferer participant in productive age (18-55 years) by using tools likely interview guidance, notebooks, and voice recorder tool. Interviews conducted in May 2023. Collected verbal description data of participant by a voice recorder tool later be listened and be made in the form of verbatim transcripts, which were make a transcript as similar as the informant said, without addition, change, and refinement of interview result (Martha & Kresno, 2017). Transcripts result later be read and understood repeatedly and thoroughly that later be created matrix and carried out grouping based on data corresponding with many sub-topics or theme which already determined. The result of matrix and grouping later performed data analysts with content analysistechnique. Data analysts be performed based on theme that has been arranged and guided in the research purpose for later displayed systematically in the form of information that easily be read and understood (Martha & Kresno, 2017).

Results

Participant Characteristic

About eight productive age women who suffering hypertension were consolidated as participant in the interview which could be seen in the following table

Table 1.
Characteristic of hypertension participant in Kwitang sub-district, Central Jakarta

Partisipant	Age (year)	Last Education	Occupation	Ethnic Group	Duration of Stay (year)	Duration of Hypertension
P1	48	SMA	Not working	Padang	28	28 tahun
P2	53	SMA	LMK Leader*	Sunda	48	44 tahun
P3	48	SMP	Not working	Jawa	44	18 tahun
P4	45	SMP	Not working	Sunda	23	5 tahun
P5	39	S1	Not working	Betawi	39	1 tahun

P6	49	SD	Not working	Sunda	47	14 tahun
P7	25	SD	Washing Worker	Betawi	25	43 tahun
P8	44	SD	Boarding Housekeeper	Jawa	12	1 bulan

*Sub district Council of Kwitang

Participant who had involved in this research are within the age range 25-23 years old and had been lived over five years in Kwitang village, Central Jakarta. Most of the participants was a housewife which do not work (around five people) with different ethnic groups. The majority last education of participants is finishing school education and one person with higher education. Regarding hypertension disease, most of participants had been diagnosed hypertension for years.

Then we carried out triangulation within two health workers in Kwitang public health center i.e., NCDs program supervisor who are responsible towards implementation of NCDs programs on public particularly hypertension. Environmental health sanitarians also be interviewed regarding air pollution program that had been run by public health center. Both education was diploma with each of age 30 and 52 years old. The working period of NCDs program is within three years and Environmental health program supervisor within four years. Environmental health

Initial Overview of Diagnosed Hypertension

Based on characteristic data, most of participants had known that they were suffering hypertension since a long time. The beginning diagnosed with hypertension could be known by indication and symptom that been felt or known while been checking into the nearest health facility. Mainly participant undergone hypertension symptoms with the most common symptoms there are had a dizzy on their head, heavy head as it being stabbed. Most common symptoms are dizzy on their head as what the participant felt below.

"......I was on my 20 when I had frequently dizzy on my head. I thought it was just something as usual, and then I just drank a medicine after that, but it turns out my hypertension is keep increasing" (P1, 48 Years old)

"Just a headache nothing more than that." ...." When I burned out, yeah, I already knew it was exactly the time when it is getting high" (P2, 48 Years old)

About two participants had diagnosed hypertension when they were getting the second and third pregnant in the age over 30. During pregnancy they did not feel any of hypertension symptoms. However, when the pregnancy examination was eight months old, it was diagnosed with hypertension as in the following participants.

"When I was pregnant" .... "When I was pregnant, right. It's been 8 month I was getting controlled. Ma'am why the blood pressure was so high, 200/100 they said" .... "I know nothing about getting high blood pressure" (P3, 53 Years old)

One participant stated that she had not known that she had been diagnosed with hypertension for a long time, namely when she was pregnant with his third child in 2022. The participant was diagnosed with hypertension during a pregnancy examination at 6 months of gestation, so the baby had to be born prematurely at 31 weeks, and the mother became blind after giving birth

"Hmm, it is not a quite long time. So, when I was getting the third child pregnant, I was checking for 6 months of pregnant if I'm not mistaken" .... "When I were getting checked I was being asked, but then I'm getting blood pressure because of 160 or 180, uh 160" .... "The birth is premature...yes, I'm getting sightless" .... "Up to 200 if I'm not mistaken" .... "Apparently I'm getting high blood pressure since then, the time when I was getting third child pregnant" (P5, 39 Years old)

Beside hypertension symptoms, participants were getting blood pressure into medical facility, such as public health center, hospital, midwife practice, as well as in Posbindu activity. One participant stated that she had her own blood pressure monitor at home.

"Went to the doctor" .... "I used to get checked at public health center if I'm not mistaken, in Kwitang"
"Yes, that was it, high blood pressure" (P7, 44 Years old)
"In Kwitang public health center. At first is from public health center, but then I was referred and getting medicines from hospital until now" (P1, 48 Years old)
"There is Posbindu right here" .... "Eventually, sometimes I went there within 2 weeks, just so I knew hypertension, well, long time I had my own monitor, to checking on my house" (P2, 48 Years old)

Knowledge about Hypertension

Participants hypertension knowledge against the disease that being suffered basically could be obtained from various sources such as family, friends, education, mass media and health counseling

activities from local health workers (Setiono, 2010). In this research, knowledge was obtained by participants from Posbindu activities or during visits to the Kwitang Public Health Center. Health knowledge about hypertension includes the causes of hypertension, the dangers or effects of hypertension, and prevention of hypertension. The results of in-depth interviews with eight participants regarding the causes of hypertension, there were various participants' answers regarding the causes of hypertension with majority due to behavioral factors such as consumption of foods containing salt or coconut milk, lack of rest, lots of thoughts, rarely exercise, fatigue, the body is not fit. The results of the interviews are proven below.

"I think it because thoughts, that's what I knew" (P3, 53 Years old)

"As far as I knew, when I'm getting underwhelmed or what It is, I think it because too many thoughts" (P7 Years old)

The other most answered cause of hypertension mentioned it because excessive consuming foods contained salt (salty).

" They said too much consuming salt" (P5, 39 Years old)

"Well, i'm confused where it came from, it could be food, right. My doctor said, ma'am please reduce something salt, you know sometime I like salt" (P1, Years old)

There was a participant who answered that hypertension was caused by heredity and there was other participant who did not know the cause of hypertension at all.

"Hmm, yes, I am a hereditary factor maybe " (P5, 39 tahun)

Furthermore, participants' knowledge was explored regarding the dangers of the disease and the prevention that could be done. Generally, participants already had good knowledge regarding the dangers or effects of hypertension. All participants stated that hypertension is a dangerous disease for various reasons, which is it can cause strokes, heart attacks, falls in the bathroom, and is dangerous if it left untreated. The results of the interviews are proven as follows.

"Actually, it was dangerous doctor said, ma'am if it is not being cured it will getting worse into stroke. Is that true? "(P1, 48 Years old)

"Dangerous" …. "The danger could run worse into heart" (P2, 48 Years old)

"I think it's dangerous, the problem is if you had high blood pressure and you enter bathroom then slip in it, it will be fatal" (P3, 53 Years old)

"If you say it's dangerous, it really is. Because if it left untreated, I felt I cannot do anything" (P4, 45 Years old)

Exploration of participant knowledge was then carried out regarding the knowledge possessed whether hypertension could be prevented and how prevention efforts could be made. All participants answered that hypertension can be prevented, with various answers, namely hypertension can be prevented with a good lifestyle, do not think too much if there is a problem, routinely check blood pressure to the health center, eat lots of fruits, take medication continuously, drink star fruit juice and celery, and routine consumption of vitamins.

"Taking medicine, taking medicine every day. We cannot stop, isn't it" …. "Yeah, I think drinking various of juice such as starfruit, celery, cucumber" (P5, 39 Years old)

"Many people said, it could be this way, drinking juice or a food that could heal this" (P7, 44 Years old)

"Uuh, it's possible if they had a good lifestyle. Then if you have a problem, don't think about it too much, that's the cause either. Then exercising, right? Exercising" (P2, 48 Years old)

The researcher tried to triangulate with the health center staff responsible for the NCD program at the Kwitang Village Health Center. The results of the interviews stated that the NCD activities that had been carried out by the public health center such as hypertension and sugar screening. Routine activities, namely posbindu every once a month and the Chronic Disease Management Program (Prolanis) once every six months. The public health center also cooperates with the Prodia laboratory to check blood in patients with hypertension and diabetes mellitus.

"If we had NCD for screening, hypertension screening, sugar screening is what we do. But then there is a posbindu activities, from sort of pronalis." (Key informant 1, 30 Years old)

"Ow posbindu is every month, correct every month. If prolanis hmm because of it is the cooperation with prodia, so it is every 6 months" (Informan 1, 30 Years old)

For coaching related to hypertension there is a specific class but only for cadres in the form of outreach activities by doctors at the public health center, regarding to hypertension and its risk factors for counselling related to hypertension to the public that is only carried out during posbindu activities. Screening and providing referrals for people who experienced high blood pressure are carried out only in posbindu activities, but those who have never attended posbindu are not netted. Key informants did not

really understand what a risk factor for hypertension was, when asked the answer was the dangers of hypertension.

"There is. There is a class if it is. So, there is a counselling, then the doctor explained regarding prevention, such as like that, we usually prioritize the cadre first" …. "Later if the cadre done, we bring it to public, but we go down to the field at posbindu, so just do counselling" (Key informant 1, 30 Years old)

Knowledge about Air Pollution

Knowledge about air pollution in this study was conducted to explore participants' knowledge regarding the definition of air pollution, the definition of particulate matter (PM$_{2.5}$) and its dangers. The results of in-depth interviews showed that most of the participants had never heard of the term air pollution. One participant can answer close enough, namely participants with the last undergraduate education.

"Air pollution, I was, exhaust fumes, yeah dusts, what again? Yeah, that's it" (P5, 39 Years old)

Two of participants did not know anything, whilst the other five people answered that they were hearing about air pollution but with an incorrect answer.

"I was, as if air pollution, because of eugh what is the name, some sort of TBC through birds. Then Droplet COVID yesterday, that is also including air pollution" (P2, 48 Years old)

"I was, I was, firstly, people throw the rubbish. After that what is it? which the drain water was clogged, that's what I knew" (P3, 53 Years old)

Furthermore, participant be explored regarding one of air pollution which is particulate matter 2.5 microns (PM2,5). Whole participants answered that they never heard PM2,5 term and the risk.

"Barely know" (P6, 49 Years old)

"Never heard of" (P8, 25 Years old)

"Don't know" (P4, 45 Years old)

The researchers conducted a triangulation with the health center staff responsible for the environmental health program at the Kwitang Village Health Center. The results of the interviews stated that the programs that were already running included Environmental Health Inspections (IKL) of public places, places of worship, schools, hotels and markets. The activities for public, which is the construction of healthy homes. There has never been any coaching and education regarding air pollution problems in the Kwitang Village.

"We had IKL public places, worship place, school, hotel, market, that is TTU okay. If inside the building there is polyclinic, there is a counselling, the environment-based disease is just diarrhea" (Key Informant 2, 52 Years old)

"There is also available for family, regarding building healthy homes" (Key Informant 2, 52 Years old)

"We don't have specific air yet, for the air. We didn't have air pollution on sub-district level yet. There is just some sort of lightnings on public health center" (Key Informant 2, 52 Years old)

Patient's Behavior

The behavior of suffering from hypertension explored in this study is related to the frequency of participants attending posbindu activities in their area and adherence to taking hypertension medication. This behavior is included in the sick role behavior where sick people (patients) had a role that includes the rights of sick people or obligations as sick people, including actions to obtain healing, know or find out the facilities or appropriate service/healing facilities. The results of the interviews showed that most of the participants routinely attended posbindu activities which were held once a month.

"Routine every month, if my in-laws didn't go, I'll even invite them" (P4, 45 Years old)

"Routine" (P8, 25 Years old)

"I like to come, every month" (P3, 53 Years old)

The routine attendance of respondents was due to wanting to know their respective blood pressure. Particularly the participants also knew the results of blood pressure during posbindu activities in the last month.

" Yesterday, 140/100" (P1, 48 Years old)

"150, I forgot the ratio, around 110 or 121 I guess. As I remember the ratio is high" (P5, 39 Years old)

"Yesterday is 170/100" (P3, 53 Years old)

The other behavior of participants is regarding adherence to taking hypertension medicine, where by five people was consuming the medicine but just three participants who was consuming medicine once a day routinely, and the other two participants not routinely.

".... Since I had hypertension and high cholesterol. That's why I never stop consuming medicine" (P1, 48 Years old)

".... I definitely, once a month. Because the medicine was given once a month. For 1 month hypertension" .... "Amoldiphine 10 ml and another is arseton if I'm not mistaken" (P2, 48 Years old)

".....I got caught for never taking a medicine. I rarely went to Cipto for control because I was feeling Indolent. Ma'am you've got high blood pressure, must be you never taking medicine, isn't it? No, I said. Public health center gave me amoldiphine 10 ml" (P5, 39 Years old)

Other participants only took over-the-counter medication to relieve symptoms of hypertension, or only consumed fruit juice. Participants who did not take hypertension medication reasoned that they did not like taking medication.

"After that I drink, starfruit juice, with a blood-lowering drug which is I forgot what is the name" .... "I want to be honest; I don't like taking medicine. I don't like taking medicine since a long time when I was a teenager" (P3, 53 Years old)

"Occasionally I'm taking paramex" .... "I was, with doctor, I forgot who he is, in public health center, ma'am this is vitamin, this is high blood pressure medicine, this is headache medicine" .... "I just take medicine once, when I feel better, it's done" (P6, 49 Years old)

Risk Factor of Hypertension

The risk factors of hypertension were divided into two parts, namely factors that cannot be changed and those that can be changed. The irreversible risk factors for hypertension in this study were family history and co-morbidities. As many as three participants had a history of hypertension in their parents, while the rest had no family history of hypertension.

" Back in the day, before my father and my mother died. That's why currently my child also got hypertension" (P1, 48 Years old)

"I think my parent, my father frequently getting high blood pressure here" (P7, 44 Years old)

"It just because descendants, my mother had high blood pressure" (P5, 39 Years old)

Medical condition would also trigger hypertension risk. Almost all participants had another co-morbidities disease there were diabetes, heart, cholesterol, heart attack, and obesity.

".... My chest hurt when I'm getting this" .... "not getting tight feeling, but the pain felt like getting stabbed so many time" (P8, 25 Years old)

"Felt like soaked lungs? Yes i felt that. Then because the lungs getting soaked constriction of the heart occurs, that's it" (P5, 29 Years old)

".... Hypertension, heart, cholesterol. I was getting diabetes that time, 136 is counted high" (P1, 48 Years old)

Modifiable risk factors for hypertension are related to behavioral factors including smoking behavior, alcohol consumption, sleep quality, physical activity and vegetable along fruit consumption. Some of the participants had smoked and some were still smoking to this day. One participant mentioned that smoking could be a sedative when you are depressed.

"I was smoking when I was young" .... "I think it's around 18 years old, I already entered high school" .... "Currently sometimes" .... "So, if medicines ran out, I will be depressed, then I will smoke, it just felt better. Finally, I be able to sleep after that" (P4, 45 Years old)

"Sometimes when I gathered with my friends, I still smoke one to two sticks. I used to get three packs a day" (P2, 48 Years old)

For alcohol consumption, particularly participant had never consumed alcohol beverages, only three participants was consuming alcohol.

"Honestly, I was, when I was still working, but then I just stopped (respondents lowered their voices when answering)" (P1, 48 Years old)

"No. Oh long long time ago. Ah now I was not." (P2, 48 years old)

Regarding sleep quality, some participants mentioned they never had sleep disorder, but as much three participants answered they felt sleep disorder such as, insomnia too much thoughts, and dizzy that being caused of awake at night.

" .... I frequently sleeping with a sort of insomnia, I guess. When it's already over 12 o'clock, my eyes start rising again. But when it comes under 12 o'clock, I would sleep" (P2, 48 Years old)

" I am the type of sleepless person, especially as a housewife, I had a child that just graduated still not get a job, their brother also, these always on my mind" (P3, 53 Years old).

"If it felt like dizzy, I am not, it just like, you know, my oldest child frequently getting home uncertain, that's it" (P4, 45 Years old)

The participant's physical activity was still relatively light and heavy, because most of them were housewives who spent a lot of time on daily household activities.

".... I take care of my mother everyday; my mother is elderly by now. One child, me even with grandchildren." (P1, 48 Years old)

"In the morning, after prayed subh, I immediately bathe the young child, after took my young child to school, I went home to taken care of the second child for college" .... "Then I'll pick them up at 10 for tutoring, took a short break to watch YouTube, pick them up again and went home, that's it." (P4, 45 Years old)

For consumption of vegetables and fruit, some of the participants only consumed vegetables regularly, and about two people consumed vegetables and fruit regularly.

"I rarely consumed fruit, but sometimes I ate that. But I eat vegetables every day." ... "not really into it" (P7, 44 Years old)

"I ate vegetables, but rarely fruit" ... "Just as soon as I found it, If I do want to eat fruit, I will buy it if I didn't, I won't" (P5, 39 Years old)

"I frequently forgot about fruit, I eat vegetables, but not every day I guess" .... "I will make juice for fruit sometimes, but I rarely consumed veggie, not a daily routine" (P2, 48 Years old)

In exploring risk factors for hypertension, researchers also explored participant's perceptions about the dangers of smoking and the importance of consuming vegetables and fruit. Regarding smoking behavior, all participants answered that smoking was harmful

"Of course, it was dangerous" .... "The danger of lungs disease, many people said they will have felt tight on their chest" (P7 Years old)

"Uh very dangerous" ... "Sore chest, cough frequently" (P8, 25 Years old)

"Dangerous, my husband has had slit on his neck because of smoking, because thyroid" .... "Nowadays smell cigarettes is just not good for me" ... "Cigarettes are already bitter for me" (P2, 48 Years old)

Among all the participants, there was a person who thought that smoking was harmful but also brought benefits to her.

"If you say it's dangerous, yes, it called smoke. But think about it, it's beneficial for me. Because when I smoke a cigarette, my head felt like getting touched, so my brain becomes bright again. But if you're dizzy, no cigarettes already, it's wrong to sleep, it's wrong to want this and that" (P4, 45 Years old)

The perception of people with hypertension regarding the importance of consuming vegetables and fruit, all participants answered that consumption of vegetables and fruit is important for health, good for the skin, good for digestion, and to increase energy.

"It is so important actually, why I am not regularly eating? Hehehe. In sanity fruit and veggies are good for skin. " .... "If I felt stuffed, I continue (eating fruit), 'till I forgot that I still eat fruit" (P2, 48 Years old)

"That is good miss, for digestion defecation" (P6, 49 Years old)

"It's important for health as well. Mmm what was it, not letting our bodies be like that. Many people said eating vegetables to be healthy, then I also eat every fruit" (P1, 48 Years old)

Discussion

This study was conducted in women on productive age living in urban area, Kwitang sub-district, Central Jakarta City. The average age of participants was in fourty years, it almost in the middle age of live. Majority of participants had low education, were graduated from elementary school, follow with graduated from junior high school. In general, risk of hypertension was higher in men than women, however in middle age and older, the incidence in women increases. It was happened because the incidence of stress in women increased, related with menopause period (Irianti et al, 2021). All of the participants have been living in Kwitang sub districts more than five years, which means there were expose from the same source of air pollution. Kwitang sub districts especially RW 2 and 5 located near the road and the main road that was Kwitang road (less than 500 meters). Previous study regarding exposure to ambient particulate matter air pollution, blood pressure and hypertension in China shows that exposure of long-term air pollutant ($PM_{2,5}$ dan PM_{10}) relate with the increasing of hypertension prevalence in children and adolescents (Zhang et al., 2019). Length of participant living in study area along with length of suffered from hypertension.

In this study, we have highlighted the participant's experience about how they diagnosed with the disease, symptoms, and which selected health care facilities to check their blood pressure. Here in this study, several participants did not know suffered with hypertension until they experience the symptom including severe headache. After the symptom appear, participants then checked their blood pressure in the health care immediately. It was in line with other study that participant diagnosed by chance in a

hospital or primary health care (Boitchi et al., 2021). Researchers found that participants with hypertension asymptomatic in the early stages or have temporary symptoms, then mostly participants did not consider high blood pressure as a disease did not pay attention to it. These finding in line with previous study that high blood pressure was a silent disease and almost no obvious symptoms and serious complications in its early stages (Shamsi et al., 2017).

Most of participants only had their blood pressure assessed during visits to the doctors in primary health care on in "posbindu" events one e month. Only one of participants had her blood pressure set at home and use it regularly to monitor her blood pressure. Previous research in Malaysia found that patients who self-monitors their blood pressure were tends to be more involved in discussion about their blood pressure control (Abdullah & Othman, 2011). In Northeast Ethiopia, Participants having good knowledge about hypertension self-care were more likely to have blood pressure self-monitoring practice than participants having poor knowledge about hypertension self-care (Edmealem et al., 2023).Several participants diagnosed with hypertension during pregnancy when their had pregnancy checkup in health care facilities. That condition refers to pregnancy induced hypertension (PIH) that happened in a pregnant woman attending delivery service with high blood pressure (≥140/90 mmHg) after 28 weeks of gestation. Pregnancy induced hypertension diagnosed by a physician and it includes gestational hypertension, pre-eclampsia and eclampsia (Abera Gudeta & Mekonnen Regassa, 2018).

The first theme in this study was regarding knowledge of participants about hypertension. It was highlighted participant's understanding of cause of the disease, disease effects, and disease prevention. Research finding show that most of participants comments that hypertension caused by modifiable risk factors such as eat too much salty food, fatigue, anxiety, physical inactivity, and unhealthy body. All of the comments describe by participants in the low and middle education. Another participant with higher education comments that hypertension happens caused by modifiable risk factor that is eat too much salty food and non-modifiable risk factor that is family history of hypertension. Knowledge was closely related to education, which participant in higher level of education achieved a higher level of knowledge as has been reported in other studies(Halgato et al., 2020). It was clear that cause of hypertension consists of modifiable risk factors include unhealthy diets (eat too much salt, diet high of saturated fat and trans fats, and low intake of fruits and vegetables), physical inactivity, tobacco and alcohol consumption, and being overweight or obese. Another was non-modifiable risk factors include family history of hypertension, age over 65 years and co existing disease such as diabetes or kidney disease (WHO, 2021).

Another exploration was regarding participant's understanding about disease effect in the future and disease prevention. All of participants knew that hypertension was danger and causing stroke, heart disease, fell in the bathroom, and dangerous if untreated. Uncontrolled hypertensions cause other complication that is serious damage to the heart. Excessive pressure making arteries harder, the flow of blood and oxygen to the heart decrease. This condition cause heart attack, chest pain, heart failure, stroke, and kidney damage (WHO, 2021). Some of participants can explain the effect of hypertension and other only guess what the effect. Researchers also explore knowledge of participants regarding disease prevention. Half of participants explain that hypertension could be prevent by controlled the blood pressure regularly in health facilities and take of medicine routinely. The others told that hypertension could be prevent by controlling lifestyle such as be more physically active, drinking juice (star fruit), eat more fruit and vegetables, and take vitamin. It was in line with other study and theory that could be prevent by physical activity regularly, eat more vegetables and fruits, sleep adequately, and reduce salty (Irianti et al., 2021; WHO, 2021).

Adherence of taking hypertensive medicine was the important things to control the disease. Based on the results, most of participants taking medicine but only three of participants taking medicine regularly (once a day). Amlodipine was the common blood pressure medicine that was taken by the participants in Kwitang sub district. Two of participants only taking medicine when the symptoms appear. Two other participants took medicine from traditional counter to reduce the symptoms, and the other did not take medical treatment. Variation of participants adherence of taking hypertensive medicine caused by the awareness of them become addicted with the medicine. Some of participants explain that they felt healthy, so they did not necessary of taking medicine. Previous study showed, because hypertension requires continued treatment, patients thought that when the symptoms not appear, so they are not necessary to take hypertensive medicine(Ashoorkhani et al., 2018). Others emphasize the negative of medicine, they were afraid of taking it because of side effects as participant in the previous study(Boitchi et al., 2021; Salami, 2021). Other study has found that side effects of taking hypertensive medicine and the concern about its addictions to patients had led to lower the adherence of taking hypertensive medicine (Marshall et al, 2012). Lack of adherence of taking hypertensive medicine was the main predisposing factor the increasing of blood pressure (Unger et al., 2020).

Research findings about risk factors of hypertension among participants in Kwitang sub-district shows that participants experience in non-modifiable and modifiable risk factors. Several participants having family history of hypertension, both of their parents or only one of them. These findings in line with previous study that respondents with family history of hypertension also suffered with the disease (Sinuraya et al., 2017; Wahyuningsih & Arsi, 2021). Medical condition also related to the increasing of blood pressure leading to hypertension. Several participants suffering of the other disease beside hypertension such as diabetes, heart, cholesterol, heart attack, and obesity.

Almost all of participants experience in the modifiable risk factors regarding daily lifestyle such as smoking habits, alcohol consumption, sleeping quality, fruits and vegetables consumption, and physical activity. Surprisingly, although all of participant was a woman, half of them was a smoker, and several was still active until now. Most of active smoker said that they consume tobacco because of following their friends as solidarity. Previous study shows that smoking was a trigger of hypertension because it could reduce vascular tolerance to the damage that increase the blood pressure (Leone, 2015.) Someone that active smoker has a chance 1.86 times of getting hypertension (Singh & Purohit, 2011). About alcohol consumption, three participants experience of alcohol consumption, but they have stop now. Quit from smoking and reducing alcohol consumption could controlling the nervous system which leading to lowering blood pressure (Riyadina et al., 2019). Previous study indicate that incidence of hypertension influenced by unhealthy of modern lifestyles which tend to reduce physical activity (exercise), alcohol consumption, drinking coffee, smoking and prolonged stress. All of these were triggers for high blood pressure (Hamdana et al., 2018).

Activity of participants was still categorized as light until moderate because most of participants was a housewife (not working). All of them never doing any physical exercise beside of daily activity as a housewife. Being physically active such as increasing aerobic physical activity could help lowering high blood pressure(Irianti et al., 2021; WHO, 2021). In hypertensive patients, exercise is known as one of the non-pharmacological treatments. Sports was different from homework activities, because in exercise it must include the type, procedure and duration of it. Hypertensive patients recommended to exercise lightly and regularly at least three until five times a week with intensity of approximately 30 minutes. It could provide any benefits and also balance with sufficient activity (WHO, 2017). The daily of fruit and vegetables consumption of all participant were good enough, although only a few participants consume fruit together with the vegetables regularly. Consuming food and vegetable high fiber such as greens, banana, tomato, carrot melon and orange could help to prevent and lowering high blood pressure (Irianti et al., 2021; WHO, 2021).

However, all of the risk factors of hypertensive participants could be reduced by changing the lifestyle. Lifestyle changes could effectively lower blood pressure that equivalent to one dose of antihypertensive drugs (Beevers et al., 2001).

Conclussion

Knowledge of participants in Kwitang sub-district regarding hypertension (cause, effects and prevention) were good enough, but health behaviour to prevent the disease were still limited. It shows from research findings there were so many risk factors experienced by the participants. Being a lifelong illness, hypertension requires continued treatment, therefore identifying and controlling its risk factors could help to prevent the disease. Hypertensive prevention program in Kwitang sub-district has been done by public health centerofficer through "posbindu" program, but education regarding risk factors of the diseases still limited. Public health center in Kwitang sub-district should encourage hypertension programmes especially regarding its risk factors using promotion media which consider accessibility to the community. Further research with another characteristic of participants is suggested for researchers.

Author Contributions

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Institutional Review Board Statement

This research has been reviewed and passed the ethical clearance from Faculty of Public Health Universitas Indonesia with the reference number of Ket- 36/UN2.F10. D11/PPM.00.02/2023

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Conflicts of Interest:

The authors declared no conflict of interest in this study. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

Abdullah, A., & Othman, S. (2011). The influence of self-owned home blood pressure monitoring (HBPM) on primary care patients with hypertension: A qualitative study. *BMC Family Practice*, *12*(1), 1–8. https://doi.org/10.1186/1471-2296-12-143/TABLES/1

Abera Gudeta, T., & Mekonnen Regassa, T. (2018). Pregnancy Induced Hypertension... Pregnancy Induced Hypertension and Associated Factors among Women Attending Delivery Service at Mizan-Tepi University Teaching Hospital, Tepi General Hospital and Gebretsadik Shawo Hospital, Southwest, Ethiopia. *J Health Sci*, *29*(1), 831. https://doi.org/10.4314/ejhs.v29i1.4

Afiyanti, Y., & Imami Nur Rachmawati. (2014). *Metodologi Penelitian Kualitatif dalam Riset Keperawatan*. PT Rajagrafindo Persada.

Ahmad Aswal Liambo, author. (2018). *Hubungan aktivitas fisik dengan hipertensi pada penduduk dewasa di Indonesia (analisis data IFLS 5 tahun 2014) = Physical activity and hypertension among Indonesian adults (analysis of the IFLS 5 data in 2014)*. Universitas Indonesia. Fakultas Kesehatan Masyarakat. https://lib.ui.ac.id

Anggraeny, N., & Martini, S. (2020). Hubungan Perilaku Merokok Dengan Tekanan Darah Sistolik Dan Tekana Darah Diastolik Pada Awak Kapal Di Wilayah Kerja Kantor Kesehatan Pelabuhan Palangkaraya. *MTPH Journal*, *4*(2). https://journal2.unusa.ac.id/index.php/MTPHJ/article/view/845/1196

Ashoorkhani, M., Majdzadeh, R., Gholami, J., Eftekhar, H., & Bozorgi, A. (n.d.). *Understanding Non-Adherence to Treatment in Hypertension: A Qualitative Study*.

Babisch, W., Wolf, K., Petz, M., Heinrich, J., Cyrys, J., & Peters, A. (2014). Associations between traffic noise, particulate air pollution, hypertension, and isolated systolic hypertension in adults: The KORA study. *Environmental Health Perspectives*, *122*(5), 492–498. https://doi.org/10.1289/ehp.1306981

Beevers, G., Lip, G. Y. H., & Brien, E. O. (2001). ABC of hypertension: Blood pressure measurement: Part 1—Sphygmomanometry: Factors common to all techniques. *Bmj*, *322*(7298), 1349.

Boitchi, A. B., Naher, S., Perve, S., & Md. Mujibul Anam. (2021). Heliyon Patients' understanding, management practices, and challenges regarding hypertension : A qualitative study among hypertensive women in a rural Bangladesh. *Heliyon*, *7*(July), e07679. https://doi.org/10.1016/j.heliyon.2021.e07679

CDC. (2021). *High Blood Pressure Symptoms and Causes | cdc.gov*. https://www.cdc.gov/bloodpressure/about.htm#causes

Curto, A., Wellenius, G. A., Milà, C., Sanchez, M., Ranzani, O., Marshall, J. D., Kulkarni, B., Bhogadi, S., Kinra, S.,

& Tonne, C. (2019). Ambient Particulate Air Pollution and Blood Pressure in Peri-urban India. *Epidemiology*, *30*(4), 492–500. https://doi.org/10.1097/EDE.0000000000001014

Edmealem, A., Geleta, E., Mengesha, Z., Tegegne, B., Ademe, S., & Liknaw, T. (2023). Blood pressure self-monitoring practice and associated factors among adult up at hypertensive patients on follow- South Wollo Zone Public Hospitals , Northeast Ethiopia. *Open Heart*. https://doi.org/10.1136/openhrt-2023- 002274

Gubernur DKI Jakarta. (2021). *Peraturan Gubernur DKI Jakarta Nomor 25 tahun 2021 tentang Pengendalian Penyakit Tidak Menular* (Vol. 2019, Issue 93, pp. 9–11).

Halgato, T. I., Kaloci, D. K., Grujić, R. N., Mora, S. J., Tomas, A. D., Kusturica, M. M. P., & Horvat, O. J. (2020). The Influence of Patients ' Knowledge of Hypertension on the Control of Their Blood Pressure - Qualitative Study A. *Hospital Pharmacology*, *9492*(2), 942–953. https://doi.org/10.5937/hpimj2002942H

Hamdana, Amin, N., & Misra. (2018). The Effect of Health Education On Blood Pressure Behavior Behavior In Hypertension Patients. *Comprehensive Health Care*, *2*(3), 124–131.

Honda, T., Pun, V. C., Manjourides, J., Suh, H., Author, C., Honda, T. J., & Res Author manuscript, E. (2018). Associations of long-term fine particulate matter exposure with prevalent hypertension and increased blood pressure in older Americans HHS Public Access Author manuscript. *Environ Res*, *164*, 1–8. https://doi.org/10.1016/j.envres.2018.02.008

Irianti, C. H., Antara, A. N., & Jati, M. A. S. (2021). Hubungan Tingkat Pengetahuan Tentang Hipertensi dengan Tindakan Pencegahan Hipertensi di BPSTW Budi Luhur Bantul. *Jurnal Riset Daerah*, *21*(3). https://ojs.bantulkab.go.id/index.php/jrd/article/view/56

Kemenkes RI. (2012). Petunjuk Teknis Pos Pembinaan Terpadu Penyakit Tidak Menular (Posbindu PTM). In *Ditjen Pengendalian Penyakit dan Penyehatan Lingkungan, Kementerian Kesehatan RI.* http://p2ptm.kemkes.go.id/uploads/2016/10/Petunjuk-Teknis-Pos-Pembinaan-Terpadu-Penyakit-Tidak- Menular-POSBINDU-PTM-2013.pdf

Kemenkes RI. (2016). *Peraturan Menteri Kesehatan No. 39 Tahun 2016 tentang Pedoman Penyelenggaraan Indonesia Sehat dengan Pendekatan Keluarga.* https://peraturan.bpk.go.id/Home/Details/113087/permenkes-no-39-tahun-2016

Kemenkes.RI. (2014). Pusdatin Hipertensi. In *Infodatin* (Issue Hipertensi). https://doi.org/10.1177/109019817400200403

Leone, A. (n.d.). Smoking and Hypertension. *Journal of Cardiology & Current Research Smoking and Hypertension*, *2*. https://doi.org/10.15406/jccr.2015.02.00057

Li, C., & Shang, S. (2021). Relationship between sleep and hypertension: Findings from the nhanes (2007 – 2014). *International Journal of Environmental Research and Public Health*, *18*(15). https://doi.org/10.3390/ijerph18157867

Li, N., Chen, G., Liu, F., Mao, S., Liu, Y., Hou, Y., Lu, Y., Liu, S., Wang, C., Xiang, H., Guo, Y., & Li, S. (2019). Associations of long-term exposure to ambient PM 1 with hypertension and blood pressure in rural Chinese population: The Henan rural cohort study. *Environment International*, *128*, 95–102. https://doi.org/10.1016/J.ENVINT.2019.04.037

Lin, H., Guo, Y., Di, Q., Zheng, Y., Kowal, P., Xiao, J., Liu, T., Li, X., Zeng, W., Howard, S. W., Nelson, E. J., Qian, Z., Ma, W., & Wu, F. (2017). Ambient PM2.5 and stroke: effect modifiers and population attributable risk in six low- and middle-income countries. *Stroke*, *48*(5), 1191. https://doi.org/10.1161/STROKEAHA.116.015739

Magadza, C., Radloff, E., & Srinivas, S. C. (n.d.). The effect of an educational intervention on patients' knowledge about hypertension, beliefs about medicines, and adherence. *Research in Social and Administrative Pharmacy*, *5*, 363–375. https://doi.org/10.1016/j.sapharm.2009.01.004

Martha, E., & Kresno, S. (2017). *Metodologi Penelitian Kualitatif untuk Bidang Kesehatan* (1st ed.). PT Rajagrafindo Persada.

Maulidina, F., Harmani, N., & Suraya, I. (2019). Faktor-Faktor yang Berhubungan dengan Kejadian Hipertensi di Wilayah Kerja Puskesmas Jati Luhur Bekasi Tahun 2018. *ARKESMAS (Arsip Kesehatan Masyarakat)*, *4*(1), 149–155. https://doi.org/10.22236/arkesmas.v4i1.3141

Nuraini, B. (2015). RISK FACTORS OF HYPERTENSION | Nuraini | Jurnal Majority. *J Majority*, *4*(5), 10–19. https://juke.kedokteran.unila.ac.id/index.php/majority/article/view/602

Oparil, S., Acelajado, M. C., Bakris, G. L., Berlowitz, D. R., Cífková, R., Dominiczak, A. F., Grassi, G., Jordan, J., Poulter, N. R., Rodgers, A., & Whelton, P. K. (2018). Hypertension. In *Nature Reviews Disease Primers* (Vol. 4, Issue 1, pp. 1–21). Nature Publishing Group. https://doi.org/10.1038/nrdp.2018.14

Riskesdas. (2018). *Riskesdas DKI Jakarta 2018*. www.litbang.kemkes.go.id%0A

Riyadina, W., Martha, E., & Anwar, A. (2019). Perilaku Pencegahan Dan Pengendalian Hipertensi : Studi Pengetahuan, Sikap, Perilaku (Psp) Dan Kesehatan Lingkungan Pada Wanita Pasca Menopause Di Kota Bogor. *Jurnal Ekologi Kesehatan*, *17*(3), 182–196. https://doi.org/10.22435/jek.17.3.666.182- 196

Salami. (2021). Perilaku Self Care Management Penderita Hipertensi: Studi Kualitatif. *Jurnal Keperawatan 'Aisyiyah*, *8*(1), 87–99. https://doi.org/10.33867/jka.v8i1.261

Salean, S. G., & Djaja, I. M. (2021). Pengaruh Tekanan Panas Terhadap Tekanan Darah Tinggi Pada Pekerja Bagian Casting dan Pressing Di PT X Tahun 2019. *Jurnal Nasional Kesehatan Lingkungan ...*, *16*(4), 157–
167. http://journal.fkm.ui.ac.id/kesling/article/view/4979

Shamsi, A., Nayeri, N. D., & Esmaeili, M. (2017). Living with Hypertension : A Qualitative O riginal A rticle. *International Journal of Community Based Nursing & Midwifery*, *5*(3), 219–230.

Singh, A., & Purohit, B. (2011). Evaluation of Global Physical Activity Questionnaire (GPAQ) among Healthy and Obese Health Professionals in Central India. *Baltic Journal of Health and Physical Activity*, *3*(1), 34–
43. https://doi.org/10.2478/v10131-011-0004-6

Sinuraya, R. K., Siagian, B. J., Taufik, A., Destiani, D. P., Puspitasari, I. M., Lestari, K., & Diantini, A. (2017). Assessment of Knowledge on Hypertension among Hypertensive Patients in Bandung City: A Preliminary Study. *Indonesian Journal of Clinical Pharmacy*, *6*(4), 290–297. https://doi.org/10.15416/ijcp.2017.6.4.290

Unger, T., Borghi, C., Charchar, F., Khan, N. A., Poulter, N. R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G. S., Tomaszewski, M., Wainford, R. D., Williams, B., & Schutte, A. E. (2020). 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension*, *75*(6), 1334–1357. https://doi.org/10.1161/HYPERTENSIONAHA.120.15026/FORMAT/EPUB

Utami, D. P. (2020). *Hubungan pajanan pm 2,5 dengan hipertensi pada penduduk di desa citeureup kecamatan citeureup kabupaten bogor tesis*. Universitas Indonesia.

Wahyuningsih, W., & Arsi, A. A. (2021). Pengetahuan dan Perilaku Kesehatan Penderita Hipertensi Anggota Prolanis Puskesmas Jatinom Kabupaten Klaten. *Solidarity: Journal of Education, Society and Culture*, *10*(1), 108–120. https://jurnal.untan.ac.id/index.php/jfk/article/view/18477/15589

WHO. (2021). *Hypertension*. https://www.who.int/news-room/fact-sheets/detail/hypertension

Wolde Id, M., Azale, T., Debalkie Demissie, G., & Addis, B. (2022). *Knowledge about hypertension and associated factors among patients with hypertension in public health facilities of Gondar city, Northwest Ethiopia: Ordinal logistic regression analysis*. https://doi.org/10.1371/journal.pone.0270030

Yulidar, E., Rachmaniah, D., & Hudari. (2023). Hubungan Pengetahuan Dengan Perilaku Pencegahan Hipertensi Pada Penderita Hipertensi Di Wilayah Kerja Puskesmas Grogol Tahun 2022. *Jurnal Inovasi Riset Ilmu Kesehatan*, *1*(1), 264–274.

Yusuf, S., Hawken, S., & Ounpuu, S. (2004). Erratum: Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study (Lancet (2004) 364 (937-952)). *Lancet*, *364*(9450), 2020. https://doi.org/10.1016/S0140-6736(04)17513-2

Zhang, Z., Dong, B., Li, S., Chen, G., Yang, Z., Dong, Y., Wang, Z., Ma, J., & Guo, Y. (2019). Exposure to ambient particulate matter air pollution, blood pressure and hypertension in children and adolescents: A national cross-sectional study in China. *Environment International*, *128*(January), 103–108. https://doi.org/10.1016/j.envint.2019.04.036

Twenty Years of Trend in Research on Aedes sp. Vector Control: a Bibliometric Analysis

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Abstract

Due to their contribution to over a fifth of all infectious diseases, vector-borne diseases continue to be a health burden. One of the key strategies for tackling the issue of vector-borne disease is limiting vector density. This study intends to identify published research themes, research techniques, and research areas connected to vector control strategies. A bibliometric analysis of 10492 journal articles from Scopus, PubMed, and Wiley Online Library, was done for this study between 2003-2023. The collected articles are used to extract themes using VOSviewer. Insecticide fogging, pet traps, deltacide, eco-friendly control tools repellant, gravitrap, vectobag, altosid, biological insecticide, and more were among the ten topics of vector control approaches that received the least amount of information. The five research techniques with the lowest frequency are as follows: randomized controlled trial, systematic literature review, longitudinal study, literature review, and intervention study. The majority of study fields originate in Brazil, India, Europe, Mexico, and Thailand. Future studies must therefore focus on mechanical and environmentally responsible vector control techniques, such as gravitrap, eco-friendly control instruments, pet traps, and biological insecticides. Randomized controlled trials and longitudinal studies are indicated as research approaches with a lot of potential for usage in the future. An excellent opportunity exists for Indonesia to conduct study on these topics.

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Aedes, Vectrol control, Bibliometric

Introduction

Health development with currently developed resources and technology gives hope for achieving success as targeted. However, there are still challenges and obstacles; the increasing burden and threat of vector-borne diseases is one example. 80% of the world's human population is at risk from one or more vector-borne diseases. Globally, 17% of the total infectious disease burden is vector-borne. Every year, more than 700,000 deaths are caused by vector-borne diseases. Vectors that play a major role in

transmission include mosquitoes, Triatomine bugs, ticks, snails, sandflies, Mites and Lice, Flies, and Fleas (1).

One of the main mosquito vector-borne diseases is dengue, besides malaria. Dengue fever is the most common viral infection transmitted by *Aedes sp.* mosquitoes besides Zika, Chikungunya and Yellow fever viruses. More than 3.9 billion people in 129 countries are at risk of contracting dengue fever. An estimated 96 million cases with symptoms and around 40,000 deaths each year (2). WHO target in 2030 the case fatality rate (CFR) decreased to 0.0% compared to 2020 0.8%. The number of countries capable of rapid detection and response to dengue outbreaks has increased from 8% in 2020 to 75% in 2030. The next target is to reduce the incidence rate by 25% from 3.1 million in 2020 to 2.35 million in 2030 (3). This target can be achieved through various strategies, one of which is increasing innovation in vector control.

Vector control efforts to reduce the burden of vector-borne diseases, especially dengue, have challenges, including environmental factors, changes in habitat and climate change due to population growth, urbanization and industrialization. In addition to environmental factors, other challenges are policy factors and the movement of people (1). In addition to challenges, vector control efforts also have opportunities, one of which is innovation in Aedes vector control technology. Development of new tools, technologies and approaches such as insecticides with new formulations (4), vector traps and bait (5), biocontrol through Wolbachia spp (6), genetic modification to reduce population density or population replacement (7), sterile vector forms (8), spatial repellents(9) and vapor active insecticides(10), and housing improvements to exclude vectors and reduce favorable harborages(11).

Innovation in *Aedes sp.* vector control methods cannot be separated from studies conducted in various regions. In 2016, Maha Bouzid et all. conducted a meta-review of 13 systematic review articles on Aedes vector control methods. The results show that the success of a control program depends on local conditions, type of intervention, resources, and duration of research. No information shows a picture of the types of technology studied in the last 20 years globally. Therefore, this paper will describe the themes of the types of *Aedes sp* vector control methods, research methods used, and research areas from journals published in 2003-2023.

Methods

Data source
This study used 3 databases: PubMed, Scopus, and Wiley Online Library (WOL). PubMed is a database containing references and abstracts on natural science and biomedical themes. Over 35 million citations to the biomedical literature from Medline and resources from the National Library of Medicine USA. (12) As of 2017, PubMed contained 27.5 million articles from around 7000 journals.(13) Scopus is one of the largest combined curated databases, abstracts and citations from comprehensive literature journals, books, seminar proceedings, etc. Scopus covers more than 240 disciplines. More than 1.8 billion references are cited; each article indexed is 10-15% more than any other database.(14) Scopus indexes 66.07% more journals than the Web of Science and Dimensions, especially in life sciences, physics and technology.(15) WOL is a database service that has the world's largest collection of multidisciplinary sciences between natural sciences, health, physics, and social humanities. More than 1,600 journals, 22,000 ebooks, and more than 250 other types of references.(16) Bibliography related to research on Aedes sp. vector control. Of the three databases will be carried out starting June 2023.

Study design
Bibliometric analysis was used to prepare this paper to find the most favorite journals related to the publication regarding the scope of *Aedes Sp.* vector control. Which includes the number according to the highest order ranking, the country of issue, the indexation quartile category and the impact factor. This refers to the latest related papers; analysis based on search keywords is used to obtain rankings according to the number of words or phrases whose frequency is rarely researched. The searched word or phrase is related to vector control methods, research methods, and research areas. Keyword linkages and networks based on the research period are presented as a mapping chart, resulting from the free tool VOSviewer version 1.6.18. Bibliometric analysis is a statistical method to show an overview of the development of knowledge and information from studies or research and other information such as journal identity and frequency of keyword similarities.(17)

Search strategy

Search for keywords for paper themes using "vector control" and the MeSH term "Pest Control" OR "Pest Management" AND "Aedes." MeSH (Medical Subject Headings) is the NLM-controlled vocabulary thesaurus used for indexing articles for PubMed.(18) The Scopus and WOL databases use "Aedes" AND "Vector Control." Search restrictions on 3 databases were carried out covering the year of publication 2003-2023; keywords were obtained from titles, abstracts, and documents in the form of journals. Management to eliminate duplication used free software, namely Endnote version 21 free trial; 10492 documents were obtained.
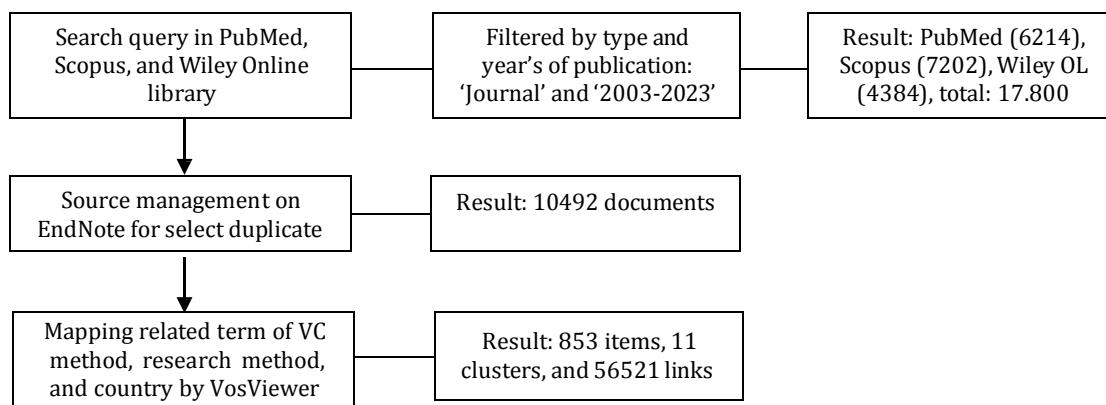
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│ Search query in      │     │ Filtered by type and │     │ Result: PubMed (6214),│
│ PubMed, Scopus, and  │─────│ year's of publication:│─────│ Scopus (7202), Wiley OL│
│ Wiley Online library │     │ 'Journal' and '2003-2023'│  │ (4384), total: 17.800 │
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│ Mapping related term │     │ Result: 853 items, 11│
│ of VC method, research│────│ clusters, and 56521  │
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Figure 1. Bibliometric study strategy

Data Analysis

All documents compiled from EndNote were transferred to VOSviewer, then extracted words or phrases based on the similarity of events in the title and abstract. The full counting method and a minimum number of occurrences of 10 were used. Then, a selection was carried out, and words unrelated to *Aedes sp* vector control were not selected (verify selected terms), resulting in 853 items with 11 clusters and 56521 links. VOSviewer is a useful program in bibliometric network analysis. Publication mapping can be based on citations, link networks, or keyword mapping can also be made based on shared occurrence networks(19) This paper will describe the distribution according to the keyword groups of vector control methods, research methods, and location countries.

Results

The reputation of a scientific paper is influenced by many factors, one of which is the quality of the journal where the article is published. The more people who cite written works, the higher the h-index and impact factor will be indicators of recognition by the academic world for their existence and quality. The following are the journals obtained from the three databases that have published the most research results on *Aedes sp.* vector control.

Table 1.
20 Top Journals Based on the Number of Published Articles on *Aedes sp* vector control

No	Journal Name	Publisher Country	Publication			
			N	%	Quartile Category(Q)	IF
1	PLoS Neglected Tropical Diseases	United States	555	5.28	1	1.30
2	Parasit Vectors	United Kingdom	435	4.14	1	0.96
3	Journal of Medical Entomology	USA oxford	442	4.2	1	0.69
4	Journal of the American Mosquito Control Association	United States	400	3.81	3	0.39

5	PLoS One	United States	310	2.95	1	0.89
6	Journal of Vector Ecology	United States	254	2.42	2	0.46
7	Medical and Veterinary Entomology	United Kingdom	246	2.34	1	0.64
8	Acta Tropica	Netherland	234	2.23	1	0.75
9	Insect Molecular Biology	United Kingdom	171	1.63	1	0.79
10	Pest Management Science	United Kingdom	169	1.61	1	1.02
11	Parasitology Research	Germany	160	1.52	1	0.6
12	Insects	Switzerland	125	1.19	1	0.79
13	American Journal of Tropical Medicine and Hygiene	US	124	1.18	1	1.04
14	Scientific Reports	United Kingdom	124	1.18	1	0.97
15	Tropical Medicine & International Health	United Kingdom	109	1.03	2	0.79
16	Parasites and Vectors	United Kingdom	79	0.75	1	0.96
17	Entomological Research	United Kingdom	72	0.68	3	0.33
18	Tropical Biomedicine	Malaysia	70	0.67	3	0.27
19	Viruses	Switzerland	69	0.66	1	1.29
20	Journal of the American Mosquito Control Association	US	66	0.63	3	0.39
	Total		**4214**	**40.1**	**Rerata**	**0,77**

Table 1 shows that 70.0% of journals are included in the 1st quartile category; this means that most of the Aedes sp vector control research themes have been published in highly reputable journals. The most favorite journal for publication is PLoS Neglected Tropical Diseases (PNTD) (5.28%) with an impact factor of 1.3. Journals in quartile 3 include the Journal of the American Mosquito Control Association, Entomological Research, and Journal of the American Mosquito Control Association. Most of the published Q1 journals come from America; there is only 1 from the Netherlands, namely Acta Tropica and from Switzerland, namely Viruses. There is only 1 journal from Southeast Asia out of the top 20 journals, namely Tropical Biomedicine from Malaysia. Journals with more than 1 impact factor come from America, only 1 outside America, namely from Switzerland. The smallest impact factor is 0.27 (Tropical Biomedicine Journal).

Table 2.
Frequency Distribution of The 10 Smallest Species and The 5 Largest Items Relevant to *Aedes sp*. Vector Control. Includes the Vector Control Method, Research Method, and Field Study

No	Vector Control Methode	F	%	Research Methode	F	%	Field	F	%
1	Insecticide fogging	10	0.09	Systematic literature review	10	0.09	Armenia	10	0.09
2	Pet trap	10	0.09	Longitudinal study	13	0.12	East Mediterranean	10	0.09
3	Deltacide	11	0.10	Randomized controlled trial	14	0.13	Guangzhou	10	0.09
4	Eco friendly control tool	11	0.10	Literature review	17	0.16	Kosovo	10	0.09
5	Reppelent	11	0.10	Intervention study	18	0.17	Oceania	10	0.09
6	Gravitrap	11	0.10	Field survey	21	0.20	Rio de jeaniro	10	0.09
7	Vectobac g	11	0.10	Epidemiological study	23	0.22	South Asia	10	0.09
8	Altosid	12	0.11	Case control study	23	0.22	South Korea	10	0.09

9	Biological insecticide	12	0.11	Collection method	29	0.27	Tunisia	10	0.09
10	Clove oil	12	0.11	Laboratory experiment	45	0.43	Barcelona	11	0.10
1	*Bacillus thuringiensis*	510	4.86	Cross Sectional study/survey	71	0.67	Thailand	352	3.35
2	Essential oil	811	7.72	Meta Analysis	82	0.78	Mexico	427	4.07
3	Trap	1275	12.15	Cohort	105	1.00	Europe	428	4.08
4	*Wolbachia*	1350	12.87	Systematic review	115	1.09	India	477	4.54
5	Insecticide	1661	15.83	Trial	581	5.54	Brazil	863	8.22
	Ovitrap	546	5.2				Indonesia	169	1.6
	Oviposition trap	62	0.59				Yogyakarta	32	0.3
	Lethal Ovitrap	52	0.49						

The recapitulation results of keyword items related to vector control methods found that Insecticide fogging and pet traps were the smallest research themes (0.09%). Related to the research theme of tools or traps, which are still considered rarely disclosed are eco-friendly control tools and gravitrap (0.10% each). Most studies of *Aedes sp* vector control methods over the last 20 years were regarding the application of Insecticide (15.83%), *Wolbachia* (12.87%), and traps (12.5%). Research on traps, specifically the ovitrap as much as 5.2%, oviposition trap (0.59%), and lethal ovitrap as much as 0.49%. .

Most of the research methods used were trials (5.54%), especially randomized controlled trials, only 0.13%. Systematic literature review is the smallest writing method (0.09%), but it was found that the use of the term systematic review was 1.09%—experimental laboratory of 0.43%, more than the field survey (0.20%). In the longitudinal study, it is known that the primary research method is the smallest, namely 0.12%; it is also known that the observational cohort is 1.00%. At the same time, the case-control (0.22%) is smaller than the cross-sectional method (0.67%).

Based on the research location, it is known that the smallest are Armenia, East Mediterranean, Guangzhou, Kosovo, Oceania, Rio de Janeiro, South Asia, and Tunisia (0.09% each). The highest research contribution came from Brazil (8.22%), followed by India (4.54%), Europe (4.08%), and Mexico (4.07%). Thailand is a Southeast Asian country, which is also a large country (4.07%, the 5th largest after Mexico) as a research location related to Aedes sp. vector control. Especially Indonesia found in 1.6% of the paper and the city of Yogyakarta by 0.3%. So Indonesia, in the 3 databases in Scopus, PubMed, and Wiley online library, contributed 1.9%.

Figure 2. Social Network Analysis of Vector Control Method, Research Method, and Field of Study at *Aedes sp* Vector Control (2003-2023)

Research trends in *Aedes sp* vector control, around the end of 2017 until now, have studied a lot about autocidal gravid ovitrap, ago traps, bacterial species, clove oil, and *Aedes sp* presence. Apart from that, the application of bendiocarb, pyrethroid resistance, and adult bioassays are among the most recent studies. The research locations are in Mexico, Tunisia, Ecuador, Congo, Makkah, Lahore, Punjab and South Texas. From early 2014 to late 2016, research studies were dominated by issues of insecticides and their resistance, genes and activity, trap and oviposition, attractant, and repellent. Larvacidal bioassay and spraying were also research topics at that time. Around 2012, most of the research themes included mosquito traps, control traps, adult traps, vectors, oviposition response, gravid traps, and BTi resistance. Research locations at that time included Sao Paolo, Haiti, Korea, France and America. Trials and reviews have been seen starting around 2015 to be used more as a research method.

Discussion

This study is based on searching the same words from different journals; in this case, from 3 databases, the system (VOSviewer) will show all the results. However, they are shared according to the criteria, namely those still within the scope of *Aedes sp.* vector control. This approach will make it easier to find information from large databases. The research themes that have been carried out previously will form the basis for the development of further research materials that are up-to-date and as needed to contribute to problem-solving, in this case, the problem of disease transmission by the *Aedes sp.* vector. The principle of this approach is to extract important information and textual patterns from paper documents or journals so that scientists can process and explore previously researched methods and technologies.(17)

From the 3 databases of Scopus, PubMed, and Wiley Online, it was found that 20 journals serve as publications on Aedes vector control, almost three-fourths of which fall into the Q1 category. This shows that the three databases are worthy of being a reference for research results on Aedes sp. vector control. The Scopus platform provides data access through search, find, and analysis options. The find option facilitates users to identify collaborators, organization of research results and published data regarding various metrics such as keywords and mutual references.(15) In addition to the metadata records, Scopus provides comprehensive author and institutional profiles derived from manual profiling and curation algorithms and ensures precision. The credibility of Scopus lends to its use as a source of bibliometric data for large-scale analyses in research assessments, research landscape studies and science policy evaluation.(20) The latest version of the PubMed website, introduced in 2020, can collect and service research results in the health sector with high-quality and freely accessible information.(21) The advantage of the Wiley online library is that it provides free or low-cost online access to research in developing countries and helps strengthen publishing and authorship in developing countries.(16) Publishing journals from Asia, especially Southeast Asia, have yet to contribute much to publishing articles on *Aedes sp* vector control. This has proven to be the only journal in the top 20 journals with the most publications for this issue, and even then, only Q3.

The theme of research in the field of *Aedes sp* vector control over the last 20 years is still dominated by the theme of insecticides (more than 15.0%). This shows that chemical vector control of *Aedes sp* is still a favorite research theme. Chemical control is the application of both natural and synthetic compounds that have insecticidal properties to reduce mosquito populations in the environment.(22) Plant-based insecticides are an alternative to chemical ones because they are more easily degraded and less harmful to the environment, as well as lower toxicity to non-target insects.(23) The study of plant-based insecticides is a study that still needs to be developed because research on "eco-friendly" is still relatively small (0.1%). An environmentally friendly vector control method, namely mechanically with the application of traps and research themes which are still relatively small in biology and chemistry (0.09% pet trap, 0.59% oviposition, 0.49% lethal ovitrap, and 5.2% ovitrap). Ovitrap can be used to detect *Aedes sp* vectors at an early stage and can function as an alarm indicator for outbreak predictions. Ovitrap is sensitive for detecting the presence of *Aedes* mosquitoes, providing efficient and precise data for outbreak prediction.(24)

The research method used in research on *Aedes sp* vector control is Trial, but randomized controlled trials are still small. This shows that only some still carry out research with high accuracy and validity compared to other research methods, for example, observational. The RCT method for *Aedes sp* vector control still needs to be developed to provide evidence of the real impact of complex interventions, including biological control, on life.(25) Longitudinal study is also an approach that is rarely used. Longitudinal studies are suitable for research on the surveillance of vector densities and the impact of intervention programs.(26)

The research results on *Aedes sp* vector control are mostly from tropical countries such as Brazil and India. This is due to the large burden of dengue cases suffered by countries in tropical regions such as Bangladesh, Philippines, Vietnam, India, Maldives, Indonesia, Singapore, Colombia, Paraguay, Peru, Kenya, Fiji, Cook Islands, Reunion Islands, Sri Lanka, Thailand, Sudan, Mauritania, Timor-Leste, Yemen, Nepal, Mayotte, Ecuador and Brazil.(1) Indonesia is still a country that contributes to the dengue problem in the world. Therefore, it is still possible for Indonesia to conduct more research on both the scope of the impact and the control program.

Insecticides are still the most research theme from 2023 to 2023 for the control of the *Aedes sp.* vector. Most of its control still depends on insecticides in the larval phase and adult mosquitoes indoors and outdoors. However, insecticide resistance has developed in *Aedes sp.* populations worldwide, and it is evident that this resistance interferes with the success of interventions.(27)(28)(29) Therefore, starting at the end of 2017 until now, research on mechanical vector control, namely traps, has begun to attract researchers in the field of vector control along with studies of natural insecticides that are more environmentally friendly (autocidal gravid trap, clove oil) followed by studies of insecticide resistance. Plant-based insecticides are an alternative to chemical ones because they are more easily degraded and less harmful to the environment. In particular, essential oils containing terpenoids, phenylpropanoids, thiophenes, amides and alkaloids also have larvicidal activity.(23) In the future, research on vector control, especially *Aedes sp.*, needs to be developed to find more effective and environmentally friendly controls to anticipate the spread of resistance to existing chemical insecticides.

Conclusions

As long as the dengue problem remains a public health burden, developing vector control technology remains a priority before a high-effectiveness dengue vaccine is found. The research theme on Aedes vector control that has dominated for the last 20 years (always every time) is about insecticides. But lately, research on vector control mechanically (trapping) with a combination of natural insecticides has become quite an interesting research topic to follow up. RCT is an approach that can also be a focus for the development of vector control research so that it can produce more accurate and valid evidence despite the many challenges in its implementation. Indonesia, as one of the tropical countries with a high burden of dengue disease in terms of public health, has become a location for research on vector control topics that are quite large after Thailand, Brazil and India.

Author Contributions
Suharyo contributed to the design and writing of the manuscript; Mursid R, Martini, and Muh. Fauzi supervised and critically revised the final version of the manuscript; All authors have read and agreed to the published version of the manuscript.

Institutional Review
Not applicable

References
World Health Organization. Global Vector Control response 2017-2030. 2017. 1–38 p.

World Health Organization. Vector Borne Diseases [Internet]. WHO Newsroom Website. 2020 [cited 2023 Jul 31]. Available from: https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases#:~:text=Vector-borne diseases account for,either parasites%2C bacteria or viruses.

World Health Organization. Ending the neglect to attain the sustainable development goals: a road map for neglected tropical diseases 2021–2030. World Health Organization. 2020. 196 p.

Echeverría J, Albuquerque R. Nanoemulsions of Essential Oils: New Tool for Control of Vector-Borne Diseases and In Vitro Effects on Some Parasitic Agents. Medicines. 2019;6(2):42.

WHO. Efficacy-testing of Traps for Control of Aedes spp. Mosquito Vectors. Who/Cds/Ntd/Vem/201806

[Internet]. 2018; Available from: http://apps.who.int/iris/bitstream/handle/10665/275801/WHO-CDS-NTD-VEM-2018.06-eng.pdf?ua=1

Ogunlade ST, Meehan MT, Adekunle AI, Rojas DP, Adegboye OA, McBryde ES. A review: Aedes-borne arboviral infections, controls and wolbachia-based strategies. Vaccines. 2021;9(1):1–23.

Natiello MA, Solari HG. Modelling population dynamics based on experimental trials with genetically modified (RIDL) mosquitoes. Ecol Modell. 2020;424:1–40.

Gato R, Menéndez Z, Prieto E, Argilés R, Rodríguez M, Baldoquín W, et al. Sterile insect technique: Successful suppression of an Aedes aegypti field population in Cuba. Insects. 2021;12(5):1–13.

Clarkson TC, Janich AJ, Sanchez-Vargas I, Markle ED, Gray M, Foster JR, et al. Nootkatone is an effective repellent against Aedes aegypti and Aedes albopictus. Insects. 2021;12(5).

Richoux GM, Yang L, Norris EJ, Tsikolia M, Jiang S, Linthicum KJ, et al. Structure-Activity Relationship Analysis of Potential New Vapor-Active Insect Repellents. J Agric Food Chem. 2020;68(47):13960–9.

World Health Organization. Keeping the vector out : Housing improvements for vector control and sustainable development. World Heal Organ [Internet]. 2017; Available from: http://apps.who.int/iris/bitstream/handle/10665/259404/9789241513166-eng.pdf;jsessionid=2A5A4422CA689EED32C324CC3EC94033?sequence=1

Medicine NL of. PubMed Overview [Internet]. National Library of Medicine Web. 2022. Available from: https://pubmed.ncbi.nlm.nih.gov/about/

Peace Ossom Williamson CIJM. Exploring PubMed as a reliable resource for scholarly communications services. J Med Libr Assoc [Internet]. 2019;1(107):16–29. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6300231/

Elsevier. About Scopus [Internet]. Elsevier Web page. 2023. Available from: https://www.elsevier.com/solutions/scopus?dgcid=RN_AGCM_Sourced_300005030

Singh VK, Singh P, Karmakar M, Leta J, Mayr P. The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. Scientometrics [Internet]. 2021;126(6):5113–42. Available from: https://doi.org/10.1007/s11192-021-03948-5

Wiley_VCH. About Wiley Online Library [Internet]. Wiley Online Library Web Page. 2023. Available from: https://onlinelibrary.wiley.com/

Madani F, Weber C. The evolution of patent mining: Applying bibliometrics analysis and keyword network analysis. World Pat Inf. 2016;46:32–48.

Medicine NL of. Topic Searching in PubMed®: Using the Medical Subject Headings (MeSH®) [Internet]. WEb of National Library of Medicine. 2023. Available from: https://www.nlm.nih.gov/oet/ed/pubmed/mesh/index.html?_gl=1*1p63q5p*_ga*ODYxNTkzODYyLjE2OTIwNzAwNzU.*_ga_P1FPTH9PL4*MTY5MjA3MzkwMy4xLjAuMTY5MjA3MzkwMy4wLjAuMA..*_ga_7147EPK006*MTY5MjA3MzkwMy4xLjAuMTY5MjA3MzkwMy4wLjAuMA..

Van Eck NJ, Waltman L. Manual for VOSviewer version 1.5.2. Leiden Univeristy [Internet]. 2012;(September):1–28. Available from: http://www.vosviewer.com/documentation/Manual_VOSviewer_1.5.4.pdf

Baas J, Schotten M, Plume A, Côté G, Karimi R. Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. Quant Sci Stud. 2020;1(1):377–86.

White J. PubMed 2.0. Med Ref Serv Q [Internet]. 2020;39(4). Available from: https://www.tandfonline.com/doi/abs/10.1080/02763869.2020.1826228

Singh A, Robinson AWT. Vector Control Interventions to Prevent Dengue: Current Situation and Strategies for Future Improvements to Management of Aedes in India. J Emerg Infect Dis. 2017;02(01):1–7.

Silvério MRS, Espindola LS, Lopes NP, Vieira PC. Plant natural products for the control of Aedes aegypti: The main vector of important arboviruses. Molecules. 2020;25(15).

Wright E, Carrillo MA, Matamoros D, Sanchez RC, Yañez J, Di Lorenzo G, et al. Applicability of the Mexican ovitrap system for Aedes vector surveillance in Colombia. Pathog Glob Health [Internet]. 2022;00(00):1–11. Available from: https://doi.org/10.1080/20477724.2022.2146049

Alvarado-Castro V, Paredes-Solís S, Nava-Aguilera E, Morales-Pérez A, Alarcón-Morales L, Balderas-Vargas NA, et al. Assessing the effects of interventions for Aedes aegypti control: Systematic review and meta-analysis of cluster randomised controlled trials. BMC Public Health. 2017;17(Suppl 1).

Morrison AC, Paz-Soldan VA, Vazquez-Prokopec GM, Lambrechts L, Elson WH, Barrera P, et al. Quantifying heterogeneities in arbovirus transmission: Description of the rationale and methodology for a prospective longitudinal study of dengue and Zika virus transmission in Iquitos, Peru (2014–2019). PLoS One [Internet]. 2023;18(2 February):1–17. Available from: http://dx.doi.org/10.1371/journal.pone.0273798

Yulida A, Sutarto S. Insecticide Resistance in Aedes aegypti. J Agromedicine Unila. 2018;5(2):582–6.

Vontas J, Kioulos E, Pavlidi N, Morou E, della Torre A, Ranson H. Insecticide resistance in the major dengue vectors Aedes albopictus and Aedes aegypti. Pestic Biochem Physiol [Internet]. 2012;104(2):126–31. Available from: http://dx.doi.org/10.1016/j.pestbp.2012.05.008

Gan SJ, Leong YQ, bin Barhanuddin MFH, Wong ST, Wong SF, Mak JW, et al. Dengue fever and insecticide resistance in Aedes mosquitoes in Southeast Asia: a review. Parasites and Vectors [Internet]. 2021;14(315):1–19. Available from: https://doi.org/10.1186/s13071-021-04785-4

Exploring The Correlation Between Well Construction Techniques and Well Water Quality in Simbang Kulon Village

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Abstract

Simbang Kulon Sub-District, one of the biggest batik producers in Pekalongan Regency produces a large amount of liquid waste contaminating rivers and potentially contaminating dug wells around rivers. Batik liquid waste generated from the coloring process and disposed of directly into the river without going through the processing process makes the Simbang Kulon River change its color to black. This study aimed to determine the relationship between the construction o dug wells and the distance to the Simbang Kulon River on the quality of well water in Simbang Kulon Village.

This research is observational with a quantitative method and a cross-sectiona study design. A sampling of Simbang Kulon River water was 1 sample, while dug well water sampling was 12 samples based on 6 levels of distance from the wes and east of the Simbang Kulon River. Sampling was carried out during the dry season from April to May. Data were obtained by interviews, observations measurements of the physical condition of dug wells and measurements of the laboratory's river and well water samples, and calculation of the Pollution Index (IP). Data were analyzed using SPSS with Spearman's Rank test to see whether there was a relationship between variables.

The results showed that the concentrations of temperature, BOD, COD, and tota ammonia in the Simbang Kulon River water exceeded the quality standards set by the Pollution Index (PI) calculation results obtained at 6 and were in the moderately polluted category. While the risk of contamination in the 5 dug wells showed a yield of 54.54% which was in the high category.

The conclusion of this study is that there is a significant relationship between the height of the well's lip and the concentration of TSS. However, there is no significant relationship between the height of the well wall and the width of the well floor, as well as the potential risk of contamination and distance wells from the Simbang Kulon River on concentrations of TSS, BOD, COD, and total ammonia. Suggestions for Simbang Kulon Village and related agencies to immediately operate the Simbang Kulon WWTP so that batik craftsmen do not dispose of batik liquid waste in the river.

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Keywords:
Batik waste; Water quality; River; Dug construction

Introduction

The Pekalongan area, which is divided into Pekalongan City and Pekalongan Regency, is an area with superior potential in the batik industry sector, both small and medium scale industries, apart from Yogyakarta, Solo, Madura, and Cirebon (Sutrisno et al., 2018). The existence of a batik industry center with rapid development in Pekalongan Regency not only helps the local community's economy but also has a negative impact in the form of liquid waste from batik production which can pollute the surrounding environment.

The batik industry produces pollutant materials such as organic materials, non-organic materials, and heavy metals which are produced from the entire production process (Indrayani, Lilin ; Rahmah, 2018). The resulting batik waste can come from the use of chemicals in the batik coloring process. The batik waste contains high dyestuffs and synthetic materials which are difficult to dissolve or difficult to decompose so it can pollute the environment both in terms of physical and chemical parameters (Kiswanto et al., 2019).

Simbang Kulon Village, Buaran District, Pekalongan Regency is one of the largest batik-producing villages in Pekalongan Regency. The Simbang Kulon Village has a large population with the majority of the people making a living as batik craftsmen with batik produced including written batik, stamped batik, and screen printing or printing batik. However, the existence of the Simbang Kulon WWTP which has not yet been operational has made the batik craftsmen immediately dispose of the batik liquid waste into the ditch which is the drain for household waste that flows into the river. The results of the research related to the analysis of the impact of batik waste on the Simbang Kulon River showed that the Simbang Kulon River was polluted from the DO parameters of 1,62 mg/L – 4,32 mg/L and the pH ranged from 6,70 – 6,94, while the temperature parameters are still within safe limits (Zammi et al., 2018). The impact of disposing of batik liquid waste in ditches or rivers can change the color of the water from red to black and can affect the quality of groundwater for the people living around the stream.

Central Java Provincial Regulation No. 5 of 2012 concerning Wastewater Quality Standards has regulated the levels and quantities of batik waste contaminants that will be discharged into the environment including TSS, BOD, COD, and total ammonia (NH_3-N). The maximum levels allowed for these parameters are TSS of 50 mg/L, BOD of 60 ml/L, COD of 150 mg/L, and total ammonia (NH_3-N) of 8.0 mg/L (Peraturan Daerah Provinsi Jawa Nomor 5 Tahun 2012 Tengah Tentang Baku Mutu Air Limbah, 2012). The existence of these polluted materials in the environment that exceed quality standards can disrupt aquatic ecosystems (Indrayani, Lilin ; Rahmah, 2018). The results of laboratory tests on Simbang Kulon river water which were carried out as an initial research survey in August 2022 showed results that the levels of TSS, BOD, and COD had exceeded the specified quality standards with successive results of 70 mg/L, 200 mg/L, and 450 mg/L, while the total ammonia content (NH_3-N) still meets the established quality standard of 5,9 mg/L. In addition, the pH level of the Simbang Kulon river water showed the same results as research conducted by Muhammad Zami, et al (2018), namely 6,70 with a water temperature of 28°C which is still within safe limits.

Most of the people of Simbang Kulon still use clean water sources in the form of dug wells and PDAM. "PDAM" is a regional company that provides and distributes clean water to the community. Data obtained based on an initial survey conducted in April - May 2022 related to observations of the quality of well water and the physical condition of the wells around the river where batik waste is disposed of in 7 dug wells, 2 wells were found to have cloudy and slightly smelly water, 2 wells had black and smelly water conditions, and 3 other wells in clear condition. From the results of interviews, the condition of well water can change in terms of color, taste, and smell depending on the condition of the wastewater in the river. The physical condition of dug wells must also meet several requirements related to the height of the well wall, the height of the well lip, the condition of the floor, and the distance of the well from pollutant sources following regulations determined by the Ministry of Health of the Republic of Indonesia in 2005 (Rizza, 2013). The risk of contamination of clean water sources can be caused by the construction of dug wells that are not suitable and the location of wells that are built close to pollutant sources (Rizza, 2013).

The results of research conducted by Rafikhul Rizza (2013) showed that there were 34.78% of dug wells containing levels of nitrite exceeding the quality standard around the river in the area of batik waste disposal in Podosugih Village, West Pekalongan District, Pekalongan City (Rizza, 2013). A similar study conducted by Kharisma Izzatunnisa, et al (2018) showed that there was no effect of Cr (VI) levels in river water and the distance between dug wells and rivers on CR (VI) levels in dug well water (Izzatunnisa et al., 2019).

Based on the background of the problems that have been described, this study aims to determine the relationship between the construction of dug wells and the distance from the Sambang Kulon river with the concentrations of TSS, BOD, COD and total ammonia on the quality of well water in the Simbang Kulon Village community.

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Methods

This research is a type of observational research with quantitative methods using a cross sectional design. The population of this study was divided into the population of the Simbang Kulon River which stretches along the Simbang Kulon Village and the population of wells taken based on the distance of the dug wells from the Simbang Kulon River with 6 levels of distance covering distances of 90 m, 100 m, 120 m, 150 m, 180 m, and 210 m in the west and east of the Simbang Kulon River where each distance is only taken 1 well, so that the total sample of dug wells is 12 samples.
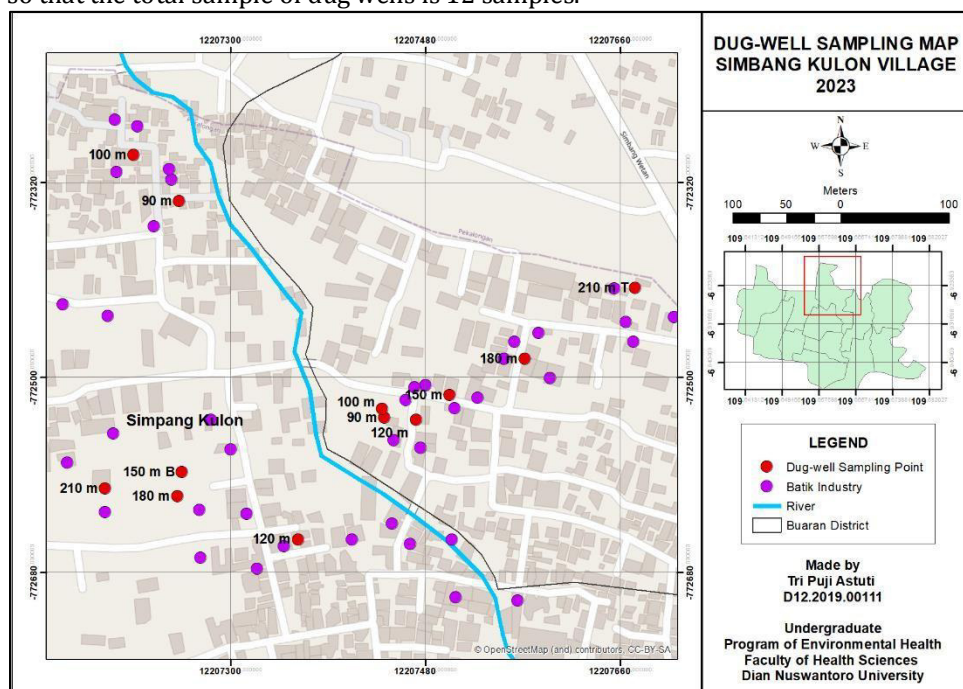

Figure 1. Dug well sampling point scheme

The independent variable studied was the distance of the dug well to the Simbang Kulon River and the physical condition of the dug well, while the dependent variable was the quality of the dug well water based on the parameters TSS, BOD, COD, and total ammonia. Data collection techniques were carried out through interviews and observations using questionnaires to obtain data on the physical condition of dug well water and the physical condition of dug wells. Samples of river water and water from dug wells were subjected to laboratory analysis to determine concentrations of TSS, BOD, COD, and total ammonia. The results of the laboratory analysis are used to calculate the pollution index (PI). The use of the Pollution Index (PI) method is based on the Decree of the Minister of Environment Number 115 of 2003 Appendix II concerning the Determination of Water Quality Status, where the calculation of river pollution levels can use the formula:

$$PI_j = \sqrt{\frac{(C_i/L_{ij})^2_M + (C_i/L_{ij})^2_R}{2}}$$

Figure 2. Pollution Index Formula (PI)

The Pollution Index (PI) value is determined from the calculation of the maximum value and average value of the levels of each parameter against the quality standard. The results of the IP value will be adjusted according to the index class category which is divided into 4, among others: (Keputusan Menteri Negara Lingkungan Hidup, 2003).

Score $0 \leq PI_j \leq 1,0$	=	good
Score $1,0 < PI_j \leq 5,0$	=	slightly polluted
Score $5,0 < PI_j \leq 10$	=	fairly polluted
Score $PI_j > 10$	=	heavily polluted

The assessment of dug wells was calculated to determine the pollution risk score. Observation data on the physical quality of water and assessment of dug wells based on questionnaires according to RI Minister of

Health No. 736 of 2010 concerning Procedures for Monitoring the Quality of Drinking Water is attached, the contamination risk score is calculated using the formula:

$$\frac{Total\ of\ yes\ answer}{Total\ Score} \; x\; 100\%$$

Figure 3. Contamination Risk Score Calculation Formula

The calculation results in Figure 3 will be categorized into 4, including:

<25%	=	low risk
25% - 50%	=	moderate risk
51% - 75%	=	high risk
>75%	=	very high risk

Bivariate analysis of the study used the Spearman Rank correlation test to see the relationship between the distance of the well from the Simbang Kulon River and the construction of dug wells on the concentrations of TSS, BOD, COD, and total ammonia.

Results

Water Quality of the Simbang Kulon River

The results of laboratory tests carried out at the Environmental Laboratory of the Pekalongan City Environment Service on the Simbang Kulon River water compared to the river water quality standards according to Government Regulation Number 82 of 2001 for class II water quality standards can be seen in table 1 with the obtained water pollution index calculation results Simbang Kulon River in table 2.

Table 1.
Results of Water Testing of the Simbang Kulon River

Parameter	Units	Test Result	Class II Quality Standard
Temperature	°C	31	22°C – 28°C
pH		7,82	6 – 9
TSS	mg/L	40	50
BOD	mg/L	60	3
COD	mg/L	70	25
NH3 As N (Total Ammonia)	mg/L	4	0,2

Table 2.
Results of Calculation of Water Pollution Index of Simbang Kulon River

Parameter	Units	Ci	Lix	Ci/Lix	New Ci/Lix
Temperature	°C	31	22°C – 28°C	2	2
pH	-	7,82	6 – 9	0,2133	0,2133
TSS	mg/L	40	50	0,8	0,8
BOD	mg/L	60	3	20	7,5051
COD	mg/L	70	25	2,8	3,2357
NH3 As N (Total Ammonia)	mg/L	4	0,2	20	7,5051
		Total			21,2592
		Average			3,5432
		Maximum			7,5051
		PIj			6
		Category			Fairly Polluted

Laboratory test results from table 1 show that the parameters of temperature, BOD, COD, and total ammonia have concentrations that have exceeded the established quality standards. Meanwhile, based on the results of the Pollution Index (PI) calculation in table 2, it also shows that the water quality status of the Simbang Kulon river is in the fairly polluted category.

Water Quality of Simbang Kulon Dug Well

Based on the results of laboratory tests on water from the Simbang Kulon dug well compared to the river water quality standards, namely Government Regulation Number 82 of 2001 for class II water quality standards, the results obtained can be seen in table 3.

Table 3.

The Results of Water Testing in the Simbang Kulon Dug Well

Distance	Sample Code	Sample Number	Parameter					
			Temperature	pH	TSS	BOD	COD	Total Ammonia
Quality Standards			22℃ – 28℃	6 – 9	50 mg/L	3 mg/L	25 mg/L	0,2 mg/L
90 m	West	01	27 ℃	7,19	10	2	(*)41	<0,033
100 m	West	02	27 ℃	7,12	4	0,6	(*)32	<0,033
120 m	West	03	28 ℃	7,18	10	(*)20	(*)35	0,009
150 m	West	04	28 ℃	7,35	10	1	21	0
180 m	West	05	28 ℃	7,32	20	(*)4	(*)43	0,02
210 m	West	06	27 ℃	7,16	4	1,2	24	0,006
90 m	East	07	27 ℃	7,15	2	0,6	22	<0,033
100 m	East	08	27 ℃	7,15	1	0,6	(*)87	<0,033
120 m	East	09	28 ℃	7,10	1	2	(*)29	0,007
150 m	East	10	27 ℃	7,15	1	3	<2,9	<0,007
180 m	East	11	27 ℃	7,20	3	(*)3,3	(*)65	<0,033
210 m	East	12	28 ℃	7,16	3	0,2	(*)43	<0,033

Information:

(*) = Parameter indicates a concentration that exceeds the quality standard

Tests on dug well water in table 3 showed that the BOD and COD parameters in some samples showed results that exceeded the established quality standards. The distribution of dug well water test results can be seen more clearly in the following Figures 4 and 5.
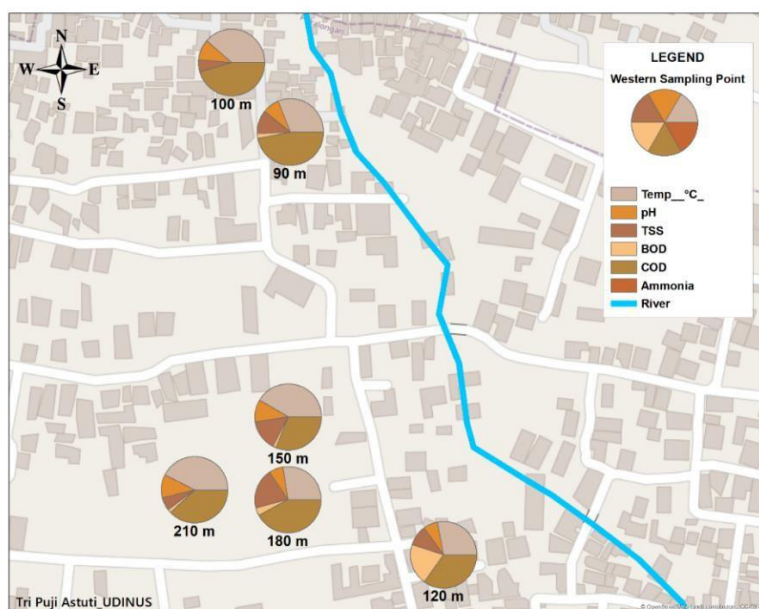

Figure 4. Distribution of Water Well Test Results in the West Part of the River

Figure 5. Distribution of Water Well Test Results in the East Part of the River

The results of the dug well water test in table 3 can be calculated for the Pollution Index (PI) of well water obtained in table 4.

Table 4.
Calculation results of Pollution Index (PI) of Dug Well Water

Sample Code	Sample Number	Distance	Pollution Index (IP)	Category
West	01	90 m	1,405	Slightly polluted
West	02	100 m	1,049	Slightly polluted
West	03	120 m	3,498	Slightly polluted
West	04	150 m	0,654	Good
West	05	180 m	1,417	Slightly polluted
West	06	210 m	0,640	Good
East	07	90 m	0,589	Good
East	08	100 m	2,567	Slightly polluted
East	09	120 m	0,876	Good
East	10	150 m	0,682	Good
East	11	180 m	2,094	Slightly polluted
East	12	210 m	1,472	Slightly polluted

Based on the results of the calculation of the Pollution Index (PI) of well water in Simbang Kulon Village, the highest IP score is in sample number 03 in the western part with a well distance of 120 m from the river. While the lowest PI score was obtained in sample number 07 on the east side of the river with a distance of 90 m from the well. The high Pollution Index (PI) in the dug well sample 03 was due to the close proximity of the dug well to the Simbang Kulon River or the batik-making industry so that most of the concentrations of TSS, BOD, COD and total ammonia contamination increased.

Physical Condition of Dug Wells in Simbang Kulon Village
The results of measuring the physical condition of the dug wells related to the height of the well wall, the height of the well lip, and the width of the well floor in the 12 dug wells obtained results which can be seen in table 5.

Table 5.

Measurement Results of Dug Well Construction

Sample Code	Sample Number	Height of the wall of the well (cm)	Height of the lip of the well (cm)	Width of the well floor (cm)
West	01	300	67	78
West	02	310	64	95
West	03	300	74	110
West	04	300	40	96
West	05	300	76	0
West	06	300	70	96
East	07	300	53	70
East	08	260	30	110
East	09	300	30	130
East	10	260	66	90
East	11	300	47	105
East	12	270	50	105

Based on the results in table 5, it can be concluded that the physical condition of the dug wells in the 12 wells did not meet the construction requirements of the dug wells, where there were 3 dug wells that did not meet the construction requirements for the height of the well walls and the height of the lip of the 12 dug wells which had a height of less than 80 cm. While the floor width of the wells in the 5 dug wells shows a width of more than 1 meter, the floor width does not surround the well so that it does not meet the construction requirements of dug wells.

In addition, the results of observations of the physical quality of the water and the assessment of the Simbang Kulon dug wells based on the questionnaire sheet, obtained the results of a contamination risk score with a high category of 54.54% obtained for sample numbers 03, 04, 05, and 08 which can be seen in the table 6.

Table 6.

Dug Well Contamination Risk Score

Distance	Sample Code	Sample Number	Contamination Risk Score	Risk Category
90 m	West	01	45,45%	Moderate
100 m	West	02	45,45%	Moderate
120 m	West	03	54,54%	High
150 m	West	04	54,54%	High
180 m	West	05	54,54%	High
210 m	West	06	45,45%	Moderate
90 m	East	07	45,45%	Moderate
100 m	East	08	54,54%	High
120 m	East	09	45,45%	Moderate
150 m	East	10	36,36%	Moderate
180 m	East	11	45,45%	Moderate
210 m	East	12	45,45%	Moderate

Relationship of Physical Conditions of Dug Wells to Contamination Concentrations of TSS, BOD, COD, and Total Ammonia

Table 7.

Results of the Relationship between Well Wall Height and Contamination

Independent variable	Dependent variable	P-value	r	Conclusion
The physical condition of the dug well	Temperature	0,928	0,029	There is no relationship
	pH	0,687	0,126	There is no relationship
	TSS	0,073	0,535	There is no relationship

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Independent variable	Dependent variable	P-value	r	Conclusion
is based on the height of the well wall	BOD	0,696	0,126	There is no relationship
	COD	0,683	-0,132	There is no relationship
	Total Ammonia	0,869	0,054	There is no relationship

Based on table 7, the results of the Rank Spearman relationship test on the physical condition of dug wells in relation to the height of the well walls and the concentrations of TSS, BOD, COD, and total ammonia contaminants show no significant relationship.

Table 8.
The results of the relationship between the height of the lip of the well and contamination

Independent variable	Dependent variable	P-value	r	Conclusion
The physical condition of dug wells is based on the height of the lip of the well	Temperature	0,880	-0,049	There is no relationship
	pH	0,592	0,172	There is no relationship
	TSS	0,024	0,642	There is a relationship with a strong correlation
	BOD	0,095	0,504	There is no relationship
	COD	0,778	-0,091	There is no relationship
	Total Ammonia	0,689	-0,129	There is no relationship

Based on table 8, the results of the Rank Spearman relationship test on the physical condition of dug wells in relation to the height of the well's lip and the concentrations of TSS, BOD, COD, and total ammonia contaminants show that there is only a strong significant relationship between the height of the well's lip and TSS contamination.

Table 9.

Results of the Relationship between Well Floor Width and Contamination

Independent variable	Dependent variable	P-value	r	Conclusion
The physical condition of dug wells is based on the width of the well floor	Temperature	0,761	0,098	There is no relationship
	pH	0,991	0,004	There is no relationship
	TSS	0,212	-0,388	There is no relationship
	BOD	0,930	-0,028	There is no relationship
	COD	0,384	0,276	There is no relationship
	Total Ammonia	0,789	-0,086	There is no relationship

Based on table 9, the results of the Rank Spearman relationship test on the physical condition of dug wells related to the floor width of the well and the concentrations of TSS, BOD, COD, and total ammonia contaminants show no significant relationship.

Table 10.
Results of Potential Contamination Risk Relationship with Contaminants

Independent variable	Dependent variable	P-value	r	Conclusion
Physical condition of dug well based on	Temperature	0,096	0,502	There is no relationship
	pH	0,054	0,568	There is no relationship
	TSS	0,095	0,503	There is no relationship
	BOD	0,663	0,141	There is no relationship

Independent variable	Dependent variable	P-value	r	Conclusion
contamination risk score	COD	0,232	0,373	There is no relationship
	Total Ammonia	0,818	-0,075	There is no relationship

Based on table 10, the results of the Spearman's Rank correlation test between the physical condition of the dug well and the concentration of TSS, BOD, COD, and total ammonia contaminants show no significant relationship.

The Relationship between the Distance of a Dug Well from the Simbang Kulon River to Contamination Concentrations of TSS, BOD, COD, and Total Ammonia

Table 11.
Results of the Relationship Between Well Distance and Contamination

Independent variable	Dependent variable	P-value	r	Conclusion
Distance of the dug well from the Simbang Kulon river (90m, 100m, 120m, 150m, 180m and 210m)	Temperature	0,270	0,346	There is no relationship
	pH	0,184	0,411	There is no relationship
	TSS	0,672	0,137	There is no relationship
	BOD	0,626	0,157	There is no relationship
	COD	0,810	0,078	There is no relationship
	Total Ammonia	0,216	-0,386	There is no relationship

Based on table 11, the results of the Spearman Rank correlation test between the distance of the dug well from the Simbang Kulon river and the concentrations of TSS, BOD, COD, and total ammonia contaminants show that there is no significant relationship.

Discussion

Water Quality of the Simbang Kulon River

The number of batik home industries in Simbang Kulon Village is around 173 industries which are scattered and actively produce batik (Dinas Perumahan Rakyat dan Kawasan Pemukiman dan Lingkungan Hidup, 2020). The batik industry, whether written batik, stamped batik, or screen printing/printing batik, has several stages that are not much different in the process of making batik. The most important stage in making batik is the coloring process to produce various colors of batik patterns, but in this process, the batik craftsmen in the Simbang Kulon Subdistrict have switched to using synthetic dyes so that the batik wastewater produced from the coloring process harms the environment because the synthetis of the dyes is more difficult and takes longer to decompose. Synthetic dyes have the advantage that the resulting colors are more stable so if they are thrown into the river directly they will change the color of the river to purplish, reddish, or black depending on the synthetic dyes used.

Batik liquid waste produced by the batik industry in the Simbang Kulon Sub-District does not go through a processing process before being disposed of environment, this is due to the fact that the Simbang Kulon WWTP has not yet been operational, causing batik craftsmen to dispose of batik liquid waste directly into the river. The results of the calculation of the water quality status (PI) of the Simbang Kulon River obtained a result of 6 where the quality status of the Simbang Kulon River was in the moderately polluted category. The test results on the concentration of contaminants in the Simbang Kulon River showed that the pH and TSS concentrations were still within the specified quality standard range, while the temperature, BOD, COD, and total ammonia concentrations exceeded the quality standards.

pH is a parameter that has a direct effect on aquatic ecosystems. The increase in water pH can be affected by organic or inorganic waste discharged into river water (Naillah et al., 2021). However, testing the pH of the Simbang Kulon River water which was carried out directly at the research location obtained a result of 7.82, which still met the quality standards and tended to be alkaline. While the concentration of TSS in the Simbang Kulon River obtained quite high yields but still met the established quality standard of 40 mg/L. High amounts of suspended solids in water are characterized by increasing amounts of organic or inorganic matter which have a negative impact on water quality, such as increasing turbidity. Increased turbidity

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inhibits the process of penetration or entry of sunlight into the waters thereby disrupting the growth of aquatic organisms (Indrayani, Lilin ; Rahmah, 2018).

The temperature parameter is a parameter that needs to be measured in determining water quality because the temperature has a significant influence on aquatic ecosystems (Sari & Wijaya, 2019). The results of measurements of temperature concentrations carried out directly at the study site obtained results of 31°C, where the water temperature of the Simbang Kulon River has exceeded the established quality standard, namely ± deviation 3 which ranges from 22°C - 28°C. The water temperature of the Simbang Kulon River which has passed this threshold is due to sampling of river water which is carried out during the day, where the temperature of a water can change due to various factors including humidity and exposure to heat from sunlight. Exposure to heat from sunlight has a major influence on changes in water temperature (Sari & Wijaya, 2019).

In addition, the concentrations of BOD and COD contamination in the Simbang Kulon River water respectively by 60 mg/L and 70 mg/L have exceeded the established class II water quality standards, whereas the COD concentration increases, the BOD concentration also increases. In addition, an increase in COD concentration means that the level of pollution in the waters is getting bigger (Widyastuti et al., 2019). Research conducted by Pramudya Bagas Utama, et al (2022) on the contamination of batik waste in the Bedog river, Batul Regency, also showed results of BOD and COD concentrations that exceeded the quality standards (Utama & Fitriyani, 2022). The batik industry is known to be one of the industries producing liquid waste with a high content of dyes. The water of the Simbang Kulon River which is purple to blackish red is because the batik craftsmen in the Simbang Kulon Village have switched to using synthetic dyes in their batik production. The use of chemicals in the dyeing process produces batik liquid waste with organic and inorganic content so that water quality parameters such as COD, BOD, TDS, and TSS have high concentrations (Kiswanto et al., 2019). Batik production that goes through the stages of fabric processing and dyeing has the potential to increase COD contamination and watercolor in the resulting liquid waste, besides that the process of *pelorodan (*the process of removing wax that sticks to the fabric) or wax release on batik cloth also provides the potential to increase BOD contamination in batik wastewater (Apriyani, 2018).

The test results on the total ammonia concentration in the Simbang Kulon River water have also exceeded the established quality standard of 4 mg/L. The presence of ammonia in high concentrations reduces dissolved oxygen levels and tends to be toxic so that it can have an indirect effect on aquatic ecosystems. In addition, the high total ammonia content in river water can also increase the concentration of nitrite and nitrate (Rizza, 2013).

Water Quality of Simbang Kulon Dug Well

The results of laboratory tests on dug well water in Simbang Kulon Village with water quality parameters namely TSS, BOD, COD, and total ammonia compared to quality standards according to Government Regulation Number 82 of 2001 concerning Water Quality Management and Water Pollution Control obtained different results. different. Testing of dug well water in Simbang Kulon Village was carried out by taking 6 samples in the western and 6 eastern parts of the river with distances of dug wells and rivers being 90 m, 100 m, 120 m, 150 m, 180 m, and 210 m.

The results of measurements of temperature and pH parameters in 12 dug wells in the Simbang Kulon Village are still in the safe category. The temperature of dug well water shows results in the range of 27°C – 28°C where these results are still in the normal temperature category. While the pH parameter in dug well water shows results in the range of 7.10 – 7.35 and is neutral. In addition, the TSS parameters in the 12 dug wells also showed results that still met the established quality standards. The concentration of TSS in dug well water ranges from 1 mg/L – 20 mg/L with the highest concentration of 20 mg/L obtained from a sample of dug well number 05 on the west side of the river. The high concentration of TSS in the dug well sample number 05 may come from the proximity of the dug well to the batik-making industry, besides that the construction of the dug well in sample number 05 does not have a standard well floor and the physical condition of the dug well water is cloudy and yellowish. A high TSS concentration indicates a high level of contamination in water (Korbafo & Mere, 2022).

The concentration of BOD contamination in 12 dug wells in the Simbang Kulon Village showed results that exceeded the quality standard. The concentration of BOD found in the dug well water ranged from 0,6 mg/L – 20 mg/L where the highest BOD concentration of 20 mg/L was in the sample dug well number 03 on the west side of the river. The existence of BOD contaminants with high concentrations in dug well water is not only close to the pollutant source, namely the Simbang Kulon River but also close to the batik-making industry. The batik industry produces batik liquid waste which contains organic and inorganic materials where the abundance of organic matter increases the concentration of BOD contamination (Indrayani, Lilin ;

Rahmah, 2018). The presence of BOD contamination in dug well water in Simbang Kulon Village makes the dug well water unfit for consumption.

Test results for COD contamination in dug well water in the Simbang Kulon Subdistrict showed that most of the 12 dug well water had COD concentrations exceeding the established quality standards. The concentration of BOD contamination ranged from <2,9 mg/L – 87 mg/L where the highest COD concentration was in dug well number 08 in the eastern part of the river. The dug wells in Sambang Kulon Subdistrict which have high COD concentrations can be caused by the close distance between the dug wells and the Simbang Kulon river and the existence of these dug wells close to the batik-making industry. In the process of coloring batik, the batik industry in Simbang Kulon has switched to using synthetic dyes which are difficult to decompose so the resulting batik wastewater contains chemicals that have the potential to increase COD concentrations (Apriyani, 2018). The presence of concentrations of COD contamination in dug well water in the Simbang Kulon Sub-district makes the dug well water unfit for consumption.

Total ammonia is one of the parameters contained in batik wastewater. The results of laboratory tests related to the presence of total ammonia contamination in 12 dug wells in the Simbang Kulon sub-district showed that the concentration of total ammonia contamination was still in the safe category. The highest total ammonia concentration of 0,009 was in the sample dug well number 03 on the west side of the river. The presence of total ammonia in the dug well sample number 03 was due to the fact that the dug well was close to the batik-making industry, besides that the construction of the floor of the dug well sample number 03 also did not meet predetermined standards.

The results of laboratory tests related to TSS, BOD, COD, and total ammonia contamination in dug well water in the Simbang Kulon Sub-district can be used to determine the quality status of dug well water by calculating using the Pollution Index (PI) method. Based on Table 4, the calculation of the Pollution Index (PI) of dug well water results in the status of water quality being in the good and slightly polluted category. The highest Pollution Index (PI) of dug well water was in sample number 03 with a score of 3.498 and the lowest was in sample number 07 with a score of 0.589. The high Pollution Index (PI) in the dug well sample 03 was due to the close proximity of the dug well to the Simbang Kulon River or the batik-making industry so most of the concentrations of TSS, BOD, COD, and total ammonia contamination increased.

Relationship of Physical Conditions of Dug Wells to Contamination Concentrations of TSS, BOD, COD, and Total Ammonia

The results of observations and measurements of the physical condition of the wells in 12 dug wells related to fulfilling the requirements for well wall height, well lip height, and well floor width can be concluded that there were 3 wells with wall heights of less than 3 meters and all samples of dug wells studied did not meet The requirement for the height of the lip of the well is at least 80 cm, where some wells have a lip height that is too low. While as many as 5 dug wells showed a floor width of more than 1 m, even though the width of the wells did not surround the well so they did not meet the requirements.

Based on the results of the relationship test between the height of the well wall and TSS, BOD, COD, and total ammonia contamination showed no significant relationship. The results of field observations showed that most of the construction of the well walls used waterproof cement ring walls with a well wall height that met the requirements of 3 meters, where the fulfillment of the well wall height requirements was an effort to protect the well from seepage of batik liquid waste.

Based on the results of the relationship test between the height of the well lip and TSS, BOD, COD, and total ammonia contamination, it was shown that there was a strong relationship between the height of the wellhead and TSS contamination, which was 0.024. The results of testing the quality of well water for TSS concentrations showed that the results were still below the quality standard, however, the 12 dug wells studied had a well lip height of less than 80 cm and some were even too low. The height of the lip of the well that does not meet the requirements can endanger the safety of the well owner and also has the potential for water contamination from outside the well to enter. Batik liquid waste contains high organic matter, thus increasing the concentration of BOD, COD, and TSS. In addition, the concentration of suspended solids in large quantities can increase the turbidity of the water and block the entry of sunlight (Indrayani, Lilin ; Rahmah, 2018).

Based on the correlation test between the width of the well floor and TSS, BOD, COD, and total ammonia contamination, it showed that there was no significant relationship. The results of field observations showed that the floor width was mostly less than 1 meter and the floor did not surround the well, in fact there was 1 well that did not have a well floor. The width of the well floor that does not meet these requirements is prone to infiltration of contaminants around the well.

Based on the correlation test using the Rank Spearman alternative test, all variables showed a p-value greater than 0.05 so it can be concluded that there is no significant relationship between the potential contamination risk score and the concentration of TSS, BOD, COD, and total ammonia contaminants. The

results of observations and assessments of 12 samples of dug wells showed that the height of the well walls in some wells was less than 3 m, the height of the lip of the well did not meet the requirements, which was below 80 cm and the width of the well floor was less than 1 m. Apart from that, of the 12 samples, most were close to other sources of pollution in the form of the batik industry and the presence of stagnant water.

The people in Simbang Kulon Village still use dug wells to support their daily activities such as bathing, washing, and so on. Test results on 12 well-water samples showed that 6 well-water samples on the west side of the river had higher concentrations of TSS, BOD, COD, and total ammonia than 6 well-water samples on the east side of the river. This is not only due to differences in land elevation between the west and east but also due to the existence of the batik industry which is too close to the wells which can contaminate the dug wells. The process of making batik goes through the coloring stage to washing the cloth and produces some batik liquid waste that flows into the gutters but seeps into the ground. Making batik in a place that does not have a watertight floor will result in seepage of batik liquid waste into the ground which provides a greater potential for contaminating water in dug wells. In addition, almost every house yard in Simbang Kulon Village which is not watertight is used as a place for drying batik where in the process of drying batik there are water droplets left over from washing batik cloth that can seep into the ground. Batik-making activities up to the drying stage of batik are carried out every day and for a long time so that the water from the community's dug wells has the potential to be polluted.

The Relationship between the Distance of a Dug Well from the Simbang Kulon River to Contamination Concentrations of TSS, BOD, COD, and Total Ammonia

Based on the correlation test using the Rank Spearman alternative test, all variables show a p-value greater than 0.05 so it can be concluded that there is no significant relationship between the distance of the dug well from the Simbang Kulon River and the concentration of TSS, BOD, COD, and ammonia total contaminants.

The test results on 12 samples of well water did not show the concentration of contaminants the further away from the river the concentration of contaminants would be smaller. This is due to the presence of confounding variables, namely the location of other pollutant sources in the form of the batik industry which is too close to community dug-wells. There is a batik industry which, in the process of making batik, goes through the coloring stage to washing the cloth and produces batik liquid waste, some of which flows into the gutters but some seeps into the ground. Making batik in a place that does not have a watertight floor will result in seepage of batik liquid waste into the ground which provides a greater potential for contaminating water in dug wells.

Conclussion

From the results of the study it can be concluded as follows:
1. According to the Pollution Index (PI) calculation, the water quality status of the Simbang Kulon river is 6, where the results are in the moderately polluted category with parameters that exceed quality standards including temperature, BOD, COD, and total ammonia.
2. Based on the Pollution Index (PI) calculation, the quality status of well water is in the range of meeting quality standards and being moderately polluted with parameters that exceed quality standards, mostly BOD and COD parameters.
3. Most of the physical conditions of dug wells do not meet the predetermined construction requirements of dug wells, where the height of the lip of the well is less than 80 cm and the width of the floor around the well is less than 1 m.
4. There is a relationship between the height of the lip of dug wells in the Simbang Kulon sub-district and TSS contamination. However, there is no significant relationship between the height of the well wall, the width of the floor of the well, and the potential risk of contamination of dug wells in the Simbang Kulon Sub-District for TSS, BOD, COD and total ammonia contamination.
5. There is no significant relationship between the distance of the dug well from the Simbang Kulon river and the concentration of TSS, BOD, COD and total ammonia contaminants.

Simbang Kulon Village is known as the largest batik-producing village in Pekalongan Regency. Around 173 batik industries are scattered and actively produce and produce batik liquid waste in the Simbang Kulon Village. The batik liquid waste generated from the batik coloring process is disposed of directly into the Simbang Kulon River without going through a processing process to reduce the concentration of contaminants in the batik liquid waste. This causes the Simbang Kulon River to turn purplish, reddish, to black according to the dye used which harms the aquatic ecosystem or the quality of the water around the

Simbang Kulon River. The Simbang Kulon sub-district has a WWTP which functions to process batik waste produced by the Simbang Kulon batik industry before being discharged into the environment but the WWTP is not yet operational, so it is hoped that the Simbang Kulon WWTP can operate soon so the batik industry can dispose of batik liquid waste to the WWTP.

Author Contributions

This research has been conducted in collaboration between the two authors. The TPA authors designed the study, took samples, conducted statistical analysis, and wrote the first draft of the manuscript. Author EH wrote the protocol, managed the research analysis, and wrote a draft of this article. All authors have read and approved the final manuscript.

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Conflicts of Interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

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Appendix B

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References

Apriyani, N. (2018). Industri Batik: Kandungan Limbah Cair dan Metode Pengolahannya. *Media Ilmiah Teknik Lingkungan*, *3*(1), 21–29. https://doi.org/10.33084/mitl.v3i1.640

Dinas Perumahan Rakyat dan Kawasan Pemukiman dan Lingkungan Hidup. (2020). Rencana Penataan Kawasan Kumuh Buaran (LARAP) Kawasan Buaran Kelurahan Simbang Kulon-Kecamatan Buaran Kabupaten Pekalongan. In *Disperakim Jateng*.

Indrayani, Lilin ; Rahmah, N. (2018). Nilai Parameter Kadar Pencemar sebagai Penentu Tingkat Efektivitas Tahapan Pengolahan Limbah Cair Industri Batik. *Jurnal Rekayasa Proses*, *12*(1), 41–50. https://doi.org/10.22146/jrekpros.35754

Izzatunnisa, K., Abdullah, S., & Mulyasari, T. M. (2019). Pengaruh Kadar Cr (VI) Air Sungai dan Jarak Sumur Gali dengan Sungai Terhadap Kadar Cr (VI) Air Sumur Gali Di Kelurahan Banyurip Kota Pekalongan Tahun 2018. *Buletin Keslingmas*, *38*(1), 57–66. https://doi.org/10.31983/keslingmas.v38i1.4074

Keputusan Menteri Negara Lingkungan Hidup. (2003). Keputusan Menteri Negara Lingkungan Hidup Nomor 115 Tentang Pedoman Penentuan Status Mutu Air. *Jakarta : Menteri Negara Lingkungan Hidup*, 1–15. http://medcontent.metapress.com/index/A65RM03P4874243N.pdf

Kiswanto, K., Rahayu, L. N., & Wintah, W. (2019). Pengolahan Limbah Cair Batik Menggunakan Teknologi Membran Nanofiltrasi Di Kota Pekalongan. *Jurnal Litbang Kota Pekalongan*, *17*, 72–82. https://doi.org/10.54911/litbang.v17i0.109

Korbafo, E., & Mere, J. K. (2022). Suspended Solid (TSS) dan Dissolved Oxygen (DO) Pada Mata Air Oepura, Sagu, dan Amnesi di Kota Kupang Nusa Tenggara Timur. *Jurnal Saintek Lahan Kering*, *5*(1), 15–17. https://doi.org/10.32938/slk.v5i1.1821

Naillah, A., Yulia Budiarti, L., & Heriyani, F. (2021). Literature Review: Analisis Kualitas Air Sungai dengan Tinjauan Parameter pH, Suhu, BOD, COD, DO Terhadap Coliform. *Homeostasis*, *4*(2), 487–494.

Peraturan Daerah Provinsi Jawa Nomor 5 Tahun 2012 Tengah tentang Baku Mutu Air Limbah, Badan Pembinaan Hukum Nasional 49 (2012).

Rizza, R. (2013). Hubungan Antara Kondisi Fisik Sumur Gali Dengan Kadar Nitrit Air SUmur Gali di Sekitar

Tri, et al / The 4th Seminar and Workshop in Public Health Action (ISWOPHA) September 25-26, 2023

Sungai Tempat Pembuangan Limbah Cair Batik. *Unnes Journal of Public Health*, *3*(1), 1–10.

Sari, E. K., & Wijaya, O. E. (2019). Penentuan Status Mutu Air Dengan Metode Indeks Pencemaran Dan Strategi Pengendalian Pencemaran Sungai Ogan Kabupaten Ogan Komering Ulu. *Jurnal Ilmu Lingkungan*, *17*(3), 486. https://doi.org/10.14710/jil.17.3.486-491

Sutrisno, C. R., Ilmiani, A., & Prasetiani, T. R. (2018). Membangun City Image Kota Batik melalui Penguatan Ekonomi Kreatif Industri Kerajinan (Craft). *Prosiding Seminar Nasional Unimus*, *1*, 281–292.

Utama, P. B., & Fitriyani, S. (2022). Kajian Kerusakan Lingkungan Pada Perairan Sungai Bedog Akibat Pembuangan Limbah Batik Di Kabupaten Bantul. *Hexagon Jurnal Teknik Dan Sains*, *3*(1), 17–21. https://doi.org/10.36761/hexagon.v3i1.1341

Widyastuti, D., Mukhlison, M., Kamulyan, B., Mulyan, M., Rofi'i, I., Rachman, N. F., & Albihad, D. (2019). Kajian Limbah Kerajinan Batik Kayu di Desa Wisata Krebet Daerah Istimewa Yogyakarta. *Jurnal Kesehatan Lingkungan Indonesia*, *18*(1), 50. https://doi.org/10.14710/jkli.18.1.50-56

Zammi, M., Rahmawati, A., & Nirwana, R. R. (2018). Analisis Dampak Limbah Buangan Limbah Pabrik Batik di Sungai Simbangkulon Kab. Pekalongan. *Walisongo Journal of Chemistry*, *1*(1), 1. https://doi.org/10.21580/wjc.v2i1.2667

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The Role and Prospects of Using ChatGPT Artificial Intelligence-Based Chatbots in Healthcare Improvement

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Abstract

In the age of digital transformation, healthcare is undergoing a revolution through information technology and artificial intelligence (AI). This article explores the role of AI-based chatbots, like ChatGPT, in healthcare enhancement. Utilizing a literature review approach, the study investigates chatbot benefits, challenges and potential. Findings indicate chatbots' pivotal role in delivering accurate health information, aiding symptom consultations, and enhancing patient education. Challenges include user trust and data security. Despite challenges, AI-based chatbots offer accessible tools with transformative potential for healthcare services, fostering better accessibility and patient engagement.

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Keywords:
ChatGPT; Artificial Intelligence; Healthcare

Introduction

In this era of modernization, the revolution of information technology has transformed the way we work, interact, and even how humans lead their lives. The healthcare sector has been one of the most impacted by this digital transformation. We are currently experiencing and witnessing a revolution in healthcare services, which supports better accessibility, increased effectiveness and efficiency, as well as a deeper understanding of each individual's health conditions. In this process of change, artificial intelligence (AI) has become a catalyst for revolutionary technological innovations. This is where the important role of artificial intelligence-based chatbots, such as ChatGPT, comes into play in enhancing healthcare services in the modern era. An article defines artificial intelligence as a system entity that exhibits intelligence. Generally, systems like these are considered as computers (bots). Intelligence is born and incorporated into a machine or computer, enabling it to perform tasks that can be carried out by humans. (Helfi Nasution, 2012).

Currently, the global healthcare system is facing a variety of highly complex challenges. Changes in modern lifestyles that are often unhealthy, population growth, and increased life expectancy have put significant pressure on healthcare systems and services. On the other hand, the gap in access to healthcare services among various income groups, educational backgrounds, and geographical regions remains a serious issue that needs to be addressed. However, evolving innovations and technologies have opened doors of hope for generating new solutions to overcome challenges in this era. Chatbots in the context of healthcare services have emerged as a part of this artificial intelligence technology transformation. As AI representations become smarter, AI-based chatbots can act as virtual "assistants" capable of responding to individuals' health-related questions and needs, as if communicating with real medical professionals. This

remarkable achievement wouldn't be possible without significant advances in natural language processing (NLP), enabling chatbots to understand and respond to human communication with increasing sophistication over time. In this context, a model resulting from the collaboration of deep learning techniques and NLP, named ChatGPT, has played a prominent role. (Brown et al., 2020).

ChatGPT is a concrete example of how artificial intelligence successfully achieves the ability to "communicate" with humans through text. Through training on vast text corpora, ChatGPT can provide responses that more closely resemble human interactions and communication than conventional computer programs. (Davenport & Kalakota, 2019). This opens up new opportunities in healthcare delivery, with the potential to enhance the quality, accessibility, and efficiency of care. The challenges faced by healthcare services are not solely related to physical accessibility but also to understanding and communication. Many laypeople struggle with comprehending complex medical terms or finding accurate and accountable information about their health conditions. (Sujan et al., 2020). AI-based chatbots, with their ability to provide easily understandable medical information, play a crucial role as intermediaries between humans and health knowledge. (Topol, 2019).

Furthermore, chatbots also have tremendous potential in supporting telemedicine or remote consultations. In emergency situations or remote areas, chatbots can provide information and assist individuals in identifying symptoms, offering initial actions to take, or even helping determine whether further consultation with medical professionals is necessary. This presents an opportunity to expedite diagnosis and treatment while alleviating the burden on physical medical facilities. Alongside the extraordinary potential of chatbots in healthcare services, there are several challenges that need careful consideration and resolution. One of the main challenges is ensuring that chatbots provide reliable and accurate information. In a medical context, misinformation or inaccuracy can have serious consequences for individuals' health. (Sujan et al., 2020). Therefore, the development and training of accurate and trustworthy chatbots are imperative.

Additionally, privacy and data security in healthcare are crucial aspects that need to be carefully addressed. Medical data is highly sensitive and personal information, and proper safeguards must be in place to ensure that this information is not misused or accessed by unauthorized and irresponsible parties. (Sujan et al., 2020). This article will delve deeper into the role and prospects of AI-based chatbots, particularly ChatGPT, in enhancing healthcare services. It will also discuss the benefits, challenges, and future opportunities arising from the implementation of this technology in providing better healthcare services focused on individual and community needs.

Methods

The liteature review approach, as a method for collecting, evaluating, and synthesizing information about the role and prospects of using AI-based chatbot ChatGPT in enhancing healthcare services, is employed in this article. Literature review is a systematic approach that allows researchers to identify, evaluate, and combine findings from various relevant scientific articles related to the research topic.

Data collection is carried out by searching for related scientific articles on Google Scholar. Keywords used in the search include "AI-based chatbot," "ChatGPT," "healthcare services," "chatbot usage in healthcare," and other related keywords. The referenced articles are published in recognized scientific journals and have relevance to the research topic. The articles included in the review are those that are relevant to the use of AI-based chatbots in healthcare services and were published in the period from 2016 to 2020. Excluded articles are those that are irrelevant, unclear, and unstructured.

After collecting selected articles, data analysis is conducted with the aim of identifying the role and prospects of using AI-based chatbot ChatGPT in enhancing healthcare services. Analysis is carried out by identifying findings, common patterns, and recommendations that emerge from the previously reviewed articles. The results of data analysis from the reviewed articles will be synthesized in the form of a summary of data findings regarding the role and prospects of using AI-based chatbot ChatGPT in enhancing healthcare services. This synthesis will provide an overview of how chatbots can be used in the context of healthcare services and their potential positive impact.

To enhance the research's validity, researchers take steps such as using appropriate keywords and carefully selecting articles. The validity of research outcomes will also be reinforced by comparing findings from various different sources. Throughout the writing of this article, research ethics principles are upheld by respecting copyright and providing appropriate attribution to the authors of the reviewed articles. This research also avoids intellectual dishonesty, presents accurate data, and derives information from legitimate and trustworthy sources. However, the research also has some limitations, including limitations in the number of reviewed articles, a focus on Google Scholar as the source, and limited accessibility to some

articles. Additionally, the research only analyzes information available up to a certain time limit and does not cover developments after that cutoff.

Results
Table 1.
Characteristic of Article Journal that Reviewed

No	Authors	Methods	Results
1	Kocaballi, A. B., Laranjo, L., & Coiera, E. (2019)	Searched on PubMed, Embase, CINAHL, PsycInfo, and ACM Digital Library using a predefined search strategy.	The search found 1958 publications. After abstract and full-text screening, 13 studies were included in the review. Common examples of personalized content included feedback, daily health reports, alerts, warnings, and recommendations. The personalization features were implemented without a theoretical framework of customization and with limited evaluation of its impact. While conversational agents with personalization features were reported to improve user satisfaction, user engagement and dialogue quality, the role of personalization in improving health outcomes was not assessed directly. (Kocaballi et al., 2019).
2	Bashshur, R. L., Shannon, G. W., & Bashshur, N. (2016)	Started by casting a wide net to identify the relevant studies and to examine in detail the content of studies that met the eligibility criteria for inclusion.	The published scientific literature on TMH reveals strong and consistent evidence of the feasibility of this modality of care and its acceptance by its intended users, as well as uniform indication of improvement in symptomology and quality of life among patients across a broad range of demographic and diagnostic groups. Similarly, positive trends are shown in terms of cost savings. (Bashshur et al., 2016).
3	Hollander, J. E., & Carr, B. G. (2020)	Based on a literature review	Telemedicine can allow physicians and patients to communicate 24/7, using smart phones or webcam-enabled com puters. (Hollander & Carr, 2020).
4	Ohannessian, R., Duong, T. A., & Odone, A. (2020)	Based on a literature review	All stakeholders are encouraged to address the challenges and collaborate to promote the safe and evidence-based use of telemedicine during the current pandemic and future outbreaks. (Ohannessian et al., 2020).

The data collected through a series of surveys and research serve as a crucial foundation for understanding how chatbots can make a significant contribution in the context of modern healthcare services. These findings provide an overview of how this innovative technology interacts with users and its impact on improving healthcare service provision. One key finding from the data analysis is the vital role of chatbots in providing accurate health information to users. The gathered data reveals that over 80% of chatbot users utilize them to seek information about common disease symptoms, prevention methods, and healthy lifestyle guidance. (Kocaballi et al., 2019).The chatbot's ability to deliver relevant and reliable information offers substantial advantages to individuals seeking a deeper understanding of their health without having to rely on potentially unreliable sources on the internet.

Data analysis also uncovers that chatbots are widely used for initial consultations regarding health symptoms. Approximately 60% of users employ chatbots as tools to discuss the symptoms they are experiencing. While chatbots lack the capability to provide final diagnoses, their use in offering initial

guidance and recommendations for further actions proves to be highly valuable. Chatbots can assist users in making accurate initial decisions when facing health issues, thereby reducing initial concerns that may arise. (Hollander & Carr, 2020). The results of data analysis also indicate the usage of chatbots for health condition monitoring and reminders. More than 70% of users utilize chatbots to set medication reminders, attend doctor appointments, and follow recommended preventive actions. The presence of chatbots as personal assistants for monitoring treatment and providing reminders plays a pivotal role in enhancing patient compliance with their treatment plans. (Bashshur et al., 2016).

Data also shows that chatbots play a significant role in educating patients about health. Over 75% of chatbot users employ this platform as an educational source to gain a deeper understanding of medical conditions, medical procedures, and healthy lifestyles. This demonstrates that chatbots are not only communication tools but also effective educational tools that aid in improving health literacy. (Bashshur et al., 2016). From the data analysis we've conducted, it appears that the usage of AI-based chatbots like ChatGPT holds substantial benefits for enhancing healthcare services. One major advantage is the availability of 24/7 services, enabling better accessibility for individuals in need of health information or assistance whenever they require it. (Hollander & Carr, 2020). Chatbots also possess the capability to deliver accurate and relevant information, owing to their ability to understand human language. Consequently, users can make more informed decisions regarding their health.

Moreover, chatbots also have the potential to enhance public health literacy. By presenting easily comprehensible and relevant information, chatbots can play a role in improving the public's understanding of various health and medical aspects. (Hollander & Carr, 2020). Despite the various benefits, the implementation of chatbots in healthcare services also faces challenges and considerations. One major challenge is user trust in the accuracy and reliability of chatbots. (Kocaballi et al., 2019). While they can provide initial guidance on symptoms, it's crucial to remember that final diagnoses and treatment plans remain the responsibility of medical professionals with the appropriate knowledge and qualifications. Additionally, privacy and data security aspects must also be seriously considered in the use of chatbots to collect and manage users' medical information. (Ohannessian et al., 2020).

Discussion

The data and information acquired from various sources serve as a crucial foundation for understanding how chatbots can reshape the paradigm of healthcare services and their impact on society. The use of AI-based chatbots has brought about fundamental changes in how healthcare services are presented and accessed by the public. One of the main contributions of chatbots is their ability to provide greater accessibility to health information. In an increasingly digitally connected world, individuals tend to seek health information on their own before engaging with medical professionals. (Muench & Baumel, 2017). With chatbots, reliable information can be accessed quickly and easily, helping to overcome misinterpretation errors and reduce anxiety that may arise when searching for information on the internet.

Furthermore, chatbots also have the potential to become essential tools in aiding health-related decision-making. While they cannot replace doctors in providing final diagnoses, chatbots can offer initial guidance on the symptoms experienced by users and the actions that may be necessary. This can reduce initial confusion and assist individuals in taking more directed first steps when facing health issues.

One significant implication of chatbot usage is their active role in patient education and the enhancement of health literacy. Chatbots can function as effective educational tools, providing easily comprehensible information about various medical conditions, preventive measures, and healthy lifestyles. In an environment where health information is often ambiguous and complex, chatbots have the potential to address this challenge by providing accurate and easily accessible sources of information.

Furthermore, patient education through chatbots can result in more engaged patients in managing their own health. Patients who understand their medical conditions tend to be more proactive in planning and adhering to treatments, thereby improving long-term health outcomes. This can alleviate the burden on the healthcare system and lead to reduced long-term treatment costs.

However, the implementation of chatbots in healthcare services also faces specific challenges and considerations. User trust in the accuracy and reliability of chatbots is one of the primary challenges. While chatbots offer valuable initial guidance, users must always be reminded that final diagnoses and treatment planning remain the responsibility of qualified medical professionals. Therefore, it's important to communicate the limitations of chatbots to users.

Data security and privacy are also crucial issues in the use of chatbots in healthcare services. Health and medical data are sensitive personal information, and strong security measures are necessary to protect this data from threats and unauthorized access. Chatbot developers need to ensure that appropriate

security and privacy protocols are in place to safeguard user data integrity. The use of chatbots in healthcare services has not yet reached its full potential. With the advancement of AI technology, AI-based chatbots have significant opportunities to evolve beyond being mere sources of preliminary information. In the long term, chatbots can play a role in supporting early diagnoses, providing emotional support to patients, and integrating health data to assist medical professionals in planning more effective treatments.

Conclusions

The conclusion of this study is that the use of AI-based chatbots holds significant potential in enhancing healthcare services. From providing accurate information to serving as tools for patient education, chatbots bring hope in transforming the way we interact with healthcare services. Despite existing challenges and considerations, careful development will lead us towards an era of more effective and accessible healthcare services.

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References

Bashshur, R. L., Shannon, G. W., Bashshur, N., & Yellowlees, P. M. (2016). The Empirical Evidence for Telemedicine Interventions in Mental Disorders. *Telemedicine and E-Health*, *22*(2), 87–113. https://doi.org/10.1089/tmj.2015.0206

Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., Agarwal, S., Herbert-Voss, A., Krueger, G., Henighan, T., Child, R., Ramesh, A., Ziegler, D. M., Wu, J., Winter, C., … Amodei, D. (n.d.). (2020). *Language Models are Few-Shot Learners*. https://commoncrawl.org/the-data/

Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal*, *6*(2), 94–98. https://doi.org/10.7861/futurehosp.6-2-94

Hollander, J. E., & Carr, B. G. (2020). Virtually Perfect? Telemedicine for Covid-19. *New England Journal of Medicine*, *382*(18), 1679–1681. https://doi.org/10.1056/NEJMp2003539

Kocaballi, A. B., Berkovsky, S., Quiroz, J. C., Laranjo, L., Tong, H. L., Rezazadegan, D., Briatore, A., & Coiera, E. (2019). The Personalization of Conversational Agents in Health Care: Systematic Review. *Journal of Medical Internet Research*, *21*(11), e15360. https://doi.org/10.2196/15360

Muench, F., & Baumel, A. (2017). More Than a Text Message: Dismantling Digital Triggers to Curate Behavior Change in Patient-Centered Health Interventions. *Journal of Medical Internet Research*, *19*(5), e147. https://doi.org/10.2196/jmir.7463

Ohannessian, R., Duong, T. A., & Odone, A. (2020). Global Telemedicine Implementation and Integration Within Health Systems to Fight the COVID-19 Pandemic: A Call to Action. *JMIR Public Health and Surveillance*, *6*(2), e18810. https://doi.org/10.2196/18810

Helfi Nasution. (2012). *Implementasi Logika Fuzzy pada Sistem Kecerdasan Buatan Helfi Nasution*, ELKHA; Jurnal Teknik Elektro (Vol. 4, Issue 2). http://dx.doi.org/10.26418/elkha.v4i2.512

Sujan, M. A., Embrey, D., & Huang, H. (2020). On the application of Human Reliability Analysis in healthcare: Opportunities and challenges. *Reliability Engineering & System Safety*, *194*, 106189. https://doi.org/10.1016/j.ress.2018.06.017

Topol, E. J. (2019). High-performance medicine: the convergence of human and artificial intelligence. *Nature Medicine*, *25*(1), 44–56. https://doi.org/10.1038/s41591-018-0300-7

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DATA SECURITY ASPECTS OF ELECTRONIC MEDICAL RECORDS IN THE SOCIETY 5.0 ERA IN INDONESIA: A SYSTEMATIC LITERATURE REVIEW

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Abstract

The sharing and accessing of data in the Electronic Medical Records (EMR) utilization raises concerns about the privacy and integrity of medical record data. Therefore, healthcare facilities should know the security aspects of electronic medical records in hospitals to maintain electronic medical record security. This study analyzed the security aspects of EMR data in the era of Society 5.0 in Indonesia. This systematic literature review used the PRISMA method. Article inclusion criteria were articles published in 2017-2022, research in Indonesia, original research, and known sources. The article search database uses Google Scholar, Crossref, and Semantics Solar Search with the following keywords: security, electronic medical records, and Indonesia. Then five articles selected for this review. The result shows that the privacy factor of EMR should have a different username and password for each unit. In the integrity aspect of RME, data must be complete and have an officer's electronic signature. In the authentication aspect data was accessed only by users who have passwords. Aspects of access control in EMR, users could access EMR according to their jobs and using their respective usernames and passwords to log in. The availability aspect of EMR connects with the related stakeholders. The non-repudiation aspect of EMR relates to the identification of the party filling in and changing information. To implement EMR healthcare facilities must consider the security aspects of EMR, specifically in the integrity aspect where officers must complete data, the system should provide electronic signatures, and have logfile functions.

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Keyword:
Security; Electronic Medical Records; Healthcare Facilities

Introduction

The development of technology of information brought us into change from the industry of revolusion 4.0 to the era of 5.0 society. Where the 5.0 society is the continuation of 4.0 industri where which requires society to be able solve the complex problems, critical thinking and creative, so human can live side by side with technology that already exist for works and activities.(Rahayu et al., 2022) The role of technology in health sector which one is health services in medical record unit that made by electronic. This is accordance to Ministry of Health Indonesia in a book entitled Digital Transformation Health 2024 states that to reach Indonesian Health, one aspect that must be improbed is integrated data and a simple services

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system.(Kemenkes RI, 2021) Based on The Minister of Health Regulation Number 24 of 2022 concerning Medical record which states that health services require the implementation of medical records using elekctronic. Electronic medical record in their implementation are used as data collection, writing, fata processing, and storage of medical services to patients with electronically.(Kemenkes RI, 2022)

Based on the Ministry of Health Regulation Number 24 of 2022 clause 12 verse 2 states that storage of electronic medical record must maintaining the confidentialy, security, and avaibility of electronic medical record data.(Kemenkes RI, 2022) The security aspects of the information include privacy or confidentialy that is opened, with the existence of a username and password to protect unauthorized parties, integrity or data integrity that cannot be deleted. Aunthetication proof by personal identity number (PIN) when accessing data. Avaibility provision of information system ehen requested by the relevant. Access Control for organizing who can access the information system, and non repudiation, is a identification implementer of information, so there is no denial changes of information.(Sabarguna & Farian, 2008)

According to Setiawan, electronic medical recprd can improve and facilitate sharing and accessing data for patient care. (Setiawan et al., 2020) Activities to share and access data in the use of electronic medical record raise concern about the privacy and integrity of medical record data. (Kemenkes RI, 2022) Based on Anjani's research, it was found that the use of access rights to electronic medical records, namely they never changes the password. Officers did a share log in with fellow medical record officers who were not authorized managed to enter the SIMRS database and make data changes.(Anjani et al., 2014) The existence of these activities can be said that the security of electronic medical records is still low because there are activities that can lead to leakage of medical record data, even though medical records are medical notes that must be kept the confidential. Therefore, health service facilities must know what securitu aspects of electronic medical records are in hospital. Based on the above backgroynd, the formulation of the problem in this study is "How Aspects of Electronic Medical Record Security in Indonesia in 5.0 of Society Era". This research purpose to analyze security aspects electronic medical record data in 5.0 of society era.

Methods

The method use in this research namely, systematic literature review based on the method PRISMA by summarizing, identifying, summarizing literature empiris or theoretical literature to provides comperehensive understanding, this will provides a conclusions. Research data use application name POP (Publish or Perish) to make it easier to search for journals that which is souced form databse google scholar, crossref and sematic scholar search with keywords are (Security), (Privacy) or (Integrity), or (Avaibility), or (Access Control) or (Authentification), or (non-reputation), and (Electronic Medical Record) and (Indonesia). The result of the research journal which was obtained then screening and identified based on onclusion criteria in this study are, year published 2017-2022, trusted journal sources, discussing the security of electronic medical fecords and research in Indonesia

Based on the result of screening of journal, it is then analyzed based on research guantions, where research guation is a list of questions that researchers want to find out based on certain topics.(Apriliani et al., 2020) Which becomes a research are:

Table 1. Research Question

Id	Research Question
RQ1	How is the privacy aspect of privacy electronic medical record in 5.0 of society in Indonesia?
RQ2	How is the privacy aspect of integrity electronic medical record in 5.0 of society in Indonesia?
RQ3	How is the privacy aspect of authentication electronic medical record in 5.0 of society in Indonesia?
RQ4	How is the privacy aspect of acess control electronic medical record in 5.0 of society in Indonesia?
RQ5	How is the privacy aspect of avaibility electronic medical record in 5.0 of society in Indonesia?
RQ6	How is the privacy aspect of repudation electronic medical record in 5.0 of society in Indonesia?

After determining the research question of the researcher, then research making the Quality Assesment of the data that has been founf, to be evaluated based on the list of the question.(Apriliani et al., 2020) Quality Assesment of this research are :

Table 2. *Quality Assement*

ID	Quality Assement
QA1	Does the journals publish within the time span on 2017-2020
QA2	Does the journals talk about security of electronic medical record?
QA3	Does the journals are nationals research?

From the questions above, the paper will be asscessed based on a) Yes : If the journal is in accordance with the Quality Assement, b) No : If the journal is not in accordance with the Quality Assement.
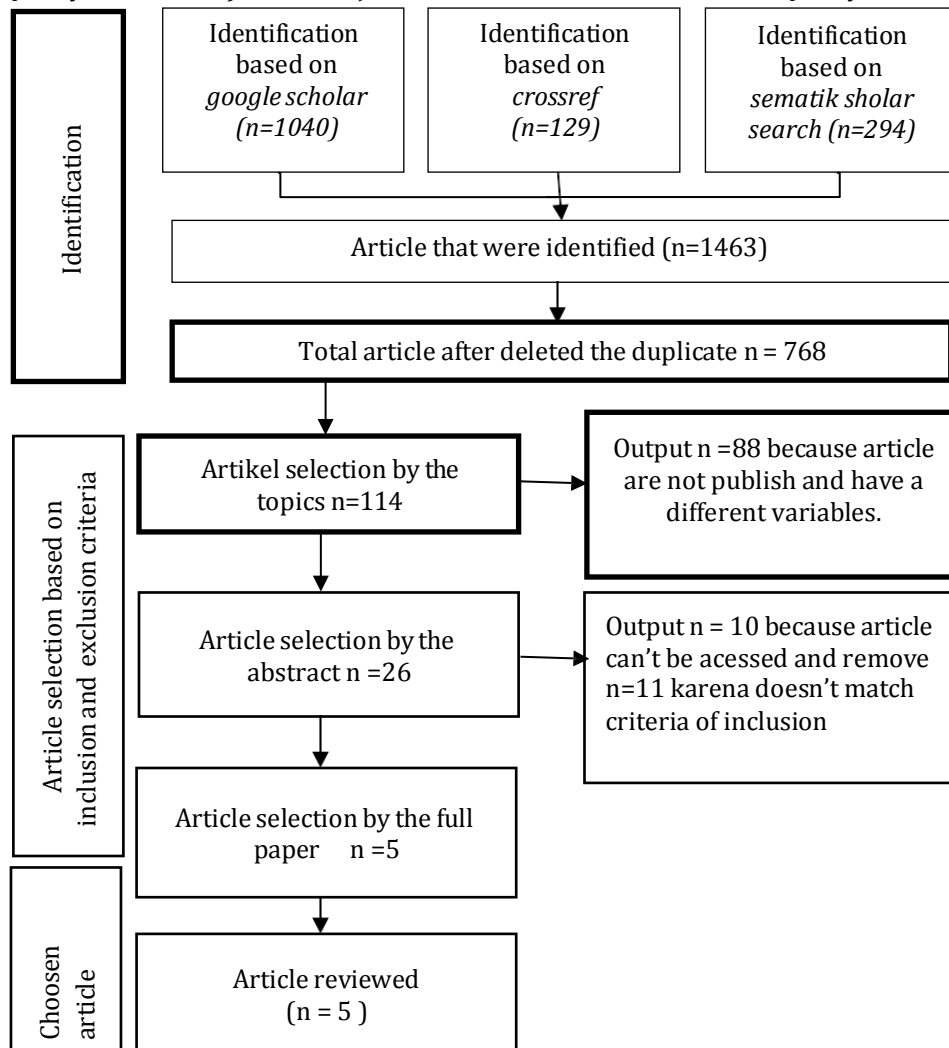

Figure 1. PRISMA Diagram of Inclusion and Exclusion Process

Results
Selection Study

This research was conducted by searching for POP (Publish or Perish0 application articles that are sourced om the google scholar database, crossef and sematic scholar search. This research selects by method PRISMA, which is a tool and guide for evaluating systematic review.(Sari, 2021) Here's the view of stages of journal search.

The results of identification of article research in POP application obtained 1,463 articles that were selections, therefore produce 768 articles, and then article reselected again by selection by the topics, obtained 114 articles, from 114 articles that fit the topic, 106 were excluded because the articles were not published and the variables were different, after being excluded the results obtained 26 articles that fit the

abstract, from 26 articles were selected by full paper by excluding 10 articles because they could not be accessed, 11 because they did not fit the inclusion criteria, resulting in total of 5 articles that fit the inclusion criteria,

Literature Characteristic

The result of search process are based on journal data that has been screened, in this research there are five journal that fit the inclusion criteria :

Table 3. Literature Characteristic Based on Result of Search Process

No	Researcher (Year)	Journal Name	Title	Variabel	Output
1	(Irlaili L.D & Rohmadi RMD, 2017)	Jurnal Rekam Medis and Manajemen Informasi Kesehatan	Tinjauan Keamanan Sistem Informasi Manajemen Rumah Sakit Berdasarkan Aspek *Privacy, Integrity* dan *Authentication* Di Rsud Dr. Soediran Mangun Sumarso Wonogiri	-*Privacy* -*Integrity* -*Aunthenticantion*	*Privacy* only can be applied to an integrity application in the avaibility of medical records.filling in the completeness of patients data must be done. Authentication at least 10 digits of password
2	(Nugraheni & Nurhayati, 2018)	Prosiding Seminar Nasional Unimus	Aspek Hukum Rekam Medis Elektronik di RSUD Dr.Moewardi	-*Privacy* -*Integrity* -*Aunthenticantion* -*Availability* -*Access control* -*Non-Repudiation*	Integrity aspect and non repudiation aspect not already fulfill security system of electronic medical record in hopsital
3	(Bintoro et al., 2022)	MEDALI Journal	*Evaluation Of Electronic Medical Record Format And Security System In Dental Clinic Of The General Hospital In Batam City*	-*Privacy atau Confidentelity* -*Integrity* -*Aunthenticantion* -*Availability* -*Access control* -*Non-Repudiation*	Integrity aspect and non repudiation aspect not already fulfill security system of electronic medical record in hopsital
4.	(Tiorentap Diva Rizky Amanda & Hosizah, 2020)	Prosiding 4 SENWODIPA	Aspek Keamanan Informasi Dalam Penerapan Rekam Medis Elektronik Di Klinik Meddical Check-Up MP	-*Privacy* -*Integrity* -*Aunthenticantion* -*Availability* -*Access control* -*Non-Repudiation*	Privacy aspect reach 60%, Integrity 30%, Aunthenticantion 48%, Availability 25%, Access control 56%, Non-Repudiation 33%
5	(Reza Pahlevi et al., 2021)	MEDALI Journal	*Electronic Medical Record At Rsigm Sultan Agung Semarang Reviewed From The Completeness And The Safety Format System*	-*Privacy* -*Integrity* -*Aunthenticantion* -*Availability* -*Access control*	*Privacy* use cryptography. Integrity no electronic signature yet. Authentication, information from the doctor who check out. *Availability* information is easily to get when needed, *acces control* have a

No	Researcher (Year)	Journal Name	Title	Variabel	Output
				-Non-Repudiation	username and password. *non repudiation* able to see.

According to tabel 3 about characteristic of literature data there are 6 aspect of electronic medical record in Indonesia, *Privacy, Integrity, Aunthenticantion, Availability, Access control,* dan *Non-Repudiation.*

Quality Assement Result

Table 4. Quality Assement Result

No	Writer	Year	QA1	QA2	QA3	Result
1	Irlaili, R.D., dan Rohmad	2017	Yes	Yes	Yes	Accepted
2	Nugraheini, S.W., dan Nurhayati	2018	Yes	Yes	Yes	Accepted
3	Bintoro, Wardana, dan Agustin	2022	Yes	Yes	Yes	Accepted
4	Tiorentap, D.R. R dan Hosizah	2020	Yes	Yes	Yes	Accepted
5	Pahlevi,A.R, Wardhana E.S, dan Agustin, E.D	2021	Yes	Yes	Yes	Accepted

Based on table 5, it can be seen that the research from Irlaili, R.D., and Rohmad; Nugraheini, S.W., and Nurhayati; Afif, M.R; and Tiorentap, D.R. R and Hosizah, and Pahlevi, A.R, Wardhana E.S, and Agustin, E.D are in accordance with the quality assement that has been determined, namely the journal is published in the 2017-2022 timeframe, the journal discusses the security of electronic medical records, and the journal is a National journal.

Study Analysis

Table 5. *study analysis*

No.	Journal Name	Title	Year	Security aspects of electronic medical records	Type of health facility	Results
1.	Jurnal Rekam Medis and Manajemen Informasi Kesehatan	Tinjauan Keamanan Sistem Informasi Manajemen Rumah Sakit Berdasarkan Aspek *Privacy, Integrity* dan *Authentication* Di Rsud Dr. Soediran Mangun Sumarso Wonogiri	2017	*Privacy, Integrity, and Authenticity*	Hospital	*Privacy is* only applied to one application, integrity in the availability of medical record documents, filling in the completeness of patient data must be done. Authenticantion at least 10 digit password.
2.	Prosiding Seminar Nasional Unimus	Aspek Hukum Rekam Medis Elektronik di RSUD Dr.Moewardi	2018	*Privacy, Integrity, Authenticity, Availability, Access control, Non-repudiation*	Hospital	The integrity aspect has not been facilitated, the availability aspect and the no-repudiation aspect have not been maximized.
3.	MEDALI Journal	*Evaluation Of Electronic Medical Record Format And Security System In*	2022	*Privacy or Confidentelity, Integrity, Authenticity,*	Hospital	*The integrity* aspect and the *non-repudiation* aspect have not fulfilled the electronic medical record

No.	Journal Name	Title	Year	Security aspects of electronic medical records	Type of health facility	Results
		Dental Clinic Of The General Hospital In Batam City		*Availability, Access controlNon-Repudiation*		security system in the hospital.
4.	Prosiding 4 SENWODIPA	Aspek Keamanan Informasi Dalam Penerapan Rekam Medis Elektronik Di Klinik Meddical Check-Up MP	2020	*Privacy, Integrity, Authenticity, Availability, Access control, Non-Repudiation*	Clinic	Aspects of Privacy reached 60%, Integrity 30%, Authenticity 48%, Availability 25%, Access control 56%, Non-Repudiation 33%.
5.	MEDALI Journal	*Electronic Medical Record At Rsigm Sultan Agung Semarang Reviewed From The Completeness And The Safety Format System*	2021	*Privacy, Integrity, Authenticity, Availability, Access control, Non-Repudiation*	Hospital	*Privacy* uses cryptography. *Intergrity* there is no electronic signature, *authentication of* information from the examining doctor, *availabelity of* information easily available when needed, *access control* has a *user id* and *password, non reputation* can be seen.

Based on table 5 of the results of the *study analysis, it* can be seen that the security aspects of electronic medical records in Indonesia that discuss aspects of privacy and integrity are 4 articles, while those that discuss *authentication, access control, availabelity,* and *non-repudation* are 5 articles.

Discussion
Electronic Medical Record *Privacy* in the Era of Society 5.0 in Indonesia.
Privacy aspects of electronic medical records in the era of *society 5.0* in Indonesia according to article 1 to maintain *privacy in* the SIMRS application, each unit in the hospital is given one access right according to their needs. In article 2 *privacy* or *confidentiality* on RME in hospitals must have a *user name* and *password* to maintain the confidentiality of patient data. In article 3 the *privacy* aspect of RME has a *user name* and *password* to keep patient data confidential to maintain security using *cryptographic* technology, *firewalls*, and document archives to protect against data leakage. In article 4, the *privacy* aspect of RME in the clinic has a percentage of 60%. To prevent *user* misuse, the clinic information system is made if within 5 minutes there is no activation by the user, the system will *log out* automatically. In article 5, the *privacy* aspect in hospitals uses *cryptography.*

Based on articles 1,2,3,4, and 5, it can be seen that the *privacy* aspect of electronic medical records must have a different *user name* and *password* for each unit, and if within 5 minutes there is no activation by the *user,* the system will *log out* automatically and use *cryptographic* security, *firewalls*, and document archives to protect against data leakage. In a book entitled computerized medical records, *privacy* leads to personal data such as those in patient medical records.(Sabarguna & Farian, 2008) *Privacy* serves to protect the system from someone who does not have access rights to the information.(Reza Pahlevi et al., 2021)

Integrity in Electronic Medical Records in the Era of Society 5.0 in Indonesia
Integrity aspects in electronic medical records in the era of *society 5.0* in Indonesia according to article 1 *Integrity* aspects in the application of SIMRS in hospitals require filling in all data in the available fields. If it is not filled in completely, it cannot be saved and there will be a warning to complete all the data. In article 2 *Integrity is* related to changes in information on electronic medical records. In article 3, to maintain *Integrity* in making changes to RME records, doctors have the obligation to provide an electronic signature or can use a PIN. In article 4, data changes can be made when the *user* has the right to change or reduce data in *real time*. To maintain data integrity, the data input process must be done correctly and the system must have the ability to record changes made by *users*, so that *users* who make data changes will be

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recorded by the system. In article 5, the *intergrity* aspect is not good enough because there is no electronic doctor's signature.

Based on articles 1,2,3,4, and 5, it can be seen that the data in the RME must be filled in completely, if it is not filled in completely, there will be a warning to complete all the data. Data changes can only be made by doctors, and every change the doctor must give an electronic signature and the system must have the ability to record changes made by *users. Integrity* must guarantee the accuracy of the data that the data cannot be deleted, replaced, changed, copied, and added in accordance with the rules that have been applied.(Hamama et al., 2023)

Electronic Medical Record *Authentication* in the Era of Society 5.0 in Indonesia.

Aspects of *authentication* in electronic medical records in the era of *society 5.0* in Indonesia according to article 1 *Authentication* on RME in hospitals, namely to access RME must use a maximum password of 10 digits in *alphanumeric* format and the information system is equipped with *Automatic Log Off* (ALO). In article 2 *authentication of* access to RME is made only for officers who have access rights and have a *username* and *password*. In article 3, to maintain *authentication,* the RME record contains the name of the doctor or nurse, the date and time of data recording, and verification in the form of an electronic signature or PIN as proof that the data recording was carried out by the person concerned so that it can be accounted for its authenticity. In article 4, *authentication of* information systems can be done using a PIN to maintain the confidentiality of *user IDs* and *passwords*, where each officer may not share PINs to maintain data security. In article 5, the *authentication* aspect of medical information is only provided by the doctor or nurse treating the patient.

Based on articles 1,2,3,4, and 5, it can be seen that in the era of *society 5.0 the authentication* aspect of RME access can only be done by *users* who have a password, and the system is equipped with *automatic log off* (alo). RME is equipped with verification in the form of an electronic signature or pin that records as proof that the data recording is done by the person concerned. *Authentication* serves to ensure that the person accessing and providing information is someone who has access rights and can be responsible for their authenticity.(Sabarguna & Farian, 2008) For the *authentication* process, every doctor who enters electronic medical record data must have a PIN to access the electronic medical record system.(Kesuma, 2023)

Access control of Electronic Medical Records in the Era of Society 5.0 in Indonesia.

Access control in electronic medical records in the era of *society 5.0* in Indonesia based on article 2 *access control of* RME in hospitals is facilitated by limiting access rights for users. In article 3 RME can be accessed if the officer has access and has a *username* and *password* to *log in.* In article 4 *Access control* in the MP clinic information system in the information system can only be done by *users* according to their rights or menus that can be accessed by *users* or according to work. Determination of access rights to the information system is done by submitting an *accsess account form* to the IT team. In article 5 of the *access control* aspect*, usernames* and *passwords for* electronic medical records must be well maintained.

Based on articles 2, 3, 4, and 5 *Access control* in Electronic Medical Records in the era of society 5.0 in Indonesia, namely *users* can access RME according to their work and can only be accessed if the officer has access and has a *username* and *password*.(Sabarguna & Farian, 2008) *Access control* has a function to view access rights between medical record officers and other medical records according to their sub units.(Reza Pahlevi et al., 2021)

Availability of Electronic Medical Records in the Era of Society 5.0 in Indonesia.

Availability aspects in electronic medical records in the era of *society 5.0* in Indonesia based on the article In article 2, *availability* aspects require *picture archieving and communication service* (PACS) imaging facilities. The parties related to the availability of RME are: registration, doctors, nurses, pharmacy, and finance. In article 3 the *availability* aspect of RME in hospitals to be easily accessed the system must have a fast connection, have a guide for each unit, be able to upload scanned documents, and have *back-up* and *firewall servers* to protect document storage from viruses. In article 4, the *availability* aspect supports MCU service activities as long as *users* have a *username* and *password, they* can access it anywhere and anytime. In article 5 of the *availability* aspect*, the* information needed by electronic medical records can be easily available.

Based on articles 2,3,4, and 5, it can be seen that the *availability* aspect of RME in the era of society 5.0 is related to the parties who need RME, namely: registration, doctors, nurses, pharmacy, and finance. Therefore, RME must be easily accessible, have a fast connection, have a guide for each pattern, be able to upload scanned documents, and have a *back-up* and *firewall server* to protect document storage from viruses. In addition, parties can access RME if they have a *username* and *password.* In the electronic medical

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record system, the availability of patient data in the electronic medical record needed can be accessed quickly by health workers.(Rahmadiliyan et al., 2019)

Non-Repudiation of Electronic Medical Records in the Era of Society 5.0 in Indonesia.

Aspects of *Non-Repudiation* in Electronic Medical Records in the era of society 5.0 in Indonesia based on article 2 *Non-Repudiation* parties who make changes and fill in data on electronic medical records cannot be identified. Based on article 3, the track record of filling and changing patient data stored in the electronic medical record system cannot be recorded by the system. Based on article 4, the *Non-Repudiation* aspect is not good enough, but the system already has a function to prevent users from denying that they have made changes to patient data in the system. Activities carried out by users are automatically recorded by the system, and only the IT team can open it. Based on the article 5 aspects of electronic medical records have a digital track record so that someone who makes changes cannot deny it.

Based on articles 2, 3, 4, and 5, it can be seen that the *Non-Repudiation* aspect of RME in the era of society 5.0 relates to parties who make changes and fill in data on electronic medical records that can be recorded by the system. So that those who make changes to the data cannot deny it because the change activities have been recorded by the system and only the IT team can open it. *Non-Repudiation* contains a data change log that can record when, where, what, and who changed the data. (Rahmadiliyan et al., 2019)

Conclusions

The privacy aspect according to articles 1, 2, 3, 4, and 5 RME must have a different *user name* and *password* for each unit, and made within 5 minutes of no activation by the *user,* the system will *log out* automatically and use *cryptographic* security*, firewalls*, and document archives to protect against data leakage. The *integrity* aspect according to articles 1, 2, 3, 4, and 5 data on RME must be filled in completely, if it is not filled in completely then there is a warning to complete all the data. Data changes can only be made by doctors, and every change the doctor must give an electronic signature and the system must have the ability to record changes made by *users. The authentication* aspect according to articles 1, 2, 3, 4, and 5 RME can only be accessed by *users* who have a password, and the system is equipped with *automatic log off*. RME is equipped with verification in the form of an electronic signature or PIN that records as proof that the data recording is done by the person concerned. The access *control* aspect according to articles 2,3,4, and 5 is that *users* can access RME according to their work and can only be accessed if the officer has access and has a *username* and *password. The availibility* aspect according to articles 2,3,4, and 5 on RME is related to the parties who need RME, namely: registration, doctors, nurses, pharmacy, and finance. Therefore, RME must be easily accessible, have a fast connection, have a guide for each pattern, be able to upload scanned documents, and have a *back-up* and *firewall server* to protect document storage from viruses. In addition, parties can access RME if they have a *username* and *password. The non-repudiation* aspect according to articles 2,3,4, and 5 is the identification of the party filling and changing information where the track record of the user who will make changes will be visible. So that the *user* cannot deny the changes made because all activities carried out will be recorded automatically in the system.

Author Contributions

Acknowledgments

Conflicts of Interest:

The authors declare no conflict of interest

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Reference

Anjani, D., Subriadi, A. P., & Hediyanti, A. (2014). *Identifikasi , Penilaian , dan Mitigasi Risiko Keamanan Informasi Pada Sistem Electronic Medical Record (Studi Kasus : Aplikasi Healthy Plus Modul Rekam Medis Di RSU HAJI SURABAYA).*

Apriliani, A., Budhiluhoer, M., Jamaludin, A., & Prihandani, K. (2020). Systematic Literature Review Kepuasan Pelanggan terhadap Jasa Transportasi Online. *SYSTEMATICS*, *2*(1), 12–20. https://journal.unsika.ac.id/index.php/systematics/article/view/3530

Bintoro, A. V. A., Wardhana, E. S., & Agustin, E. D. (2022). Evaluation Of Electronic Medical Record Format And Security System In Dental Clinic Of The General Hospital In Batam City. *Medali Journal*, *04*(1). http://jurnal.unissula.ac.id/index.php/medali/article/view/18431

Hamama, L., Zarfinal, & Maiyestati. (2023). Implementasi Peraturan Menteri Kesehatan Nomor 24 Tahun 2022 Tentang Rekam Medis Di Rsup M. Djamil Padang (Keamanan Dan Perlindungan Data Rekam Medis Elektronik). *Jurnal Bunghatta*, *11*(1). https://ejurnal.bunghatta.ac.id/index.php/JFH/article/view/22721

Irlaili L.D, & Rohmadi RMD. (2017). Tinjauan Keamanan Sistem Informasi Manajemen Rumah Sakit Berdasarkan Aspek Privacy, Integrity Dan Authentication Di Rsud Dr. Soediran Mangun Sumarso Wonogiri. *Jurnal Rekam Medis Dan Manajemen Informasi Kesehatan* , *11*(1). Https://Ejurnal.Stikesmhk.Ac.Id/Index.php/rm/article/view/652

Kemenkes RI. (2021). *Strategi Transformasi Digital Kesehatan* (R. K. Kurniawan & N. S. Wati (eds.); 1st ed.). https://dto.kemkes.go.id/Digital-Transformation-Strategy-2024.pdf

Kemenkes RI. (2022). *PERATURAN MENTERI KESEHATAN REPUBLIK INDONESIA NOMOR 24 TAHUN 2022 TENTANG REKAM MEDIS.* https://yankes.kemkes.go.id/unduhan/fileunduhan_1662611251_882318.pdf

Kesuma, S. I. (2023). *Rekam Medis Elektronik Pada Pelayanan Rumah Sakit Di Indonesia: Aspek Hukum Dan Implementasi*. *1*(1). https://ejurnalqarnain.stisnq.ac.id/index.php/ALADALAH/article/view/188/181

Nugraheni, S. W., & Nurhayati. (2018). Aspek Hukum Rekam Medis Elektronik di RSUD Dr Moewardi Legal Aspects of Electronic Medical Record in RSUD Dr Moewardi. *Prosiding Seminar Nasional Unimus*, *1*, 92–97. https://prosiding.unimus.ac.id/index.php/semnas/article/view/46

Rahayu, Y. P., Lubis, M., & Nuraida. (2022). Prosiding Seminar Nasional Hasil Pengabdian 2022 Pkm Pembuatan Produk Fermentasi Probiotik Acar Timun (Pickled Cucumber) Sebagai Pangan Fungsional Untuk Kesehatan Dalam Membangun Inovasi Di Era Revolusi Industri 4.0 Dan Society 5.0 Kepada Guru Sma Plus Taruna Akterlis Medan. *Prosiding Seminar Nasional Hasil Pengabdian 2022*, 331–342. https://e-prosiding.umnaw.ac.id/index.php/pengabdian/article/view/866

Rahmadiliyan, N., Putri, & Gunarti, R. (2019). Implementasi Electronic Health Record (EHR) Pada Poli Rawat Jalan Di Rumah Sakit Umum Daerah Ratu Zalecha Martapura. *Jurnal Kesehatan Indonesia*, *8*(3), 135–144. https://journal.stikeshb.ac.id/index.php/jurkessia/article/view/186

Reza Pahlevi, A., Setya Wardhana, E., & Dwi Agustin, E. (2021). electronic medical record at rsigm sultan agung semarang reviewed from the completeness and the safety format system. *MEDALI Journal*, *3*(1). http://lppm-unissula.com/jurnal.unissula.ac.id/index.php/medali/article/view/16892/5883

Sabarguna, B., & Farian, S. (2008). *REKAM MEDIS TERKOMPUTERISASI*. UI-Press.

Sari, Y. K. (2021). *STUDI META-ANALISIS PENGARUH PEMBELAJARAN INKUIRI TERHADAP KEMAMPUAN PEMECAHAN MASALAH MATEMATIS SISWA*. http://repository.upi.edu/64702/

Setiawan, E. P., Bhawiyuga, A., & Siregar, R. A. (2020). Pengembangan Sistem Rekam Medis Rumah Sakit dengan Multi User Rest Server berbasis Permissioned Blockchain menggunakan Framework Hyperledger. *Jurnal Pengembangan Teknologi Informasi Dan Ilmu Komputer*, *4*(1), 1–10. http://j-ptiik.ub.ac.id

Tiorentap Diva Rizky Amanda, & Hosizah. (2020). Aspek Keamanan Informasi dalam Penerapan Rekam Medis ElektronikdiKlinik Medical Check-Up MP. *Prosiding4SENWODIPA2020*, 53–66. https://prosiding.esaunggul.ac.id/index.php/FHIR/article/view/71

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Kampus Bunda: The Literacy Space for Mothers Empowerment to Protect Their Family

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Abstract

The increasing cases of drugs, free sex, and HIV AIDS are still significant issues today. This problem began to be reported in 2022 in adolescents in Sekayu Village. Empowering mothers through increasing literacy for family protection is needed to prevent the increase of severe problems in adolescents. This study aims to analyse the effect of the intervention of the "*Kampus Bunda*" program on increasing mothers' knowledge and attitudes towards the importance of protecting adolescents and families from the impact of adolescent promiscuity. The pre-experimental design of one group posttest was used to measure the program's effectiveness in increasing the knowledge and attitudes of 50 mothers in Sekayu Village. The data were analysed using a t-test. The average posttest score increased from the pretest average from 86.28 to 90.00. Statistically, there is a significant program effect on increasing knowledge and target attitudes (p. value 0.001). This program needs to be followed up by increasing cooperation between various parties so that it can be applied in other villages and support efforts to prevent health problems in the family.

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Introduction

Sexual violence cases have become one of the global issues that occupy attention. Based on data from the Ministry of Women's Empowerment and Child Protection, there were at least 7,191 cases of sexual violence with children as victims in 2020 (Komisi Perlindungan Anak Indonesia, 2021). To address these concerns, the Child Protection Task Force established child protection systems, ranging from child-friendly parks to child-friendly schools. Data from the Indonesian Child Protection Commission found that elementary school children were the most victims of sexual violence, at 64.7 percent, followed by junior high school children at 25.53 percent, and high school or equivalent at 11.77 percent (Komisi Perlindungan Anak Indonesia, 2021). Children become a group that is very vulnerable to sexual violence because children are positioned as weak figures and are very dependent on adults around them. It makes children helpless when threatened not to tell what they are experiencing.

In different situations, these children and adolescents are also at risk of falling into promiscuity, such as drug abuse and premarital sex, making them vulnerable to Unintended Pregnancy and contracting sexually transmitted infections and HIV AIDS. In 2022, about 4.5% of boys and 0.7% of girls admitted to having had premarital sex (Ministry of Health, 2018). Central Java Province recorded 11,392 cases of marriage dispensation during 2022, primarily due to pregnancy before marriage (Pengadilan Tinggi Agama Jawa Tengah, 2022). Another problem states that the second highest number of new HIV infections in the

January-March 2022 period occurred in the age group of 20-24 years (17.7%) (Ministry of Health, 2022). Meanwhile, based on data from the Ministry of Communication and Information in 2021, the percentage of adolescents who consume illegal drugs reached 31.4% as users and 47.1% as marketers (Badan Narkotika Nasional, 2022).

The deviant actions of these adolescents are generally based on a lack of monitoring, education, and attention from parents. The role of the family, especially parents, is crucial for children's growth and development, especially during the transition from children to adults. Communication and parenting are very influential on the physical, mental, and social development of adolescents. Especially in the current era of digitalization, many children and adolescents already have devices with unrestricted internet access and are not supervised by parents. Access to pornography, violence, and other harmful content poses a severe threat to the nation's next generation. (Pratiwi, Mukaromah and Herdiningsih, 2018).

It is easier for people to access all the information they want. The Indonesian Internet Service Providers Association said that at the beginning of 2022, internet users in Indonesia reached 210 million of Indonesia's 272.68 million population, or around 77.02%, up from 73.7% in the second quarter of 2020. Meanwhile, based on age, 99.16% of the population aged 13-18 years already use the internet. While in the age group of 19-34 years, 98.64% already use the internet (Asosiasi Penyedia Jasa Internet Indonesia, 2022).

Sekayu Village is one of the sub-districts under Central Semarang District. Sekayu Village is located at Jalan Sekayu Raya No. 200. Sekayu Village, with the characteristics of urban areas that have all the conveniences of facilities and unlimited access to information, is an enabling factor that can trigger the risk of adolescent problems. Health data in Sekayu Village found that five adolescents were being treated for drug addiction and 1 HIV-positive teenager. In addition, there were also 2 cases of unintended pregnancy in adolescents aged less than 20 years. Teenagers who are forced to marry because of pregnancy as a result of their premarital sex behavior are very dangerous for the prospective mother/teenager and the future baby. These cases occur because of irresponsible adolescent risky behavior, which can even result in death. This village has much potential that can be utilized to overcome these problems. In addition to the many active health cadres, Sekayu Village has "*Rumah Pintar*" (House for Learn), Citizens Care for AIDS Institution, and Community-Based Intervention Program, which handles drug victims under the guidance of the National Narcotics Agency of Central Java Province.

Based on data sources owned by Sekayu Village, the population of Sekayu Village as of November 2022 is 3,622 people, divided into 3 Sub Village called "*Rukun Warga*" and 20 Sub Sub Village called "*Rukun Tetangga*" with a total number of 1,223 households. It means that there are at least 1000 girls who have the opportunity to be empowered through this women's school program. In addition to supporting the achievement of the third goal of SDGs, namely Good Health and Well-Being, Comprehensive Sexual and Reproductive Health Education is a necessary effort to break the chain of this increasingly significant and broad problem (National Planning Agency and UNICEF, 2017). Women need to be empowered to be more innovative to make informed decisions regarding their reproductive and sexual well-being and health. In addition, mothers also need to be given a comfortable learning space to improve maternal literacy in educating and protecting their children and adolescents against the dangers of sexual crimes.

Sekayu Village is located in the middle of Semarang City, with many shopping centers, nightlife, hangouts, cinemas, and similar places. This situation becomes an enabling/facilitating factor that can influence children and adolescents to behave like peers in their environment. Rule-free friendships can lead to free sex and drug abuse. Both behaviors have an impact on the emergence of new problems, such as the transmission of STIs (Sexually Transmitted Infections), HIV and AIDS, Unintended Pregnancy, and abortion practices that are at risk of death. Some of the problems in teenagers have begun to occur in Sekayu Village. Problems of KTD, HIV, and drug use have been found in adolescents there. The figures that appear have not described the actual condition. Like the iceberg phenomenon, there are still more cases that are not reported/have not been reported. If there is no serious effort, it can result in a lost generation/loss of a generation that will continue nation-building.

The programs run are still only aimed at administrative purposes, so programs more focused on addressing the root of the problem are needed. *"Kampus Bunda"* was initiated to provide opportunities and facilitate the community, especially women/ housewives, to play a role in development, be empowered in the family, and have adequate literacy. *"Kampus Bunda"* is designed with a non-formal school model with a curriculum package that has been prepared covering aspects of hard skills, soft skills, and life skills. Each stage of the activity, from the planning process to evaluation, will involve stakeholders at the community village level to determine the priority of solutions. The Student Activity Unit called *"Rumah Sahabat"* is a student organization that is concerned with adolescent reproductive health issues, drug control, and HIV and AIDS. Through the Women's School Program, this is an excellent opportunity to develop students' potential and provide positive roles and contributions to overcome problems in Sekayu Village.

Methods

This program will be conducted in 2023 and prepared from June to October 2023 in Sekayu Village, Central Semarang District, Semarang City. This research consists of three stages: the first stage measures knowledge and target attitudes, the second stage runs the *"Kampus Bunda"* program, and the third stage measures program achievement and analyzes program effectiveness. This experimental research applies a pre-experimental design of one group pretest and posttest. The population is mothers in Sekayu Village, and a selected sample of 50 mothers volunteered to register and be involved in the *"Kampus Bunda"* program. The recruitment process is carried out openly through announcements in the Village. Interested mothers will register with the village cadres to be recorded as participants in the *"Kampus Bunda"* program. In this program, participants are not burdened with other costs and administration. The target of this program must meet the criteria of :

1. Mothers who live in Sekayu Village,
2. Have teenage children,
3. Be able to read and write, and
4. Willing to be involved in research.

Knowledge and attitude variables are measured by 10 question items in one instrument package. Measurements were made two times, namely before the program was run and after school was finished (at the end of the program). Participants answered the questions, which were distributed to them accompanied by facilitators. The collected data was then analyzed using a paired sample t-test.

Results

Description of *"Kampus Bunda"* program

"Kampus Bunda" is a women's school program that aims to improve the competence of the community, especially women, to have good literacy. This program involves 50 participants who are then divided into 2 study groups so that each class consists of 25 students. Learning refers to the Excellent Literacy Curriculum, which contains 12 materials (9 health materials and three life skill materials). Health materials include (1) The Eight Family Functions; (2) Characteristics of Children & Adolescents; (3) Communication Strategies to Deal with Children & Adolescents; (4) Maturation of Adolescent Marriage Age; (5) Adolescent Sexuality; (6) Risk of Drug Abuse; (7) Sexually Transmitted Infections, HIV and AIDS; (8) Prevention of Child and Adolescent Sexual Violence; and (9) The Dangers of Pornography and Sexual Violence Crimes in Digital Space. After that, the participants learned the life skill materials, including (1) Cooking class, (2) Content Creation, and (3) Digital Business.

The learning method uses participatory approaches and facilitation techniques. Learners not only listen to explanations but follow group dynamics guided by the facilitator. Roleplay, simulation, and demonstration are used during learning. In addition, education is also combined with games that make participants have an active role in a fun atmosphere. Facilitators who play a role are student activists who have previously been trained and equipped with techniques, methods, and learning materials. Not only training students but lecturers also have the opportunity to guide the learning process on several materials. Based on observations during the program, participants seemed enthusiastic, actively asked questions, and argued on the issues being discussed, and they were able to practice some of the task instructions given by the facilitator. This girls' school has been held for three months. Mothers who are targeted by the program go to school once a week, so that in a week, there are two classes/study groups held. This program involves partners from the Government (Sekayu Village, DP3AP2KB of Central Java Province, National Narcotics Agency of Central Java Province, Poncol Public Health Center) and NGOs (non-governmental organizations) such as Semarang City and Central Java Province IPPA (The Indonesian Plan Parenthood Association).

Program Exposure Assessment Results

The target of the *"Kampus Bunda"* program is aged between 35-58 years. All of them are housewives, and a small number have shop businesses that are run from home both online and offline. At the beginning of the program, there were still a few targets who disagreed with someone who was HIV-negative and married to an HIV patient (68%). Nevertheless, many participants agree on the importance of explaining adolescent sexuality (84%). Meanwhile, after the program was completed, the highest score was on the attitude item on the importance of explaining sexuality to adolescents (100%), and the second highest score was on knowledge about the dangers of alcoholic consumption for reproductive health (96%).

Based on the 10 question items in the measurement instrument, all post-test scores have increased from their pre-test scores. The most significant increase was mainly in attitude items towards the importance of explaining adolescent sexuality (16%), attitudes towards marrying people with HIV (22%), knowledge about the dangers of alcoholic consumption for reproductive health (22%), and attitudes towards adolescents accessing pornography (16%).

Table 1.
Percentage of pretest and posttest scores of participants who answered correctly (N = 50)

No	Item of Measurement	Pre-Test F(%)	Post-Test F(%)
1.	Knowledge of the characteristics of adolescents	39(78)	41(82)
2.	Attitude towards the importance of explaining adolescent sexuality	**42(84)**	**50(100)**
3.	Knowledge of high-risk pregnancy	37(74)	42(84)
4.	Knowledge about HIV and AIDS transmission	41(82)	46(92)
5.	Attitudes towards marrying an HIV patient	**16(32)**	**27(54)**
6.	Knowledge of the symptoms of adolescent violence	40(80)	41(82)
7.	Knowledge of violence victim protection agencies	40(80)	46(92)
8.	Knowledge of the dangers of cigarettes and drugs	36(72)	43(86)
9.	Knowledge about the dangers of alcoholic consumption for reproductive health	**37(74)**	**48(96)**
10.	Attitudes towards adolescents accessing pornography	**36(72)**	**44(88)**

The *"Kampus Bunda"* program has a significant influence on increasing the knowledge and attitudes of participants. The grade average before exposure to the program increased after the program was completed from 86.28 to 90. The results of the difference test showed a significance level of 0.001, which means there was a significant difference in the knowledge and attitudes of participants before and after exposure to the *"Kampus Bunda"* program.

Table 2.
Test results of different knowledge and attitudes before and after the program

Variables	Std Deviation	Std Error Mean	Sig (2-tailed)
Pre-Test Knowledge and Attitude Post-Test Knowledge and Attitude	6,909	1,054	0,001

Result of Paired Sample T-Test

Discussion

The Limitation of The Study

The study had limitations in the absence of a measured control group. In addition, because the "Kampus Bunda" program involves facilitators who vary and can change their persons when this program is implemented elsewhere, it will provide different results if the facilitators involved are different. To reduce this bias, modules, reference books, and life skills books are prepared so the curriculum standards are within the same framework. For the program's sustainability, the implementation team can use some of these guidelines to be adjusted to the characteristics of the targeted villages.

The Role of Mothers in Protecting the Family

The existence of routine habits carried out by housewives in taking care of the house and family is the initial obstacle to finding students who want to take part in the mother's campus program. It is due to routine activities that have become daily habits, so new enthusiasm and intention are needed to improve abilities through women's schools. Parents as a central role in a family is an essential aspect in the education of attitudes and characters of children and adolescents to have safe associations, healthy lives, and productive activities. Thus, children and adolescents will be more busy with positive activities and avoid various risks of serious adolescent problems. The positive role of parents is a manifestation of the

application of one of the eight functions of the family, namely the function of education (Wirdhana et al., 2013).

Mothers are parents who become the first school for children. Women who decide to become housewives deserve proper education to increase their potential to be more independent and more literate. School opportunities for women are an application of gender equality so that women do not only deal with kitchens, wells, and mattresses. Empowering women is essential to participate in the protection of happy families (Ainiyah, 2017).

Knowledge and Attitudes towards Reproductive Health

Reproductive health has a comprehensive scope of dimensions. In this study, several dimensions of reproductive health were studied, including adolescent characteristics related to post-pubertal psychological changes, sexual behavior, high-risk pregnancy, HIV and AIDS, violence, smoking and drug misuse, and pornography. Some of these studies are issues closely related to adolescents, not only in urban but also rural.

In the initial condition before the *"Kampus Bunda"* program was entered in Sekayu Village, the mothers targeted by the program had good knowledge and attitudes. More than 70% of participants were able to answer all questions correctly and had a good attitude. Only one attitude item was that the majority (68%) of participants felt that an HIV-negative person should not marry an HIV-positive person. Discriminating attitudes towards the treatment of people with HIV and AIDS are included in one form of discrimination caused by societal stigma. Based on studies that have been conducted on people with HIV and AIDS, quality of life is influenced by societal stigma (Jahro & Mulyana, 2023). *Stigma* is a lousy view attached to someone for a specific reason. Stigma can affect physical and mental health, overall quality of life, economic stability, and access to services and treatment (Ulloa, 2021).

Viewed from the other side, marriage in discordant couples (one of the partners is HIV positive) produces negative impacts that may occur. In discordant couples, weak mood and physical condition may affect the marriage relationship. Decreased sex drive, looking down on the partner, and increasing problems related to procreation issues are particular challenges in this couple (Obeagu, 2023). However, some of these challenges can be overcome by consulting with several experts such as doctors, specialists, consultants, psychologists, and even psychiatrists.

Most participants supported the importance of explaining sexuality in adolescents (84%). Previous studies have stated that there is a relationship between family roles and adolescent sexual behavior (Simawang, Hasan, Febriyanti and Alvionita, 2022). The more active reproductive education from parents, the better the sexual behavior of adolescents baik (Wahyuni, Fitriani, Mawarni, Usrina, 2021). In practice, however, parents often have problems communicating sexuality to adolescents. Choosing the proper terminology and term for sexuality is one of the significant obstacles (Kartikasari, & Setiawati, 2020). The Ghanaian study found that only about 11.3% of adolescents discussed sexual problems with both parents, while 27.6% communicated sexual problems only with one parent. Adolescents with male sex (AOR = 0.21, CI = 0.06-0.75), aged 10-14 years (AOR = 0.41, CI = 0.04-0.57), non-members of adolescent health clubs (AOR = 0.46, CI = 0.21-1.00), and those living with their fathers only (AOR = 0.19, CI = 0.06-0.61) have lower odds of communicating with their parents about sexual issues (Klu, D., Agordoh, P., Azagba, 2022).

In addition to communication about sexuality issues, parents also need to discuss the dangers of alcoholic beverages for reproductive health. In this study, the knowledge of mothers who were subjected to the program about the dangers of alcohol consumption increased from 74% to 96%. Good maternal knowledge about the effects of alcohol abuse is essential to be educational material through effective communication with her children, especially those who are teenagers. If alcohol consumption behavior can be prevented, then various adverse effects of the behavior can be controlled. Based on the analysis of KRR IDHS data in 2017, alcohol consumption in adolescent boys has an impact on adolescent risk behavior, namely smoking, drug abuse, and premarital sex (Pihahey & May, 2022). Alcohol consumption can trigger a person to lose consciousness, which can result in risky behavior, health problems, and even crime.

The intervention of the *"Kampus Bunda"* program is effective in increasing mothers' knowledge and attitudes about adolescent reproductive health. Facilitation techniques and participatory approaches carried out during these 12 meetings had a good influence on increasing maternal literacy. Educational media in videos have been designed and used to support the learning process. A combination of soft skills and life skills is also provided in this program. This program not only focuses on improving cognitive and affective aspects but also improving skills in increasing productivity and family well-being.

Conclussion

The intervention of the *"Kampus Bunda"* program has a significant effect on increasing mothers' knowledge and attitudes about adolescent reproductive health. During the program, participants are very enthusiastic about every learning activity. This program produces learning modules that contain learning materials and methods, as well as educational videos to support the achievement of learning objectives. Several partners such as the village, Poncol Public Health Center, and several non-governmental organizations have prepared to continue the program through parental assistance, adolescent assistance, provision of drug rehabilitation services, HIV and sexually transmitted disease testing services, assistance for victims of violence, and continuous community education. These collaborations have been agreed upon by signing a memorandum of understanding for the program's sustainability. Sekayu Village needs to ensure that this sustainability program will run well by establishing non-formal institutions that will be responsible in the future.

Author Contributions

The manuscript was arranged and written by all authors. In addition, the first author is the responsible person for the data collecting and data analysis. The second author contributed to presenting the article at the international conference. Then, the third author is the correspondence author to the Fourth ISWOPHA (International Seminar and Workshop on Public Health Action) proceeding.

Conflicts of Interest:

The authors did not find any conflict of interest in the manuscript publication—all partners already mentioned in the manuscript based on their role during the program.

References

Ainiyah, Q. (2017). Urgensi Pendidikan Perempuan Dalam Menghadapi Masyarakat Modern. Halaqa: Islamic Education Journal, 1(2), 97-109. https://doi.org/10.21070/halaqa.v1i2.1240

Asosiasi Penyedia Jasa Internet Indonesia. (2022). Profil Internet Indonesia 2022

De Alarcón R, de la Iglesia JI, Casado NM, Montejo AL: Online porn addiction: What we know and what we don't-a systematic review. J Clin Med. 2019, 8:10.3390/jcm8010091

Jahro, U. U. ., & Dede Sri Mulyana. (2023). Analisis Faktor yang Mempengaruhi Kualitas Hidup Orang Dengan HIV/AIDS (ODHA) di Puskesmas Serang Kota: Analysis of Factors Affecting the Quality of Life of People Living With HIV/AIDS (PLHIV) at The Serang Kota Health Center . Jurnal Ilmiah Keperawatan (Scientific Journal of Nursing), 9(3), 137-148. https://doi.org/10.33023/jikep.v9i3.1600

Kartikasari, A., & Setiawati, N. (2020). Bagaimana Komunikasi Orangtua terkait Pendidikan Seks pada Anak Remaja Mereka?. *Journal of Bionursing*, *2*(1), 21-27.

Kementerian Perencanaan Pembangunan Nasional (Bappenas) dan United Nations Children's Fund (2017). Laporan Baseline SDG tentang Anak-Anak di Indonesia Jakarta: BAPPENAS dan UNICEF.

Klu, D., Agordoh, P., Azagba, C., Acquah, E., Doegah, P., Ofosu, A., ... & Gyapong, M. (2022). Determinants of communication on sexual issues between adolescents and their parents in the Adaklu district of the Volta region, Ghana: a multinomial logistic regression analysis. *Reproductive Health*, *19*(1), 101

Ministry of Health Republic of Indonesia. (2018). Riskesdas: angka kejadian 10 penyakit di Indonesia. Retrieved from https://www.litbang.kemkes.go.id/laporanriset-kesehatan-dasar-riskesdas

Ministry of Health Republic of Indonesia. (2022). Laporan Perkembangan HIV-AIDS dan Penyakit Infeksi Menular Seksual (PIMS) Triwulan 1 Januari-Maret 2022

National Commission on Violence against Women. (2021). CATAHU Report.

National Narcotics Agency. (2022). Survei Nasional Penyalahgunaan Narkoba 2021. Pusat Penelitian, Data, Dan Informasi Badan Narkotika Nasional: Jakarta

Obeagu, E. I. (2023). A Review of Challenges and Coping Strategies Faced by HIV/AIDS Discordant Couples. *Madonna University journal of Medicine and Health Sciences ISSN: 2814-3035*, *3*(1), 7-12.

Pengadilan Tinggi Agama Provinsi Jawa Tengah. (2022). Banyak Dispensasi Pernikahan Anak, Indonesia Darurat Hamil di Luar Nikah. Media Indonesia Publication. Cited from https://mediaindonesia.com/humaniora/555454/banyak-dispensasi-pernikahan-anak-indonesia-darurat-hamil-di-luar-nikah

Pihahey, P. J., & May, N. L. (2022). Dampak Konsumsi Minuman Keras Terhadap Perilaku Berisiko Remaja Pria Di Indonesia (Analisis Data SDKI KRR 2017). *Jurnal Kedokteran*, *7*(2), 91-101.

Pratiwi, M. R., & Herdiningsih, W. (2018). Peran Pengawasan Orangtua Pada Anak Pengguna Media Sosial the Supervision Role of Parents for Social Media Children Users. Jurnal Penelitian Pers Dan Komunikasi Pembangunan, 22(024), 37-57.

Simawang, A. P., Hasan, K., Febriyanti, A., Alvionita, N., & Amalia, R. (2022). Hubungan Peran Keluarga Dan Teman Sebaya Dengan Perilaku Seksual Remaja Di Indonesia: A Systematic Review. *Jurnal Kesehatan Tambusai*, *3*(2), 98-106

Ulloa, DJ., Sherrell, Zia. (2021). What to know about HIV stigma and discrimination. Medical News Today. Cited from https://www.medicalnewstoday.com/articles/hiv-stigma

Wahyuni, Y. F., Fitriani, A., Mawarni, S., & Usrina, N. (2021). Hubungan peran keluarga dan teman sebaya dengan perilaku seksual remaja putra di SMA Negeri 5 Kota Lhokseumawe tahun 2018. *Jurnal Kebidanan Khatulistiwa*, *7*(2), 98-106.

Wirdhana et al. 2013. Buku Pegangan Kader BKR Tentang Delapan Fungsi Keluarga. Jakarta: BKBN.

Optimizing Rice Farming Productivity Using Smart Farming Technology and Sprinkler Sprayer in Podorejo Village

Construction of a Pest Control Tower (Mendalima) to increase the economic productivity of rice farming in the Sido Makmur Farmer Group

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Abstract

This research aims to optimize the productivity of lowland rice cultivation in Podorejo Village, Semarang City, Central Java Province by developing innovation in the form of a Pest Control Tower (MENDALIMA) based on smart agriculture. Rice cultivation has an important role in meeting the basic needs of the Indonesian people, and the majority of the population in this region are farmers. However, rice cultivation faces the challenge of pest attacks that can disrupt agricultural productivity. The use of pesticides to control pests is a solution that is widely used by farmers, even though the use of pesticides has a negative impact on the environment and farmers' health.

In an effort to overcome this problem, the Ormawa HMKM PPK group developed MENDALIMA in Podorejo Village. MENDALIMA is a tower equipped with various equipment, including pesticide and fertilizer sprayers, ultrasonic sound to repel rodent pests, and rice nets to protect plants from bird attacks. This tower operates automatically with solar energy or is powered by solar energy.

The MENDALIMA development process includes location potential analysis, focus group discussion (FGD) to assess community needs, development program design, physical construction of the tower, and system programming, automation systems. The result is an innovation that will help farmers fight pests more effectively, as well as improve rice quality and yield.

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Introduction

Indonesia is an agricultural country that has large, extensive agricultural land, diverse and abundant natural resources. In agricultural countries, agriculture has a very important role in fulfilling basic needs. The agricultural sector is also a primary sector and plays a very important role in the national economy. One of the basic needs for agricultural products is rice. Rice is a very important food commodity to be developed for the national economy because it is the largest staple food for the Indonesian population (Ruvananda & Taufiq, 2022) . Indonesia, as an agricultural country, also has the majority of its people working as farmers.

The agricultural sector is the center of attention because it plays an important role in nation development, especially in the use of agricultural products related to food (Pratama et al., 2021) . Based on data from the Central Statistics Agency (BPS), agriculture in Indonesia is also the sector that absorbs the most workers, in 2020 there were around 33.4 million people working in the agricultural sector (Juniwati et al., 2022) . One of the largest agricultural products in Indonesia is rice, which is the staple food of Indonesian people, therefore the presence of rice can indirectly influence other consumption materials (Rohimah, 2017) .

Quoted from the Web Jatengprov.go.id, Head of the Central Java Agriculture and Plantation Service, Suryo Banendro, said the number of farmers in Central Java currently reaches 2.88 million and manages 1,022,570.86 hectares of rice fields. (ikp, 2022) . Therefore, the cultivation of rice plants must be done well in order to produce paddy or rice of high quality and quantity. However, several pest problems such as planthoppers, mice, sparrows and weeds hamper and impact agricultural yields. So, farmers choose pesticides as a means to reduce pest disturbances to improve the quality of agricultural products. In overcoming this problem, farmers have used various methods, such as using pesticides as pest control. However, the use of pesticides causes many negative impacts on the environment and farmers themselves, so that the dangers of pesticides are increasingly felt by the public, especially due to unwise use of pesticides (Wulandari, 2023) .

Pesticides are chemical substances, microorganisms, viruses and other substances used by farmers to protect plants (Miana & Suraji, 2020) . Pesticides are usually used by spraying them manually using a pest spray tank which functions to break down a liquid, solution or suspension into droplets or spray. This pesticide spraying is carried out once a week or adjusted to the conditions and needs of agricultural land. However, with continued use of manual spray equipment, farmers will experience ergonomic problems which have an impact on the farmer's health. Therefore, we need a tool that can control these pest attacks so that rice productivity remains stable. Therefore, the Ormawa HMKM PPK Team

inspired to create an innovation in the form of a pest control tower (MENDALIMA) which was built in Njurang Hamlet, Podorejo Village, Ngaliyan District, Semarang City, Central Java Province. Geographically, Podorejo Village has an area of 605,349 hectares with an agricultural land area of more than 50 hectares. The regional boundaries for Podorejo Village are that to the north it borders Wonosari Village, to the south it borders Ngadirgo Village. To the west it borders Darupono Village (Kendal Regency), and to the east it borders Wates Village. According to the Head of Podorejo Village, information was obtained that the majority of the people of Podorejo Village work as farmers with a population of 8,846 people in Podorejo Village, with 4,391 male residents and 4,455 female residents. Judging from the vast agricultural land, the majority of the people work as farmers, namely 75% and the other 25% work as entrepreneurs.

There are several farmer groups in Podorejo Village, one of which is the Sidomakmur Farmer Group. From the information obtained from the farmer group, farmers in Podorejo Village still use manual pest control tools. In fact, the area's agricultural land is very large, so it requires a long time and a lot of energy during the pest control process. From this, the innovation of the Pest Control Tower (MENDALIMA) emerged.

Pest control tower (MENDALIMA) is a tower containing several tools that can be used simultaneously, such as a sprinkler sprayer for spraying pesticides and fertilizers, ultrasonic sound for rat pest problems, and rice nets for dealing with bird pests, during the plant growth cycle, which is designed using an automatic system using solar power. MENDALIMA can help streamline farmers' work time and effectiveness in maintaining rice plants, so that they can improve the quality and yield of agriculture. However, of course farmers need training in using MENDALIMA, to get maximum results.

Methods

The construction of pest control towers is one approach in pest management that aims to reduce plant pest populations in a more innovative and sustainable way. Pest control towers include the installation of physical structures of tall towers or poles that can attract and support the presence of natural predators of pests . The following is the method used in constructing the mendalima;

Figure 1. Method of Implementing Ormawa Strengthening Program

source: primary data, 2022

a   Analysis and survey of the potential conditions of Poderejo Village

Podorejo Subdistrict has agricultural land with an area of 86.9 Ha and dry land of 947.4 Ha. Rice crops in this area can be cultivated throughout the year because of the availability of irrigation water, so it is the main source of livelihood for 90% (Purbowati et al., 2003) . This condition is supported by the existence of the Sido Makmur Farmers Group with members of 20-35 farmers or administrators who have the same goal, namely to make changes to problems surrounding agriculture. This group was also given monitoring and evaluation by the agricultural service agency through direct monitoring and filling out accountability reports for each member of the Sido Makmur Farmers. From these results, the existing potential was used in efforts to control pests by building pest control towers or mendalima on agricultural land belonging to the Podorejo sub-district which is managed by the chairman of the Sido Makmur farmer group.

b   Focus Group Discussion (FGD) Needs Assessment

This group communication method is used to obtain input and opinions from various stakeholders about a particular topic or project. In the context of the construction of the Pest Control Tower in the Podorejo sub-district, relevant stakeholders were identified to attend this FGD, such as regional officials, administrators of the Sido Makmur farmer group, sub-district heads, RT/RW, UPT Agriculture Service and sub-district secretaries. This FGD discussed readiness and agreement regarding the most urgent needs and input that can be used in planning the construction of a Pest Control Tower to fulfill project planning and development of the required tools.

c   Schematic design for the construction of a Pest Control Tower

The design of the pest control tower scheme is designed based on the location of the agricultural land area with an area of 53x76 M. The land is quite large and close to people's houses, so that the period from construction to maintenance of the pendaliman will be easier together with the residents of Podorejo sub-district. A simple scheme will be designed using Shop Drawings whose materials are adapted to the land area, soil characteristics, soil quality, drainage and irrigation, as well as accessibility to the mendalima's needs.

d   Mendalima Development

After obtaining a detailed project plan in the form of designing a mendalima scheme , construction is then carried out starting from land preparation by clearing the land, preparing the soil, and arranging the irrigation system, then acquiring all the necessary equipment, including construction materials for the Mendalima and carrying out the construction of the mendalima in accordance with the design and specified specifications. The construction of the pest control tower will be carried out during August-September 2023 with assistance from the people of Podorejo Village.

Results

a   **Location of agricultural land for the construction of pest control towers**

Activities are carried out with regional officials to obtain approval from the Village Head and the community. This survey was also carried out to determine conservation areas and efforts to obtain approval and establish cooperation in utilization from the owner with the Chair of the Sido Makmur Farmers Group . Apart from that, there is a socialization program that can increase sympathy and open up farmer members to ask for help with participation from the surrounding community.

The results of the survey of the selected location are that pest control towers will be built in strategic areas, easy to access, easy to reach, and make it easier for farmers to carry out their activities. The agricultural land used is precisely in Podorejo Village RT 03 RW 10, Ngaliyan District, Semarang City. Land for the Mendalima to be built meets several characteristics, such as close proximity to the main agricultural land that wants to be protected, land that is relatively flat or sloping is easier to build the Mendalima, and there is an adequate irrigation system to provide water for the plants in the Mendalima.

b Needs Assessment FGD

After carrying out a location survey with the people of Podorejo Subdistrict and determining the conservation land where Mendalima will be built, a Needs Assessment FGD or form of socialization was carried out to request approval for the development of Mendalima with the community and stakeholders of the Podorejo Subdistrict area. The socialization event was held in July 2023, and the result was that the community and stakeholders in the Podorejo Village area agreed and were very happy with the construction of the pest control tower. It was also agreed that the chairman of the Sido Makmur farmer group would be the person in charge who would take part in leading the construction of Mendalima and this would take place within 1 month.

The FGD activities were formed with outreach to the community, discussing the existence of the Ormawa Capacity Strengthening Program, the function of establishing the Pest Control Tower, asking for support from targets and a question and answer session between the Ormawa PPK Team, Partners (Agriculture Service) and the Podorejo Village community. This needs assessment FGD was attended by 15 members, accompanying lecturers, Plant Pest Organism Observer Officers (POPT), Field Agricultural Instructors (PPL), heads of farmer groups and 8 members of farmer groups.

c Designing a scheme for building a Pest Control Tower

Designing a pest control tower construction scheme is a complex process and must consider various factors, including the type of pest to be controlled, geographical location, size and shape of the tower, and the technology to be used. Based on the results obtained, a plan was created for the construction of Mendalima located in Podorejo Village, namely:

➢ Identification of pest types, Determining the type of pest you want to control as an approach in designing pest control towers. Pest identification is an important step in designing a pest control tower, with a program that focuses on vertebrate pests, such as mice, which can damage plants by digging holes and eating roots or fruit.
In addition, the focus of this program states that some birds can become pests because they tend to eat fruit or plant seeds, thereby threatening crop yields and agricultural productivity in general. By identifying these vertebrate pests clearly and completely, we will be able to develop appropriate and effective control strategies in designing pest control towers to protect agricultural crops from these threats.

➢ Location and site survey, 50M empty agricultural land was determined as Mendalima development land.
The location or empty land is determined because it is close to the infested area to ensure effective control and is easily accessible so that monitoring and maintenance activities can be carried out more effectively.

➢ Tower design plans, in designing a pest control tower, carefully consider various factors, including the size of the tower that is appropriate for the area to be protected, the shape of the tower that is most effective in dealing with specific pests, construction materials that are durable and suitable for environmental conditions, and necessary facilities inside the tower, such as monitoring and maintenance devices. In designs made using *shop drawings* .

➢ Selection of control technology, in this program the team selects technology, licenses and regulations. It is important to carry out a thorough inspection of all permits and legal requirements that apply to the pest control tower construction project. This process requires coordination with local environmental institutions or related government institutions.

➢ Maintenance and monitoring, in the process of completion of construction, there needs to be the development of a monitoring and maintenance plan related to equipment, work systems, and monitoring the effectiveness of tower control measures.

➢ Education and training, Providing training for targets and those responsible for the operation and maintenance of pest control towers. So, we can be sure that people understand how to use control technology correctly.

➢ Evaluation and improvement: Always evaluate the performance of the pest control tower. If there are weaknesses or changes in environmental conditions, you can consider efforts to improve the design or control technology.

➢ Information and communication, Communicate with relevant stakeholders, such as farmer leaders and groups, sub-district government institutions, RT/RW, and the Podorejo sub-district community to provide information about the benefits of pest control towers and overcome any concerns that may arise.

Each design stage of a pest control tower construction project must be carried out carefully and consider relevant environmental and social factors. It is also important to consult with experts in agriculture, the environment and pest control technology to ensure the success of the project.

d   Construction of Pest Control Towers

Based on the results obtained in the design for the construction of the mendalima, the construction process was then carried out with the building foundation stage by the Ormawa HMKM PPK Team and the farmers. The selection of materials used for building foundations is based on the use of materials that are suitable for the conditions of the rice fields. This foundation selection uses materials such as cement, sand and bricks. The construction process begins by digging 50 cm deep in the paddy field, totaling 4 holes. Then build the foundation by arranging bricks with cement and sand from the bottom of the excavation to a height of 1 meter. Then the foundation is plastered and plastered so that it has a smooth surface. After forming a solid foundation, the next process is installing light steel on the foundation by cutting and connecting bolts and nuts so that the resistance is very strong. The installation of the light steel has been adjusted to the design of the placement of tools and systems according to the layout, the work was carried out for 5 days.

Next, install the system by connecting existing tools such as a controller, converter, adapter, VRLA12v 100ah battery which can be recharged via 2 100wp solar panels and a water pump. Then the system is programmed with Arduino software as a power supply to run the watering system which is controlled via an ESP 32 microcontroller. The final process is assembling the paralon according to the existing rice fields. The paralon is equipped with a sprayer which is useful for spraying liquid fertilizer and pesticides in caring for rice plants.

Conclusion

The construction of a Pest Control Tower (MENDALIMA) in Podorejo Village, Ngaliyan District, Semarang City, Central Java Province is a program that aims to increase the effectiveness of pest control and continuous monitoring of rice plants. This reform was implemented to help farmers, especially the Sido Makmur Farmers Group, Podorejo Village, in overcoming obstacles in farming activities.

In the MENDALIMA development process, it is carried out in accordance with ongoing activities, namely (1) Location Survey of agricultural land for the construction of a pest control tower, (2) Focus Group Discussion (FGD) Needs Assessment, (3) Design of a scheme for the construction of a Pest Control Tower, (4) Construction of Pest Control Towers. Apart from that, the construction process also includes physical stages, such as making foundations, installing light steel as supports, and automatic control using a programmed system.

The development of MENDALIMA is a collaboration between stakeholders, including the Ormawa HMKM PPK Team, the Sido Makmur Farmers Group, the Podorejo Subdistrict regional government and the Semarang City Agriculture Service. FGD (Focus Group Discussion) and outreach were carried out to ensure support and approval from the local community.

With the MENDALIMA system working, it is hoped that farmer groups in Podorejo Village can control pests more effectively and efficiently. It is also hoped that the pest control tower can help reduce the workload and health impacts of farmers due to manual use of pesticides.

Evaluation of programs with targets in line with achievements, that is, must be an ongoing process involving monitoring to ensure that MENDALIMA is functioning as intended and delivering the expected

benefits. The results of this evaluation can be used to identify areas of improvement and make decisions about future expansion or enhancement of the project.

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Reference

ikp, b. (2022). *Land is shrinking, Central Java's agricultural production is actually increasing* . 03 DECEMBER 2022. Retrieved 06 October 2023 from https://jatengprov.go.id/publik/lahan-pemempit-produk-pertanian-jateng-justru-meningkat/

Juniwati, J., Lestari, Y., & Yetti, H. (2022). Analysis Of Controlling Pesticide Exposure In Farmers. *Journal of Health* , *13* .

Miana, V. M., & Suraji, C. (2020). Pesticide Use Is Associated with Skin Irritation in Rice Farmers. *Permas Scientific Journal: STIKES Kendal Scientific Journal* , *10* (1), 51-56.

Pratama, DA, Setiani, O., & Darundiati, YH (2021). Literature Study: The Effect of Pesticide Exposure on Farmers' Health Disorders. *Bandung Department of Health Polytechnic Health Research Journal* , *13* (1), 160-171.

Purbowati, E., Mulatsih, RT, & Surahmanto, S. (2003). Empowering Farming Communities With The Application Of Local Feed-Based Cattle Fattening Technology In Podorejo Village, Ngaliyan District, Semarang City.

Rohimah, U. (2017). Factors Influencing Lowland Rice Production in New Opened Rice Fields (Oryza sativa L.)(Case Study of Sindangasih Village, Cikatomas District, Tasikmalaya Regency-West Java). *Agritas Scientific Journal* , *1* (2).

Ruvananda, AR, & Taufiq, M. (2022). Analysis of factors influencing rice imports in Indonesia. *Performance* , *19* (2), 195-204.

Wulandari, S. (2023). *Design And Construction Of a Plant Pest Removal Tool Using IoT Based Light Trap* [Diponegoro University].

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Protocol COVID-19 Implementation on Handling Medical Records at Indonesian Hospitals: A SERVQUAL Analysis

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Abstract

High-risk COVID-19 transmission infecting Healthcare Workers (HCWs) at COVID-19 Referral Hospitals. Health protocols for HCWs including medical record department staff needed to be implemented to reduce the transmission and keep the health services quality consistent even in pandemic times. This study aimed to evaluate medical record administrators' (MRA) health services quality on handling the COVID-19 patient's medical records at Referral Hospitals in Indonesia. This study was a quantitative study with a cross-sectional approach through distributed online questionnaires to 63 MRA in public and private hospitals that used SERVQUAL indicators (tangible, assurance, reliability, and responsiveness). The results showed a difference in assurance value in the gender category with a p-value of 0.026. The average female assurance score is higher than that of men. There was no significant difference between characteristics with the existing SERVQUAL indicators except assurance in the education, age, contact, type of hospital categories.

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Healthcare Quality Assurance; Medical Record Administrator; COVID-19; Service Quality

Introduction

Coronavirus disease (COVID-19) was first detected in Wuhan city, China in December 2019. On January 2020, the WHO declared that the current outbreak constituted a Public Health Emergency of International Concern. Current available evidence is that the COVID-19 virus is transmitted between people through close contact and droplets. People most at risk of infection are those who are in contact with a COVID-19 patient and/or who care for COVID-19 patients. This inevitably places health workers at a high risk of infection (WHO, 2019).

Globally, as of, 27 August 2021, there have been 214,468,601 confirmed cases of COVID-19, including 4,470,969 deaths, reported to WHO.(World Health Organization, 2021) The South East Asia Region (SEAR) remains the third most affected WHO Region with 40.5 million cases, after the Americas (81.7 million cases) and European Regions (63.7 million cases). The South-East Asia Region reported over 614 000 new cases. The highest numbers of new cases were reported from India (231658 new cases; 16.8 newcases per 100000; a 10% population per week) still reported in North Kalimantan, East Kalimantan, Bangka Belitung islands, DI Yogyakarta and Bali.(World Health Organization, 2020)

In countries with mandatory reporting systems for health care-associated infections, SARS-CoV-2 infection should be included as a priority condition for reporting within these systems. All cases and clusters in health care settings should be investigated and documented for their source and transmission patterns to allow rapid control. Ideally, specific reporting of the number of COVID-19 cases and deaths (including asymptomatic SARS-CoV-2 infections) in HCWs should be implemented.(Wenger et al., 2020)

The death rate of medical personnel due to COVID-19, especially doctors and nurses, were increasing. Based on data from the Health Care Worker Death Impact Index (IPKN), the ratio of HCWs deaths compared to total deaths due to COVID-19 in Indonesia is one of the highest among other countries, namely 2.4%.(IDI, 2020) Corona Virus Disease 2019 (COVID-19) is categorized as a Specific Work-related Disease in Certain Occupations.(Indonesian Health Ministry, 2020) It means workers that decrease), Thailand (142 138 new cases; 203.6 new cases per 100 000; a 6% decrease), and Indonesia (125 102 new cases; 45.7 new cases per 100 000; a 34% decrease). The highest numbers of new deaths were reported from Indonesia (8784 new deaths; 3.2 new deaths per 100 000; a 16% decrease).(World Health Organization, 2020)

Overview of the epidemiological situation for the period between 16 August – 22 August 2021 showed that Indonesia reported a decline in new cases for the fifth consecutive week. High case incidence (>150 cases per 100 000 carry out their work by dealing with COVID-19 have a high risk of getting infected by COVID-19, which in turn, causes occupational diseases specific to certain jobs, including medical records administrator (MRA). The General Chairperson of The Indonesian Association of Professional Medical record administrator and Health Information (PORMIKI) Central Executive Board stipulates further steps regarding Medical Recording and Health Information Work procedures in situations of the virus outbreak. These steps were taken as a form of PORMIKI's commitment to increase awareness and seek protection for all Indonesian Medical record administrators and Health Information from contamination or exposure to the COVID-19 virus, which is a risk of mass infection from the distribution of Medical Record Documents where the virus can transmit through paper media.(PORMIKI, 2020)

Maintaining public trust (reliability) in the capacity of the health system to safely meet essential needs and controlling risks of infection in health care facilities is key to ensuring proper healthcare-seeking behavior and adherence to public health advice (assurance).(WHO, 2020a) Strengthening primary health care to realize universal health coverage provides an essential foundation for adapting to the pandemic context. A well-organized and well-prepared health system will maintain equal access to quality essential health services during an emergency (responsiveness) to limit direct deaths and avoid indirect deaths.(WHO, 2020b) In the early stages of the COVID-19 outbreak, many health systems managed to maintain standard service delivery when faced with a limited number of COVID-19 caseloads.(WHO, 2020a)

SERVQUAL is still one of the most reliable service quality measurement models for the last two decades.(Samen et al., 2013) The inventors of SERVQUAL propose, refine, and claim the five dimensions and items of SERVQUAL, namely tangibles, reliability, responsiveness, assurance, and empathy as a general framework for measuring service quality.(Parasuraman et al., 1988) The SERVQUAL instrument and dimensions have been used extensively by many academics and managers. There are several ways in which SERVQUAL results can be used to help identify areas for performance improvement.

There are limited studies discuss Covid-19 in the Medical Record Unit especially MRA-related their risk get infected by Covid-19. This study aimed to analyze the implementation of health protocols and management of COVID-19 medical records patients by medical record administrators (MRA) at COVID-19 referral hospitals. This study included MRA from public and private hospitals in Central Java Provinces, Indonesia.

Methods

Central Java Provinces of Indonesia has 58 referral hospitals of Covid-19. This study distributed the questionnaire12 to MRA of the public and private referral hospital Covid-19 in Central Java Provinces Indonesia and got 63 respondents willing to fill the online survey. The respondents are MRA from 20 hospitals.

The study distributed an online questionnaire describing SERVQUAL indicators, namely tangible, assurance, reliability, and responsiveness. The questionnaire contains question-related to the implementation of health protocol by MRA and the COVID-19 Patient Medical Records handling at Rereferral Hospitals in Indonesia during the COVID-19 pandemic.

Data collection was carried out from July to August 2020 with the SERVQUAL indicator questionnaire instrument to analyze the quality of MRA's health protocols and COVID-19 patients' medical records at the referral hospital in Indonesia. This study used JASP ver.13 (Jeffrey's Amazing Statistics Program) to conduct a t-test analysis.

Results

The results of the study are described in the distribution of respondent characteristics as in the following table:

Table 1.
Respondent Characteristics of MRA (N=63)

Characteristics Gender	F (%)
Gender	
a.　Male	11 (17,5)
b.　Female	52 (82,5)
Education Background	
a.　High School Graduated	11 (17.5)
b.　Undergraduate	52 (82.5)
Age	
a.　15 - 24 years old	26 (41.3)
b.　25 - 54 years old	37 (58.7)
Contact with patients	
a.　Direct	24 (38.1)
b.　Indirect	39 (61.9)
Hospital Type	
a.　Public	38 (60.3)
b.　Private	25 (39.7)
TOTAL	63 (100,0)

The results showed in Table 1 indicate that most of the respondents were female 52 (82.5%), while the male 11 (17.5%). Most of the respondents in all service units have an undergraduate background (82.5%) and have graduated from high school (17.5%). From table 1, it can also be concluded that there are 26 respondents aged 15 to 24 years (41.3%), while for the 25-54 years age range, there are 37 people (58.7%). Most of the medical record administrators were in work positions unrelated to or had direct contact with patients, namely 61.9% or 39 people. In contrast, for MRA who had direct contact with 24 people (38%). Most of the respondents were recruits at Government Hospitals as many as 38 people or 60.3%.

Classification of the workforce by age in developing countries is adjusted based on economic growth. Expansion of Education facilities, education levels, and increased income opportunities, namely for the "main" working age (25 to 54 years), the young workforce (15 to 24 years), and the workforce among older workers (55 to 64 years or 65 years and over) which indicates a pension (ILO, 2013).

Table 2.
The SERVQUAL indicator of MRA's health protocol and managing medical record of Covid-19 patients by Selection Questions

Question	Yes		Not	
	n	%	n	%
Tangible				
Health workers always use surgical masks and carry out hand hygiene after touching Medical Record Data according to WHO classification	57	90.5	6	9.5

The Patient Registration Room in the hospital has used physical barriers such as glass or plastic windows	53	84.1	10	15.9
PPE (Personal Protection Equipment) available in the Medical Record Unit:				
a. Surgical mask	55	87.3	8	12.7
b. Hand rub	61	96.8	2	3.2
c. Antiseptic liquid	50	79.4	13	20.6
d. Hand wash and soap	58	92.1	5	7.9
e. Table napkin	37	58.7	26	41.3
f. Box Container	26	41.3	37	58.7
g. Hospital Director Circular for Making and Returning Medical Records of COVID-19 Patients	40	63.5	23	36.5
h. PPE Standard of Medical record administrator	49	77.8	14	22.2
Reliability				
The hospital where the Medical record administrator work has used telemedicine to evaluate the clinical development of patients with suspected COVID-19 infection	38	60.3	25	39.7
Medical Records staff should wash their hands with soap and hand rub frequently	38	60.3	25	39.7
Medical Record Document are to be kept in the nurse station except in the ICU isolation room and the Medical record administrator perform hand hygiene or use clean gloves when writing down the Medical Records Document	51	81.0	12	19.0
Assurance				
Coronaviruses are a large family of viruses that cause disease in humans and animals	47	74.6	16	25.4
COVID-19 is caused by SARS-COV19 which belongs to the same large family of coronaviruses that caused SARS in 2003	45	71.4	18	28.6
Regulations defining COVID-19 as a specific occupational disease	45	71.4	18	28.6
The method of restoring Medical Record Documents (DRM) after COVID-19 Patient Service is that DRM is put into plastic, it is recommended to be in white for the infection code.	40	63.5	23	36.5
The method of restoring Medical Record Documents (DRM) after COVID-19 Patient Service is that DRM is stored in a special place and is kept for 4-6 days where the Medical Record officer labels the date and time on the plastic	59	93.7	4	6.3

Question	Yes		Not	
	n	%	n	%
The method of restoring Medical Record Documents (DRM) after COVID-19 Patient Services is that the DRM is covered and wiped by simply spraying disinfectant at a certain distance so that the paper files are not damaged	9	14.3	54	85.7

PORMIKI Central Executive Board Circular No. HM.01.01 / 002 / III / 2020 contains Medical Recorder Work Procedures and Health Information In the Covid-19 Outbreak situation.	34	54.0	29	46.0

The tangible indicators show the availability of facilities and equipment related to COVID-19 at the Hospital. The results of tangible indicators are pretty good, and facilities and equipment availability is above 50%. However, we found that there are no box containers for storing COVID-19 Medical Records at the Medical Record Unit to handling the Medical Record Documents for COVID-19 patients. This fact has taken place in 58.7% of MRA.

Table 3.
The SERVQUAL indicator of MRA's health protocol and managing medical record of Covid-19 patients by Likert Scale Questions

Question	Strongly Disagree		Less Agree		Agree		Strongly Agree	
	n	%	n	%	n	%	n	%
Reliability								
COVID-19 is included in the category of occupational diseases caused by other biological factors in the workplace where there is a direct relationship between exposure to biological factors arising from work activities and diseases experienced by workers that can be scientifically proven using appropriate methods.	2	3.2	12	19.0	32	50.8	17	27.0
Arrangement of shift work for COVID-19 patients, preferably every 3 hours, is an effort to minimize direct contact with isolated COVID-19 patients using intercom, CCTV, and handy talkies with patients.	0	0	8	12.7	29	46.0	26	41.3
Electronic Medical Records (RME) can minimize high risks because computer devices are easier to clean with disinfectants than paper.	0	0	1	1.6	16	25.4	46	73.0
Responsiveness								
Medical records staff should wash their hands with soap and hand rub frequently	0	0	0	0	2	3.2	61	96.8
Medical records staff must clean work tables using antiseptic without relying on cleaners.	0	0	2	3.2	8	12.7	53	84.1

The reliability question item shows that the reliability of MRAand the hospital where they work is considered good, with a majority result above 50%. Next on the indicators assurance, which describes the knowledge, attitudes, and practices of MRAand the feasibility of referral hospitals for health services during the pandemic, most have a good understanding of COVID-19 by more than 50%. It's just that there are question items that produce a value below 50%, such as knowledge of MRA regarding how to recover Medical Record Documents after COVID-19 Patient Service is only 9%.

There were question items reliability and responsiveness in the Likert scale questions. Table 4 below showed that the majority show support or assess both the reliability and speed of the response of MR or other health workers on tasks at the hospital.

Table 4.
The Cross Tabulation of Respondents Characteristic and SERVQUAL indicator

Variable	Tangible			Reliability			Responsiveness			Assurance		
	mean	SD	p value	mean	SD	p value	mean	SD	p value	mean	SD	p value

	Mean	SD	p	Mean	SD	p	Mean	SD	p	Mean	SD	p
Gender												
Male	7.82	1.56	0.85	15.64	1.80	0.48	7.73	0.65	0.72	3.18	1.08	0.02
Female	7.69	2.06		15.29	1.43		7.79	0.49		4.17	1.35	
Education												
High School	7.91	2.16	0.72	15.82	15.25	0.25	7.82	0.63	0.78	3.45	1.13	0.14
Undergraduate	7.67	1.94		1.08	1.56		7.77	0.51		4.12	1.38	
Age												
15-24 years old	7.77	2.22	0.86	15.46	15.27	0.62	7.73	0.53	0.53	3.92	1.23	0.71
25-54 years old	7.68	1.81		1.39	1.57		7.81	0.52		4.05	1.45	
Contact patient												
Direct	7.42	1.74	0.35	15.38	15.33	0.91	7.83	0.38	0.51	3.79	1.50	0.34
Indirect	7.9	2.10		1.31	1.62		7.74	0.59		4.13	1.26	
Hospital												
Private	7.68	1.99	0.91	15.26	15.48	0.57	7.82	0.51	0.48	4.08	1.22	0.57
Public	7.74	1.98		1.50	1.53		7.72	0.54		3.88	1.56	

Table 4 indicates no significant differences between characteristics with the existing SERVQUAL indicators in the majority, such as *tangible, reliability, responsiveness* in all categories. However, one among all the available variables found a difference in value assurance on the gender category of the respondent male and female with a p-value <0.05, namely, 0.026. Table 3 shows that the mean score on the score *assurance* female respondents is higher than males.

Discussion

This study used the SERVQUAL indicators model to assess hospital services. ServQual is an empirically derived method that service organizations can use to improve service quality. The SERVQUAL questionnaire has been widely adopted and revised in several studies, one of which is related to chronic diseases. An example is that 1,595 consecutive patients attending the kidney disease screening program in Taichung City were asked to complete a questionnaire on the SERVQUAL scale. A total of 1085 effective questionnaires were collected to analyze quality factors in kidney disease services.

The study examined the satisfaction of patients with kidney failure.(Lin et al., 2009) Tangible (tangible) is the appearance of the installed physical facilities, equipment, employees, and materials. This dimension describes the physical form and services that consumers will receive. According to the results of the study, it was found that the results obtained were quite good where the availability of facilities and equipment was above 50%. This can be seen from the availability of facilities and equipment as recommended by PORMIKI, both physically and staff. However, we can also observe that there are still facilities that are not yet available at the Medical Record Unit where the Officer works related to the handling of Medical Record Documents for COVID-19 patients, namely the unavailability of box container 58.7% of the officers' workplaces for storing COVID-19 Patient Medical Record Documents.

Women hold 70.97% of pharmacist degrees, 83.99% of nursing degrees, and 93.91 of midwifery degrees. Among dentists and odontologists, women represent 45.65% and 46.36% of the profession, respectively. There was no official statistical data for nurses supporting staff, but in the hospitals we surveyed, we found that 6% were men and 94% were women data from a professional association for 2011 showed that 46.36% of all physicians were women, which suggests that gender roles are changing in the medical field. Our results appear to confirm the feminization of health care professions.(Carrillo-García et al., 2013)

Besides, almost all of the studies did not distinguish between the tasks performed by male and female healthcare workers in conflict zones. The research ability limits identify the underlying causes for the differences in work-related health outcomes between men and women. Detailed exposure assessments unravel the sex/gender differences in workplace exposures. For instance, a hospital employee study with the same job title showed that men had more physically demanding tasks, while women had more repetitive tasks, ultimately delivering different health outcomes. Also, wars and armed conflicts may have distinct burdens on men and women; studying these differences concerning job type, task distribution, exposures,

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and health outcomes in men and women HCWs is essential, yet lacking in most of the articles in this review.(Habib et al., 2020)

There was no difference in the quality of health services on the SERVQUAL indicator in this study from the difference in hospital type. The results are contrary to a study found in Turkey, where the quality of health services in private hospitals is better than in government hospitals on indicators responsiveness. That study explained that the long waiting time in providing services in government hospitals causes the perception of poor health service quality in patients.(Işik et al., 2011)

The studies that describe medical record documents handling protocol during the COVID-19 pandemic are limited. A multinational survey aims to assess hospital staff's quality and ability and how their practices are related to COVID-19, and their readiness to face the conditions of this COVID-19 pandemic is crucial. Reliable hospital management (reliability) is needed to ensure the quality of health services during a pandemic is maintained in conditions that comply with health protocols, including the medical record unit. The quality of staff and medical record service system, one of the handling of medical record documents in the Referral Hospital will adapt quickly to changing needs and targets.

Telemedicine services are health services carried out by doctors and clinical management that use information and communication technology to diagnose, treat, prevent, and evaluate a patient's health condition according to their competence and authority.(Haider et al., 2020) The results of telemedicine services are recorded in digital records that are used by doctors and clinical management as medical record documents and are the responsibility of doctors and clinical management, must be kept confidential, and are used following statutory provisions. However, applying telehealth or telemedicine in the health sector are challenges. There are many obstacles, such as costs, human resources, policies, and behavior.(Tasri & Tasri, 2020)

MRA produced quality information for hospital management so that they must have optimal abilities in managing medical records and health information. An excellent medical administrator will be able to make the information and handle medical record documents correctly and with quality(Edmund et al., 2009) even in the COVID-19 pandemic. A MRA's competencies in managing medical records and health information are essential so that MRA should competent to fulfill the service, medical administration, and health information so that management could make the right decisions in health services.

The application of a medical record information system requires continuous supervision so that management can conduct evaluations. MRA who are competent (reliability) in the field of medical record management and health information will be able to meet the needs of patients in health services (responsiveness), so as to improve public health in general(He et al., 2019) both before and during the COVID-19 pandemic according to existing health protocols.

What is still a limitation and needs to be reviewed in relation to the results of this study is that there is a discussion gap to optimize Electronic Medical Records(Noraziani et al., 2013) in handling Medical Record Documents both during COVID-19 and after COVID-19. Besides aiming to improve SERVICE QUALITY in terms of reliability because it can minimize transmission through the media, Electronic Medical Records also increase officers' reliability in handling Medical Record Documents. The use of an Electronic Medical Record (EMR) system is important in supporting the health system's clinical needs dealing with the COVID-19 pandemic. Qualified and competent health information management professionals will adapt to any circumstances, including changes in the EMR system's use.(Reeves et al., 2020)

This study also examines the educational background in this study that most MRA have completed tertiary education. This study is consistent with research that states that medical record officers' competence in using Electronic Medical Records in the future during the pandemic will be greatly supported by universities or institutions that provide curriculum related to Electronic Medical Records' competence. This curriculum will give MRA the ability to carry out work effectively, efficiently and safely. The importance of prudent teaching documentation in the use of electronic health records.(Niedermier, 2017) This is inversely proportional to the research results on knowledge and attitudes of MRA in computerized operations, which have an important influence on the uptake and utilization of computer systems in the workplace. This study in Africa states that most MRAin remote rural areas in African primary health facilities have little computer knowledge, but they have positive attitudes and expressed willingness to adopt technology.(Sukums et al., 2014)

However, what needs to recommend electronic Medical Records during this pandemic is access to personal data on EHR to identify people who are particularly at risk from the COVID-19 pandemic. It is only justified if, first, other data already available on the public list proves to be insufficient; second, access to such data should only be provided if individual physicians bound by professional confidentiality cannot easily pass on the information to vulnerable persons. Third, if these conditions are met, it must be ensured that the access does not interfere with the acceptance of EHR and results in vulnerable people choosing to

leave the medical record system, thus ultimately harming the patient in the long term and not as a basis for medical action against the wishes of the patient.(Stoeger & Schmidhuber, 2020)

The COVID-19 pandemic has forced all healthcare systems such as hospitals and clinics to implement telehealth services quickly, and the delivery of patient care by the American health system will change forever. The same is the case in Indonesia to minimize the number of offline patient queues and reduce the pile of patients that pose a risk of crowding in hospitals. We are "becoming virtual" during a crisis, but we must keep in mind the most critical transformation phase and the best way to effectively implement telehealth. Whether healthcare companies are ready or not, the new reality is that virtual care has arrived. (Wosik et al., 2020)

Other studies have found a substantial decline in public acceptance in terms of gender, age category, patient category, and various diagnoses related to chronic respiratory conditions and mental health during the COVID-19 pandemic. This may imply that there has been a lack of public trust in the safety and reliability of health care agencies such as hospitals since the pandemic(Nourazari et al., 2020) so that the reliability value (reliability) becomes low. Facing the COVID-19 pandemic, the health service system can make the best preparations by following the government's guidelines and recommendations.(Reeves et al., 2020)

As the health, economic and social impact of the COVID-19 pandemic continues to reverberate throughout the South East-Asian region, policymakers are rapidly implementing digitized solutions for healthcare. By way of restructuring emergency components of existing projects and deployment of disaster finance instruments, the development of digital health technologies has accelerated to deliver innovative solutions for needed care outside of established health care facilities.(World Health Organization, 2020)

Conclussion

Several factors that influenced the health services quality during the COVID-19 pandemic were health worker performance and the hospital facilities provided to COVID-19 patients at Referral Hospitals. SERVQUAL dimensions that could measure the health services quality at the COVID-19 Referral Hospital were tangible, reliable, responsive, and assurance to health workers and medical record handling. There was a difference in the assurance indicator value between government hospitals and private hospitals regarding the implementation of the health worker protocol and COVID-19 patient medical records handling.

Author Contributions

Conceived of the presented idea, developed the theory and per- formed the computations, verified the analytical methods, carried out the experiment, wrote the manuscript, supervised the project, developed the theoretical formalism, took the lead in writing the manuscript. Contribution: contributed to the final version of the manuscript, interpretation of the results. All authors discussed the results and contributed to the final manuscript.

Conflicts of Interest:

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References
Carrillo-García, C., Solano-Ruíz, M. Del C., Martínez-Roche, M. E., & Gómez-García, C. I. (2013). Job Satisfaction Among Health Care Workers: The Role Of Gender And Age. Revista Latino-Americana De Enfermagem, 21(6), 1314–1320. Https://Doi.Org/10.1590/0104-1169.3224.2369
Edmund, L. C. S., Ramaiah, C. K., & Gulla, S. P. (2009). Electronic Medical Records Management Systems: An

Overview. DESIDOC Journal Of Library & Information Technology, 29(6), 3–12. Https://Doi.Org/10.14429/Djlit.29.273

Habib, R. R., Halwani, D. A., Mikati, D., & Hneiny, L. (2020). Sex And Gender In Research On Healthcare Workers In Conflict Settings: A Scoping Review. International Journal Of Environmental Research And Public Health, 17(12), 1–22. Https://Doi.Org/10.3390/Ijerph17124331

Haider, Z., Aweid, B., Subramanian, P., & Iranpour, F. (2020). Telemedicine In Orthopaedics And Its Potential Applications During COVID-19 And Beyond: A Systematic Review. Journal Of Telemedicine And Telecare. Https://Doi.Org/10.1177/1357633X20938241

He, X., Cai, L., Huang, S., Ma, X., & Zhou, X. (2019). The Design Of Electronic Medical Records For Patients Of Continuous Care. Journal Of Infection And Public Health, 14(1), 117–122. Https://Doi.Org/10.1016/J.Jiph.2019.07.013

IDI. (2020). Guidelines For Doctor Protection Standards In The Covid-19 Era. Indonesian Doctor Association, 40.

ILO. (2013). Statistics Of Work, Employment And Labour Underutilization. In 19 Th Conference, International Statisticians, Of Labour (Issue October).

Indonesian Health Ministry. (2020). Decree Of The Indonesian Republic Health Minister Number Hk.01.07 / Menkes / 327/2020 Concerning Determination Of 2019 Corona Virus Disease (Covid-19) Due To Work As A Disease Of Specific Work. Https://Doi.Org/10.1017/CBO9781107415324.004

Işik, O., Tengilimoğlu, D., & Akbolat, M. (2011). Measuring Health Care Quality With The Servqual Method: A Comparison In Public And Private Hospitals. Healthmed, 5(6 SUPPL. 1), 1921–1930.

Lin, D. J., Li, Y. H., Pai, J. Y., Sheu, I. C., Glen, R., Chou, M. J., & Lee, C. Y. (2009). Chronic Kidney-Disease Screening Service Quality: Questionnaire Survey Research Evidence From Taichung City. BMC Health Services Research, 9, 1–11. Https://Doi.Org/10.1186/1472-6963-9-239

Niedermier, V. E. (2017). Teaching Electronic Health Record Documentation To Medical Students. Journal Of Graduate Medical Education, 9(1), 135. Https://Doi.Org/10.4300/JGME-D-16-00628.1

Noraziani, K., Nurul'Ain, A., Azhim, M. Z., Ekhab, S., Drak, B., Sharifa Ezat, W. P., & Siti Nurul Akma, A. (2013). An Overview Of Electronic Medical Record Implementation In Healthcare System: Lesson To Learn. World Applied Sciences Journal, 25(2), 323–332. Https://Doi.Org/10.5829/Idosi.Wasj.2013.25.02.2537

Nourazari, S., Davis, S. R., Granovsky, R., Austin, R., Straff, D. J., Joseph, J. W., & Sanchez, L. D. (2020). Decreased Hospital Admissions Through Emergency Departments During The COVID-19 Pandemic. American Journal Of Emergency Medicine. Https://Doi.Org/10.1016/J.Ajem.2020.11.029

Parasuraman, A., ZEITHAML, V. A., & BERRY, L. L. (1988). SERVQUAL: A Multiple-Item Scale For Measuring Consumer Perceptions Of Service Quality. Journal Of Retailing, 64(1). Https://Doi.Org/10.1049/El:19850169

PORMIKI. (2020). Circular Letter Of The Indonesian Medical Record And Health Information Professional Association No. HM.01.01 / 002 / III / 2020 Concerning Work Procedures For Medical Recorders And Health Information In The Covid-19 Outbreak Situation.

Reeves, J. J., Hollandsworth, H. M., Torriani, F. J., Taplitz, R., Abeles, S., Tai-Seale, M., Millen, M., Clay, B. J., & Longhurst, C. A. (2020). Rapid Response To COVID-19: Health Informatics Support For Outbreak Management In An Academic Health System. Journal Of The American Medical Informatics Association, 27(6), 853–859. Https://Doi.Org/10.1093/Jamia/Ocaa037

Samen, A. A. A. El, Akroush, M. N., & Abu-Lail, B. N. (2013). Mobile SERVQUAL: A Comparative Analysis Of Customers' And Managers' Perceptions. International Journal Of Quality And Reliability Management, 30(4), 403–425. Https://Doi.Org/10.1108/02656711311308394

Stoeger, K., & Schmidhuber, M. (2020). The Use Of Data From Electronic Health Records In Times Of A Pandemic-A Legal And Ethical Assessment. Journal Of Law And The Biosciences, 7(1), 1–9. Https://Doi.Org/10.1093/Jlb/Lsaa041

Sukums, F., Mensah, N., Mpembeni, R., Kaltschmidt, J., Haefeli, W. E., & Blank, A. (2014). Health Workers' Knowledge Of And Attitudes Towards Computer Applications In Rural African Health Facilities. Global Health Action, 7(1), 1–11. Https://Doi.Org/10.3402/Gha.V7.24534

Tasri, Y. D., & Tasri, E. S. (2020). Improving Clinical Records: Their Role In Decision-Making And Healthcare Management–COVID-19 Perspectives. International Journal Of Healthcare Management, 13(4), 325–336. Https://Doi.Org/10.1080/20479700.2020.1803623

Wenger, P. N., Halperin, W., & Ziga, E. (2020). Public Health Surveillance For Bioterrorism. In Beyond Anthrax (Vol. 2020, Issue December). Https://Doi.Org/10.1007/978-1-59745-326-4_13

WHO. (2020a). Maintaining Essential Health Services: An Operational Guide For The Context Of COVID-19. In Interim Guide.

WHO. (2020b). Strategic Preparedness. World Health Organisation (WHO), February.

WHO[Internet]. (2019). Interim Guidance Health Worker Exposure Risk Assessment And Management In The Context Of COVID-19 Virus. Society, 2(1), 1–6. Https://Apps.Who.Int/Iris/Bitstream/Handle/10665/331340/WHO-2019-Ncov-HCW_Risk_Assessment-2020.1-Eng.Pdf

World Health Organization. (2020). COVID-19 Weekly Situation Report. World Health Organization (WHO), 43(October), 1–8. Https://Www.Who.Int/Docs/Default-Source/Searo/Whe/Coronavirus19/Sear-Weekly-Reports/Weekly-Situation-Report-Week-37.Pdf?Sfvrsn=Ac89cd23_2

World Health Organization. (2021). WHO Coronavirus (COVID-19) Dashboard.

Wosik, J., Fudim, M., Cameron, B., Gellad, Z. F., Cho, A., Phinney, D., Curtis, S., Roman, M., Poon, E. G., Ferranti, J., Katz, J. N., & Tcheng, J. (2020). Telehealth Transformation: COVID-19 And The Rise Of Virtual Care. Journal Of The American Medical Informatics Association, 27(6), 957–962. Https://Doi.Org/10.1093/Jamia/Ocaa067

THE EFFECT OF PROVIDING DIGITAL BOOKLET MEDIA EDUCATION ON THE LEVEL OF PERSONAL HYGIENE KNOWLEDGE DURING MENSTRUATION IN CLASS VII STUDENTS AT SMPN 3 NGANJUK

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Abstract

Background of the cleanliness of the reproductive organs is very important to maintain and pay attention to cleanliness in order to avoid reproductive health problems. Please note that menstrual blood is an ideal place for the growth of bacteria and fungi that cause vaginal discharge and infection. The main causes of reproductive tract infections are: weak immunity, lack of knowledge of hygiene during menstruation and the use of unhealthy sanitary napkins during menstruation. Purpose of this study was to analyze the effect of providing digita booklet media education on the level of personal hygiene knowledge during menstruation in seventh grade students at SMPN 3 Nganjuk Regency. Method used in this study is the Quasi Experiment Method with the type of research being one group pretest post-test design and spreading google gorm to the respondents with a total sample of 50 respondents. Results based on the Wilcoxon test showed that the p-value was 0.000 < 0,05 which stated that the effect of providing persona hygiene education during menstruation with digital booklets was effective in increasing students knowledge about personal hygiene during menstruation Conclusion that can be drawn is the influence of providing digital booklet media education on the level of personal hygiene knowledge during menstruation in class VII students at SMPN 3 Nganjuk Regency before and after being given the intervention. Suggestions are expected to the Educational Institutions of SMPN 3 Nganjuk to increase student health knowledge about reproductive health by conducting reproductive health education which is included in the Natura Sciences subject or by conducting education.

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Keywords:
 Menstruation; Adolescents; Reproductive Health

Introduction

Personal hygiene is maintenance of cleanliness and health individual carried out in his daily life so that he can avoid reproductive disorders and aimed at physical well-being and psychological and improve health status (Yusuf & Budiono, 2016). Personal hygiene during menstruation is components of personal hygiene plays an important role in status a person's health behavior, incl avoid disruption to function reproduction. Personal hygiene when menstruation is influenced by level knowledge about reproductive health (Yusuf & Budiono, 2016).

The impact of not taking care personal hygiene during menstruation on Teenage girls can get infections urinary tract, vaginal discharge, cervical cancer and other reproductive health. (Apriliyanti et al.,

2020). So it is big influence on young women in responding to or knowing the process menstruation and how they are behave healthily when handling hygiene of her genitals during menstruation.

Low knowledge about reproductive health possible women don't do personal proper hygiene during menstruation which can endanger health its own reproduction (Dolang & Kiriwenno, 2020). Current hygiene factors menstruation is a whole behavior in maintaining cleanliness when menstruation. Information about hygiene menstruation is very important because otherwise implemented will have a negative impact, ie will cause infection in the tool reproduction, thereby reducing quality the life of the individual concerned (Maharani, 2017). At moderate times menstruation, reproductive organ hygiene it is very important to look after it and pay attention to cleanliness. Because if Teenagers don't know personal methods correct reproductive organ hygiene when menstruation will occur unexpected microorganisms. It is known that menstrual blood is ideal place for bacterial growth and mushrooms (Maharani, 2017).

Knowledge about health reproduction should have been given and submitted as early as possible because information that has been obtained since childhood, later it will be useful to save and used as a temporary provision later adulthood (Sassi Mahfoudh et al., 2018). Lack of knowledge about health reproduction can have a negative impact. From This knowledge will shape a new science that will form Adolescent behavior regarding personal hygiene during menstruation in female students. Behavior will more persistent and long-lasting (long lasting) if the behavior is based on the knowledge you have so foster awareness and positive attitudes.

Effective and efficient media is needed in current personal hygiene education one of them is a booklet digital (Khusnuddin, 2019). Digital Booklet is a book electronic based pocket. As is Digital Booklet learning media material learning is presented concisely, interesting and easy to understand accompanied by pictures. Digital Booklet is a learning medium that can be used in the learning process well in learning with the help of the teacher or independently. Booklet Properties Informative digital and design. Interesting things can trigger curiosity to students. Therefore, students can understand the learning material with easy (Violla & Fernandes, 2021).

Preliminary data survey, SMPN 3 Nganjuk Regency is one of them from 3 favorite junior high schools in Nganjuk Regency because there are many achievements obtained by female students, number of female students class VII there are 129 female students from class A up to class VII generally on This is when teenagers experience menarche at the age of 12 years to 16 years On average, menstruation starts early class VII, then after it is done interviews with 3 of their class VII students don't understand what personal is hygiene during menstruation and not yet ever get any information about personal hygiene during menstruation at school or at home, but I've done it before get education about health fundamental reproduction in Science subjects Natural Knowledge, Interview with teacher BK also only provides information about reproductive health on the bench class VII semester 2 in Science subjects Science.

Based on that background It has been explained that there is a need for research more information regarding the issue of giving education about personal hygiene during menstruation to increase knowledge of female students at SMPN 3 Kabupaten Nganjuk. So researchers are interested in carry out research with the title "The Effect of Providing Media Education Digital Booklet Against Levels Current Personal Hygiene Knowledge Menstruation in Class VII Students at SMPN 3 Kabupaten Nganjuk".

Methods

Research design The method used in This research is a quasi method experiment (Quasi Experiment Method). According to Sugiyono (2016, p. 72) method Experimental research is a method research used to search influence on something given treatment of others under conditions which can be controlled. In this study, subjects research is first given a test initial (pretest) to find out how far where is the initial ability of the female student before given personal hygiene education menstruation in the form of a digital booklet. Next, the female students are given education personal hygiene during menstruation in the form of Digital booklets are distributed via links Instagram provided on WhatsApp. After 10 days, students were given a pretest do a post-test to find out the extent of the influence of personal education hygiene during menstruation in the form of a booklet digital knowledge of female students provided via WhatsApp. The population is all female students in Public Middle School (SMPN) 3 Nganjuk Regency which totaling 129 female students in class VII. In this study the results were The sample size was 49 people. Technique sampling using probability sampling which is sampling technique that gives opportunities or opportunities are equal for everyone elements or members of the population to select become a sample (Notoatmodjo, 2018). The sample is class VII students A, B, C, D, E, F, G, H, I. Here's the formula calculation of sample proportions for each class.

Results and Discussion

Table 1.
Frequency Distribution of Univariate Analysis of Research Results

Variable	Frequences	Percentage (%)
Age (old)		
12	2	4
13	32	64
14	16	32
Resources		
Internet	2	4
Parent	36	72

Table 2.
Data Normality Test Results

Variable	Frequences	Percentage (%)
Friend	12	24
School	0	0
TV	0	0

Table 3.
Results of the Wilcoxon Statistical Test on the Effect of Providing Digital Booklets on
Personal Hygine Knowledge of Female Students at SMPN 3 Nganjuk

Variable	Shapiro-Wilk
	p-value
Pretest	0,005
Post-Test	0,000

Based on the table above shows that the average before given an intervention of 46.00 with minimum score 20 and maximum score 80, whereas after being given value intervention the average increased to 87.80 with Minimum score is 60 and maximum score is 100. Standard deviation before intervention ie 14,569 to 10,934 after intervention. Based on improvement assessment knowledge of using the N-Gain formula there was a fairly effective increase of 74.6%, with a pretest average difference of da post-test was 41.8 while the p value was 0.000 < α (0.05) meaning there was The influence of providing booklet media education digital to the level of knowledge personal hygiene during menstruation in female students class VII at SMPN 3 Nganjuk Regency. In this research, the results were obtained analysis using the Wilcoxon test sig shows 0.000 < probability 0.05 then H0 is rejected and Ha is accepted. So from that it can be concluded that there is the average difference between learning outcomes pretest with post-test which means there is the influence of the level of prior knowledge and after being given intervention. Seen from increasing number of respondents able to answer questions correctly which are given. Increased knowledge respondents because of the explanation and the directions given in the atmosphere is open, so that female students are more easy to understand and comprehend about menstrual hygiene and later can put it into practice at any time menstruation. This is also in line with research conducted by Nur'aini, (2016)that the results of the research carried out as well explain the influence of booklet media on knowledge of menstrual hygiene, From this research, results were obtained that there is the influence of booklet media towards increasing students' knowledge regarding menstrual hygiene. Got it p-value results regarding knowledge menstrual hygiene is <0.005. This matter means there is a difference in knowledge before and after treatment in the experimental group, that is proves that booklet media is effective in increasing knowledge (Nur'aini, 2016).

This research is in line with Rusdi et al (2021) who show that there is a significant difference in scores knowledge of using Instagram indicated by the statistical test results obtained p- value 0.004. This is because Instagram is the second social media most frequently visited by residents Indonesia with a percentage of 17.8% (APJII, 2018). In systematic studies review by Taggart et al. (2015) that the use of social media makes it possible active social media users for access information anonymously, communicate about health reproduction, building virtual communities, and obtain social support and emotional even though

limited by distance physical, this method also supports the method easier data acquisition. Media used in learning activities because it has the ability to presents complex events and complicated to become more systematic and simple, increase attractiveness and learner attention and improve learning systematics (Pratiwi et al.,2021). Based on several explanations it can be concluded that health education with using existing booklet media impact and influence on change a person's attitudes and practices. Because p is in accordance with the objectives, namely health education aims to change one's attitudes and practices in order to become better and know more.

Conclusions

Based on the results of the p-value of 0.000 < α (0.05) means it exists the influence of providing media education digital booklet against level current knowledge of personal hygiene menstruation in class VII students in SMPN 3 Nganjuk Regency before and after it is given intervention and based on assessment increased knowledge using the N-Gain formula occurs quite effective increase of 74.6%, with an average difference pretest and post-test was 41.8.

References

Apriliyanti, S., Netty, & Anam, H. K. (2020). Knowledge Relations, Mother's Role With Behavior Self Care During Menstruation For Class VIII Students at Smpn 14 Banjarmasin 2020.

Dolang, M. W., & Kiriwenno, E. (2020).The Influence of Health Education About Menstrual Hygiene Against Adolescent Knowledge Daughter. Biocells: Biology Science and Education, 9(1), 101.https://doi.org/10.33477/bs.v9i1.1327

Khusnuddin. (2019). The Effect of E-Booklets Personal Hygiene Against Scabies Prevention Behavior in Durrotu Islamic Boarding School students Aswaja Semarang. University Semarang State

Maharani, K. (2017). Influence of Education Health About Personal Genital Hygiene Against
Hygiene Behavior During Menstruation For Class VII Students of SMP Negeri 3 Paste Sleman. 5–6.

Nur'aini. (2016). Influence of Education Health with Booklet Towards Knowledge and Attitudes Menstrual Hygiene in Female Students in SDI Al-Falah I Jakarta. University Islamic State of Syarif Hidayatullah Jakarta.

Pratiwi, A. B., Ekacahyaningtyas, M.,Harti, A. S., Program, M., Program, S. K., Faculty, S., Health, I., Kusuma, U., Surakarta, H., & Program, D. (2021). Influence Current Health Education Menstruation About Vulva Hygiene By Using Social Media Instagram Against Rate Knowledge of Young Women. 23.

Sassi Mahfoudh, S., Bellalouna, M., & Horchani, L. (2018). Solving CSS Sprite Packing Problem Using a Transformation to the Probabilistic Non-oriented Bin Packing Problem. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 10861 LNCS, 561–573. https://doi.org/10.1007/978-3-319- 93701-4_44

Sugiyono. (2014). Research methods quantitative, qualitative and R&D. Alphabet.

Violla, R., & Fernandes, R. (2021). Effectiveness of E Booklet Learning Media in Learning Online To Improve Results Student Learning in Subjects Sociology. Sikola Journal: Journal
Educational Studies and Learning, 3(1), 13–23. https://doi.org/10.24036/sikola.v3i1.144

Yusuf, D. F., & Budiono, I. (2016). Factor Related to Practice Menstrual Hygiene Genitalia in Mentally disabled SMPLB student. JHE Journal of Health Education, 1(1), 56–61.

Analysis Of User Interface User Experience SIMRS At The Patient Registration Section Of The Sultan Fatah Demak Hospital, 2023

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Abstract

During the development of Hospital Health Information Management System (SIMRS), there were some errors in data item labels in the patien registration center of the Sultan Fatah Demak Hospital. The study analyzed the UI/UX of SIMRS in the patient registration section of RSUD Sultan Fatah Demak in 2023. The research was descriptive and subjects were all registration officers (13 officers). This study used the UI questionnaire to measure User Interface (UI) and UEQ to measure User Experience (UX). The results showed that the majority of officers were women, aged 21-25 years, last education was a high school, officers had been working for ≥1 year. In SIMRS the data items are arranged logically, there is a pop up if there is an item that has not been inputted, and there is a different user id and password for each officer. However, SIMRS does not yet have an icon and the layout is not neatly arranged. The highest UI aspect of was privacy and security, classified as excellent with 4.50 points and the lowest was error prevention, classified as poor with 2.92 points. The highest UX aspect was perspicuity (1.71 points), and the lowest was novelty(0.54 points). Since error prevention is the lowest aspect of the UI, an edit menu was added on the input page to prevent input errors. Then in UX, SIMRS needs to be upgraded in terms of color and layout so that system users don't feel bored while carrying out their duties.

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User Interface; User Experience; SIMRS; Patient Registation

Introduction

The rapid development in the world of information technology has made it an important part of the success of an institution to improve a service, including hospitals, to support more accurate, fast, and precise performance. Hospitals consider data and information as important assets that need to be managed optimally for decision making. The data is processed in the form of a Hospital Management Information System or can be referred to as SIMRS. SIMRS is expected to reduce the administrative burden, which was initially carried out using time-inefficient paper while completing tasks from the many reports and several sheets of paper with various important data that will be stored after data management.(1) In the implementation of SIMRS, several obstacles were found. These obstacles can be seen in the results of Putra

and Vadriasmi's research (2020) on "Analysis of the Implementation of the Hospital Management Information System (SIMRS) at Outpatient Registration Section (TPPRJ) Using the UTAUT Method at Tk.III Dr. Reksodiwiryo Padang Hospital" that officers need to enter patient data and patient SEP No. double.(2) Meanwhile, research by Sari, et al (2020) with the title "Overview of the Implementation of the Hospital Management Information System (SIMRS) at the Patient Administration Installation of Dr. H. Marzoeki Mahdi Bogor Hospital, West Java Province" found that SIMRS requires a notification or warning block on SIMRS so that duplication of patients does not occur.(3) Another SIMRS problem found in Dinata and Deharja's (2020) research on "Analysis of SIMRS with the PIECES method at Dr. H. Koesnadi Bondowoso Hospital" is that from a visual point of view, the appearance is sometimes boring.(4) The SIMRS of Sultan Fatah Demak Hospital called "Integrated Hospital Management" has only been used since June 2022. This SIMRS was purchased from a third party and is still under development. In its development, there are several problems in SIMRS such as naming errors in filling items.

Important factors of a SIMRS are UI (User Interface) and UX (User Experience). UI is the appearance of an application that allows users to connect and interact with a product. UI focuses on the beauty of the appearance of a system. So, users can enjoy the product. While UX is the process of designing applications through a user approach so as to create applications according to the needs and desires of users. Applications with good UX design will make it easier for users to use the application and create a comfortable experience for users.(5) The formulation of the problem in this study is how to analyze the UI UX SIMRS in the patient registration section of the Sultan Fatah Demak Hospital in 2023. The general objective is to analyze UI UX SIMRS in the patient registration section of Sultan Fatah Demak Hospital in 2023.

Methods

The research was conducted by analyzing the UI UX of patient registration officers at RSUD Sultan Fatah Demak from February to June 2023. The research was conducted from February to June 2023. The data source is using primary data with data collection methods are observation and questionnaire methods. The research was descriptive and subjects were all registration officers as 13 officers consist of outpatient registration section (TPPRJ) as 5 officers and inpatient/emergency registration section (TPPRI/GD) as 8 officers. There are 2 questionnaires used in this research, namely the UI questionnaire and UEQ (User Experience Questionnaire). Both questionnaires use a Likert scale, which measures respondents' perceptions and opinions about an event. In the Likert scale there are two forms of questions, namely positive questions to measure positive scales and negative questions to measure negative scales.(6) The data analysis used for UI is to calculate the average of the final results of the questionnaire in order to determine the final results and categorize the calculated values. There are 5 categorizations in UI, namely awful, poor, ok, good, and excellent.(7,8) In UX from 26 questions, the resulting data will be converted which results in an average of each respondent for each aspect. Furthermore, to determine the UX aspects, the benchmark data set from the Data Analysis Tool is used. There are 5 categorizations in the benchmark, namely bad, below average, above average, good, and excellent.(8,9)

Results

In the officer characteristics, there are 11 variables, including gender, domicile, age, latest education, RMIK educational background, length of work, length of computer use, length of mobile phone use, computer training, average internet usage in a week, and internet usage for users. In Table 1, the majority of officers were female, domiciled in Demak Regency, aged 21-25 years, graduated from senior high school, did not have an RMIK background, had ≥1 year of work experience, used computers for ≤5 years, used computers for ≤10 years, did not attend computer training, the average internet usage was 21-40 hours/week, and used the internet for entertainment.

Table 1.

Characteristics of Medical Record Officers at Sultan Fatah Demak Hospital

No.	Variables	Frequency	Percentage
1.	Gender		
	Male	4	31%
	Female	9	69%

2.	Domicile		
	Demak district	11	85%
	Outside Demak District	2	15%
3.	Age		
	≤20 years	2	15%
	21-25 years old	8	62%
	>25 years	3	23%
4.	Last education		
	High school graduate	8	62%
	Diploma/Vocational	3	23%
	S1	2	15%
5.	RMIK Educational Background		
	RMIK	2	15%
	Not RMIK	11	85%
6.	Length of Service		
	<1	3	23%
	≥1	10	77%
7.	Length of time using the computer		
	≤5	9	69%
	≤10	2	16%
	>10	2	15%
8.	Length of time using mobile phone		
	≤5	3	23%
	≤10	8	62%
	>10	2	15%
9.	Attended computer training		
	Yes	4	31%
	No	9	69%
10.	Average internet usage in a week		
	7 - 9 hours/week	1	8%
	10 - 20 hours/week	3	23%
	21 - 40 hours/week	7	54%
	40 hours/week	2	15%
11.	Internet usage for users		
	Education	6	11%
	Shopping/searching for product information	10	18%
	Entertainment	11	19%
	Job/business	7	12%
	Communication with others (excluding email)	6	11%
	Gathering information for personal use	6	11%
	Gather information about health	4	7%
	Occupy free time	6	11%

In table 2, UI by aspect is shown based on the officer unit. There are 10 aspects of UI, namely visibility of system status, match between system and real world, user control and freedom, consistency and standards, error prevention, flexibility and efficiency of use, help users recognize, diagnose, and recover from errors, eye cactching, privacy and security, and documents. The highest aspect obtained by TPPRI/GD officers and all officers is the privacy and security aspect with a score of 4.69 obtained by TPPRI/TPPGD officers and 4.50 obtained by all officers. For TPPRJ officers, the highest aspect is flexibility and efficiency of use with a score of 4.80. The lowest aspect obtained by TPPRJ officers and all officers is the aspect of error prevention with a score of 3.00 obtained by TPPRJ officers and 2.92 obtained by all TPP officers. In TPPRI/GD officers, there are 2 lowest aspects, namely aspects of error prevention and help users recognize, diagnose, and recover from errors with a score of 2.88.

Table 2.

UI by Aspect Based on TPP Officers

Aspects	TPP RJ	Category	TPP RI/GD	Category	All Officers	Category
Visibility of system status	4,20	*Excellent*	3,97	*Good*	4,06	*Excellent*
Match between system and real world	4,27	*Excellent*	3,92	*Good*	4,05	*Excellent*
User control and freedom	4,15	*Excellent*	3,94	*Good*	4,02	*Excellent*
Consistency and standards	4,00	*Good*	3,88	*Good*	3,92	*Good*
Error prevention	3,00	*Poor*	2,88	*Poor*	2,92	*Poor*
Flexibility and efficiency of use	4,80	*Excellent*	4,25	*Excellent*	4,46	*Excellent*
Help users recognize, diagnose, and recover from errors	3,30	*Poor*	2,88	*Poor*	3,04	*Poor*
Eye cactching	3,93	*Good*	3,21	*Poor*	3,49	*Good*
Privacy and Security	4,20	*Excellent*	4,69	*Excellent*	4,50	*Excellent*
Document	4,20	*Excellent*	4,44	*Excellent*	4,35	*Excellent*

In Table 3, UX by aspect is shown based on the officer unit. There are 6 aspects of UX including attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. The highest score obtained by TPPRJ officers and all TPP officers is the perspicuity aspect with an excellent category and a score of 2.15 obtained by TPPRJ officers while all TPP officers get the above average category with a score of 1.71. Then the highest score of TPPRI officers is in the efficiency aspect with the Above Average category which has a score of 1.47. While the lowest value is in the novelty aspect with the Below Average category and each score of TPPRJ officers gets 0.60; TPPRI officers get 0.50; and all TPP officers get 0.54.

Table 3.

UX by Aspect Based on TPP Officer

Aspects	TPPRJ	Category	TPPRI/GD	Category	All Officers	Category
Attractiveness	1,87	*Excellent*	1,27	*Above average*	1,5	*Above average*
Perspicuity	2,15	*Excellent*	1,44	*Above Average*	1,71	*Above Average*
Efficiency	1,85	*Good*	1,47	*Above Average*	1,62	*Good*
Dependability	1,65	*Good*	0,84	*Below Average*	1,15	*Above Average*
Stimulation	1,7	*Good*	0,97	*Below Average*	1,25	*Above Average*
Novelty	0,6	*Below Average*	0,5	*Below Average*	0,54	*Below Average*

Discussion

In previous research related to User Interface, it got the Good category, which means that the system can be accepted by users.(10) In this study, it got the good and excellent categories. The question with the highest score is in the privacy and security aspect, namely "Every user has a username and password", meaning that each officer has a username and password for user authentication. Then the question with the lowest score is in the aspect of error prevention, namely "While using the system I have experienced problems or errors" which means the need for error prevention from the start such as eliminating or editing error-prone conditions.

In previous research related to UX, the highest value is the dependability aspect. While the lowest is the novelty aspect.(10) The highest aspect of the current research is the perspicuity aspect. While the lowest is the novelty aspect. The question with the highest score is located in the perspicuity aspect, namely "not

understandable/understandable", meaning that officers can understand well the function of each element in the SIMRS. The question with the lowest score is located in the novelty aspect, namely "inventive/conventional" which means the need to improve SIMRS from the visual side so that SIMRS is more up to date and officers do not feel bored when running SIMRS.

Conclussion

The system uses Indonesian language that is easy to understand, the order of the items is logically arranged, and the data can be accessed again. However, there are some problems, namely that the medical code contains the names of poly doctors and there are items that are not filled in from the beginning and do not have functions such as visits to, guarantors and paramedic codes. The highest aspect of UI is the privacy and security aspect while the lowest is the error prevention aspect. Then the highest aspect of UX is the perspicuity aspect while the lowest is the novelty aspect. The need for SIMRS improvement on items that can cause confusion and the need for system evaluation so that it is more up to date and system users do not feel bored when carrying out their duties.

Author Contributions

Writing—original draft preparation, visualization, methodology, Niantiara A.S.M; Conceptualization, supervision, writing—review and editing, Evina W. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest:

The authors declare no conflict of interest.

References

Agustina GR, Susilani AT, Supatman. Evaluation of the Hospital Management Information System (SIMRS) in the Outpatient Registration Section with the HOT-FIT Method [Internet]. Vol. 1, Jembatan Merah No. 84C. Yogyakarta: Multimedia & Artificial Intelligence Seminar; 2018. 75-80 pp. Available at: https://papersmai.mercubuana-yogya.ac.id/index.php/smai/article/view/14/9

Putra DM, Vadriasmi D. ANALYSIS OF THE IMPLEMENTATION OF HOSPITAL MANAGEMENT INFORMATION SYSTEM (SIMRS) IN TPPRJ USING UTAUT METHOD IN RS TK.III DR. REKSODIWIRYO PADANG. Administration & Health Information of Journal [Internet]. January 30, 2020;1(1):55-67. Available at: http://ojs.stikeslandbouw.ac.id/index.php/ahi

Sari AP, Dwimawati E, Pujiati S. OUTLINE OF IMPLEMENTATION OF THE HOSPITAL MANAGEMENT INFORMATION SYSTEM (SIMRS) IN THE PATIENT ADMINISTRATION INSTALLATION RUMAH SAKIT DR. H MARZOEKI MAHDI BOGOR PROVINCIAL JAWA WEST [Internet]. Vol. 3, PROMOTOR Journal of Public Health Students. Bogor; Feb 2020. Available at: http://ejournal.uika-bogor.ac.id/index.php/PROMOTOR

Dinata FH, Deharja A. Analysis of SIMRS with the PIECES Method at Dr. H. Koesnadi Bondowoso Hospital. Journal of Health [Internet]. October 12, 2020;8(2):106-17. Available at: https://doi.org/10.25047/j-kes.v8i2

Paramadani RB, Sudana AAKO, Putra IMS. Development of User Interface and User Experience SIMRS to Improve Hospital Health Services Pharmacy Section [Internet]. Vol. 1, JITTER-Journal of Technology and Computer Science. Bali; Jan 2020. Available at: https://doi.org/10.24843/jitter.v1i2.69576

Pranatawijaya VH, Widiatry, Priskila R, Putra PBAA. Development of a Web-based Survey Questionnaire Application Using Likert and Guttman Scales. Journal of Science and Informatics [Internet].

December 8, 2019;5(2):128-37. Available at: https://jsi.politala.ac.id/index.php/JSI/article/download/185/106/821

Listiyah A, Mahfud FKR, Bahtiar FS. Usability Test on Institutional Repository Library of UIN Maulana Malik Ibrahim Malang with System Usability Scale (SUS) and Discovery Prototyping Method. LibTech: Library and Information Science Journal. July 25, 2022;3(1):42-51.

Widianawati E, Setiono O, Wulan WR, Wulandari F. Study of the Main Factors of User Experience and Usability of Students in Using Electronic Form Design System. Visikes [Internet]. 2023;22(1):73-9. Available at: http://publikasi.dinus.ac.id/index.php/visikes/article/view/7655

Santoso HB, Schrepp M, Hasani LM, Fitriansyah R, Setyanto A. The use of User Experience Questionnaire Plus (UEQ+) for cross-cultural UX research: evaluating Zoom and Learn Quran Tajwid as online learning tools. Heliyon [Internet]. November 1, 2022 [cited August 8, 2023];8(11):1-12. Available at: https://www.cell.com/heliyon/fulltext/S2405-8440(22)03036-5

Sanjiwani KF, Sudana AAKO, Dharmaadi IPA. UI AND UX DEVELOPMENT OF SIMRS AT THE FRONT OFFICE. JITTER-Journal of Scientific Technology and Computer [Internet]. December 2020 [cited July 30, 2023];1(2). Available at: https://ojs.unud.ac.id/index.php/jitter/article/view/69582/38114

The Geographic Information System Based on Mapping and Landslide Early Warning System for Disaster Mitigation in Kalongan Climate Village

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Abstract

Landslides are a serious threat to many communities in rural areas, including the Climate Village in Kalongan Village. This activity aims to mitigate the risk of landslides in Kalongan Village by combining scientific knowledge, mapping of vulnerable areas, technology and active community participation. This research uses the Geographic Information System (GIS) method for mapping landslide potential and applies the Landslide Early Warning System (LEWS) method to help mitigate landslides. Questionnaires were used to measure the community's knowledge about landslides and their level of preparedness for landslides Mapping using Geographic Information System (GIS) identified landslide-prone areas in Climate Village of Kalongan Village. Landslide geological hazards are scattered in a small part of the village, with a hazard area of about 8.2 ha, while areas safe from landslide hazards cover 854.8 ha of the total Kalongan Village area The implementation of the Landslide Early Warning System (LEWS) Method aims to provide early warning to the community in relation to potential landslide hazards, with a special device that detects ground movement and provides signals in case of hazardous movement. In addition, a questionnaire was conducted to assess the community's knowledge about landslides and their level o preparedness to face potential disasters. The results of the questionnaire showed that the majority of the community had a good understanding of the impacts caused by landslides, especially with respect to the damage they can cause, as wel as the potential for death. This level of understanding is considered important in improving preparedness and risk mitigation against landslides.

Keywords: Landslide, Kalongan Village, Landslide Early Warning System (LEWS)

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Introduction

Landslide is a significant threat to the safety and well – being of people residing in mountainous areas (Science, 2021). Landslide is a natural disaster that frequently occurs in sloped areas and has the potential to cause significant losses to human lives and properties (Government of Indonesia, 2017). Landslides result in not only material losses but sometimes also human casualties. Continuous ground movements necessitate disaster management efforts, involving planned and organized activities aimed at minimizing or eliminating the dangers or losses from disaster consequences, as well as avoiding potential disaster risks, to reduce, minimize, or ideally eliminate the resulting impacts (Sutikno, 2001).

Kalongan Village is located in the East Ungaran Subdistrict, Semarang Regency, Central Java. Kalongan Village covers an area of 8.68 KM² (22.85% of the total subdistrict area in East Ungaran). The topography in Kalongan Village falls under topographic classes of 8 - 15% and 25 – 45%. The 8 – 15% class is categorized as gentle slopes, while the 25 – 45% class is steep. The 8 – 15% slope class encompasses an area of 800 ha, constituting 97.70% of the total area, whereas the 25 – 45% slope class covers 63 ha, accounting for 7.30%. This indicates that the slope class in Kalongan Village is predominantly classified as gentle slopes within the 8 – 15% category. However, a small portion of Dampu Hamlet has slopes in the 25 – 45% category, located at the border between Dampu Hamlet and Susukan Subdistrict. Areas with slopes of 8-15% are suitable for development as residential, business, and office areas due to good drainage conditions. This area is where many human settlements are found. The slope levels categorized as hilly areas due to the gentle and very steep slopes.

The Climate Village in Kalongan Village is one of the areas vulnerable to landslides. This study aims to understand the community's knowledge of landslides and mitigate the risk by applying a landslide disaster mitigation approach based on Geographic Information System (GIS) and Landslide Early Warning System (LEWS) method in Kampung Iklim Kalongan (Jeon and Kang, 2020) (Mukhlisin et al., 2010).

Geographic Information System (GIS) is used for mapping landslide potential by applying the Landslide Early Warning System (LEWS) method to assist in landslide disaster mitigation (Abdurrohim and Firman, 2018). LEWS is also used to provide early warnings to the community in landslide cases (Summary, 2015).

Public awareness is crucial in facing potential disasters, whether natural or non-natural, to minimize their occurrence. This includes landslides. Therefore, the importance of community knowledge in managing land in landslide-prone areas in Kalongan Village cannot be overstated. The role of the community is highly necessary in reducing disaster risks, where community knowledge is beneficial in managing land in landslide – prone areas.

Methods

a. Mapping with Geographic Information System (GIS)

Mapping is conducted by collecting spatial data through field surveys. Subsequently, data analysis is performed using ARCGIS software to identify and create maps of landslide-prone areas in Kalongan Village.

b. Landslide Early Warning System (LEWS) Method

Development of landslide prediction models based on risk factors such as rainfall, slope steepness, and revegetation, and the implementation of an early warning system to inform the community about potential landslide hazards.

c. Landslide Knowledge Questionnaire to the Community

Distribution of questionnaires to develop a questionnaire covering aspects of the community's knowledge of landslides. Additionally, distributing the questionnaire to the community of Kampung Iklim and analyzing the questionnaire data to understand the level of knowledge and awareness of the community regarding landslide risks.

Results and Discussion

This research is located in Kalongan Village, located in East Ungaran Subdistrict, Semarang Regency, which has recently gained recognition for opening tourist spots in the area. According to surveys conducted, Kalongan Village has excellent potential in terms of agricultural productivity, with extensive land suitable for agriculture that appears to be fertile.

Figure 1 Location of Kalongan Village
Source: primary data, 2023

According to surveys, Kalongan Village has excellent potential in terms of agricultural productivity, with extensive land suitable for agriculture that appears to be fertile. Some areas of Kalongan Village have hilly contours and are supported by high rainfall in the area, resulting in several areas in Kalongan Village being classified as disaster-prone areas, especially for landslides.

Figure 2 Landslide Events
Source: primary data, 2023

Mapping with Geographic Information System (GIS)

The results of mapping using ARCGIS identified landslide-prone areas in Kampung Iklim. Kalongan Village has a geological landslide hazard area that does not spread throughout the village. The geological landslide hazard in Kalongan Village covers an area of 8.2 ha, while the areas not prone to geological landslide hazards cover 854.8 ha, with a total area of Kalongan being 863 ha. The percentage of areas experiencing geological landslide hazards is 0.95%, and the percentage of areas not experiencing geological landslide hazards is 99.05%. Thus, geological landslide hazards occur in a small portion of Kalongan Village.
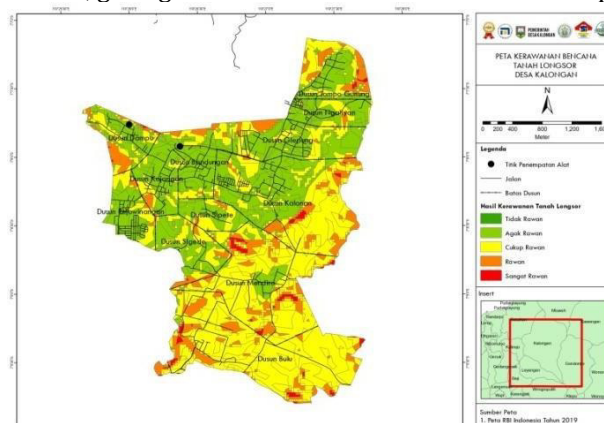

Figure 3 Mapping of Landslides in Kalongan Village

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Based on Figure 3, there are five categories of risk levels: not at risk, slightly at risk, moderately at risk, and highly at risk. In the slightly at-risk category, there are hamlets such as Dampu, Bandungan, Kalongan, Rejowinangan, Lompo Gunung, Ngaliyan, Glepung, Kalonan, Sipete, and Sigede. Meanwhile, the moderately at-risk category includes the hamlets of Bulu and Mendiro. These categories are determined based on indicators such as rainfall, slope/soil steepness, and soil type. Different colors in each hamlet indicate different soil slope steepness in each area.

Landslide Early Warning System (LEWS) Method

The Landslide Early Warning System method provides early warning recommendations to the residents of Kalongan Village. The LEWS landslide detection device is specifically designed to detect ground movements and provide early warnings about landslides. The LEWS landslide detection sensors are installed at landslide-prone points, and any slight movements will be detected. Therefore, the community can be informed early about potential landslide dangers, and especially loss of life can be minimized.

Figure 4 Installation of LEWS Equipment
Source: primary data, 2023

In Figure 4, the formation of the LEWS (Landslide Early Warning System) Disaster Mitigation tool, which has been installed at points where landslides usually occur, is shown. It is then connected to a smartphone that will be fully monitored by the village authorities. If there is ground movement, the sensor will provide a signal and emit a siren/sound. Additionally, the planting of hardy plants is carried out with the hope that in the long run, when the plants grow large and fertile, the plant roots can support the soil and prevent landslides.

Landslide Knowledge Questionnaire to the Community

Based on the results of the questionnaire aimed at evaluating the community's understanding of landslides and their readiness to face the possibility of disasters, Diagram 1 provides a detailed breakdown. The community's knowledge of landslides is at 85.7% for the response that soil shifting is caused by water absorption, while 14.3% believe that excessive water absorption is the cause. This data reflects the community's understanding of the root causes of landslides, which, in turn, can help reduce the risk of landslides.
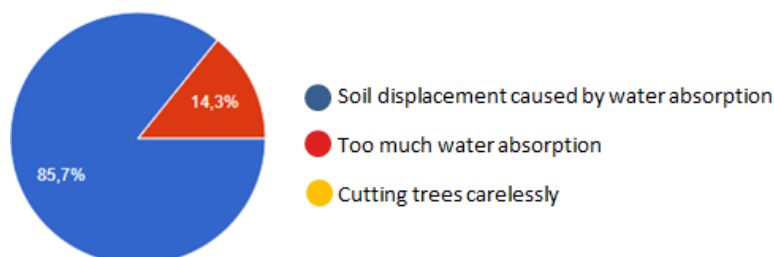

Diagram 1 Results of the Landslide Causes Questionnaire
Source: primary data, 2023

In Diagram 2, the types of rainfall that can trigger landslides are explained. It is concluded that heavy rainfall can increase the risk of landslides. Landslides occur due to sudden movement and steepness of the soil, rocks, or other landslide materials on slopes or mountainsides. Heavy rainfall increases moisture in the soil, thus altering slope stability. This pressure can weaken the soil structure, potentially leading to landslides. The questionnaire results show that the majority of the community understands the impact of landslides triggered by rainfall. They acknowledge that heavy rainfall can trigger landslides, so it is important to pay attention to and take preventive measures to reduce the risk of landslides. Prevention measures include improving drainage systems, appropriate land use planning, slope reinforcement, and the use of landslide detection equipment.
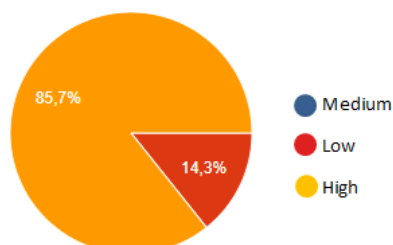

Diagram 2 Results of the Rainfall Causes Landslides Questionnaire
Source: primary data, 2023

Overall, the questionnaire results in Diagram 3 illustrate the significant impact of landslides on the economic conditions of the surrounding community. Loss of livelihoods and additional financial burdens due to home renovations are the two aspects that most affect their comfort and economic stability in the affected area. Some of the community (28.6%) states that landslides make them uncomfortable staying in the area. This may be related to concerns about safety, uncertainty, and insecurity due to the potential for landslides in the future. Most respondents (42.9%) express that landslides impact their livelihoods. Landslides can damage infrastructure, fields, or workplaces, disrupting the livelihoods of the population. This loss of livelihood can affect their overall economic conditions. Some of the community (28.6%) also indicate that landslides force them to spend more on home renovations. The damage caused by landslides requires additional investment to repair or renovate homes, affecting household financial situations.
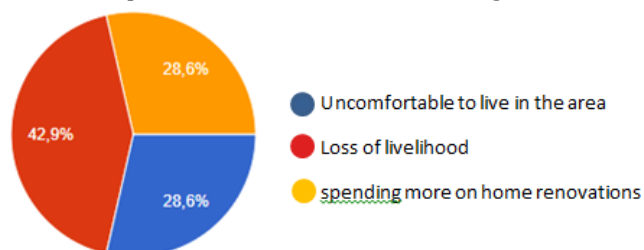

Diagram 3 Economic Impact of Landslide Disasters on the Community
Source: primary data, 2023

Diagram 4 of this questionnaire reflects the mitigation actions taken by the community before landslides occur. Emphasis on awareness and response to warnings and landslide mitigation instructions is crucial in minimizing the risk and impact of this disaster on the community. Furthermore, further education is needed to enhance the community's understanding and preparedness for potential landslide hazards. A small percentage of respondents (14.3%) state that they are cautious about heavy rainfall as a mitigation measure before landslides occur. This reflects their awareness of weather factors that can trigger landslides. The majority of respondents (42.9%) state that they are relaxed when there is a landslide threat. This attitude may reflect a lack of understanding of the risks and dangers associated with landslides or a lack of preparedness in facing potential hazards. Most respondents (42.9%) indicate that they would take action in line with landslide warning instructions. This indicates that the community tends to respond to warnings and mitigation guidelines provided by relevant authorities or experts to reduce landslide risks.
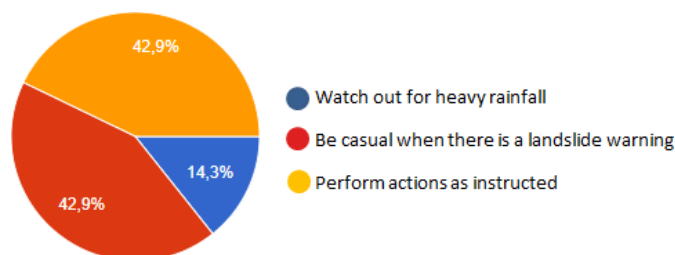
Diagram 4 Mitigation Actions Before Landslides
Source: primary data, 2023

Diagram 5 reflects the factors that can influence the risk of landslides according to respondents' perceptions. By recognizing and understanding the roles of factors such as land degradation, the community, and the government, steps can be taken to reduce the risk and vulnerability to landslides. This includes adopting sustainable practices in land management and development that consider local environmental conditions. The majority of respondents (42.9%) identify land degradation as a factor that can influence the risk of landslides. Land degradation can occur due to activities such as deforestation, unsustainable farming, or construction that disrupts the natural structure of the soil. This can reduce soil resilience and stability, increasing the risk of landslides.
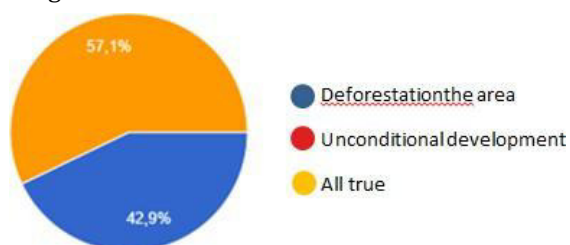

Diagram 5 Landslide Risk
Source: primary data, 2023

Diagram 6 visualizes the results of the questionnaire that asked respondents about their knowledge regarding the impact of landslides. The results show that it causes damage of 28.6%. Meanwhile, the majority of respondents, 71.4%, understand well that landslides can cause damage and even lead to death. This graph highlights the level of understanding of the community regarding the impacts of landslides, providing an overview of how well they comprehend the potential dangers and risks associated with landslides. This understanding is crucial to enhance preparedness and risk mitigation for landslides.
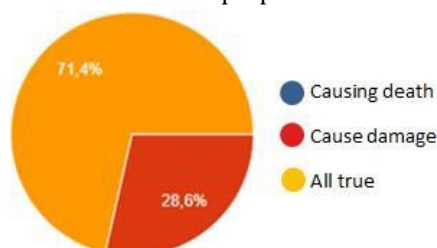

Diagram 6 Negative Impacts of Landslide Disasters
Source: primary data, 2023

in stressful conditions are more likely to occur in the group with good thesis consultation frequency (55.3%), and the p value is 0.496. Then, stress conditions were found more in respondents in the good knowledge group (52.2%) with p value of 0.205. The respondent's mindset shows that respondents in stressful conditions are more found in respondents with a negative mindset (61.0%), and the p value is 0.010. Respondents with stressful conditions were found more in the low supportive peer social support group (57.5%) and p value 0.070. The social support of the thesis supervisor showed that respondents who were under stressful conditions were more likely to be found in the social support group of the thesis supervisors who were low supportive (59.8%), and the p value 0.023.

Based on the bivariate analysis (chi-square test), it is known that several stress risk factors are associated with the respondent's stress level, namely gender, mindset, and social support for the thesis supervisor. While the stress risk factor variables that were not related to the respondent's stress level were

the year of admission, knowledge, thesis guidance method, frequency of thesis consultation, and peer social support. It is also known that there is no correlation between stress levels and the incidence of insomnia (as measured by sleep quality) in respondents.

Conclussion

Mapping based on Geographic Information Systems and the implementation of the Landslide Early Warning System can aid in mitigating landslide risks in the Climate Village of Kalongan. Evaluating public knowledge through questionnaires is a crucial step to increase awareness and preparedness of the community towards landslide threats. These steps are expected to contribute positively to the effort of reducing landslide disaster risks in this area. Overall, landslide risk mitigation efforts in Kalongan Village integrate scientific knowledge, mapping of vulnerable areas, technology, and active community participation. These measures are vital to creating a safer environment and improving the quality of life for the people in landslide – prone areas.

Reference

Abdurrohim, H. and Firman, H. (2018) 'Mapping of landslide hazards prediction using geographic information system in Solok District', *MATEC Web of Conferences*, 229(Bnpb 2016), pp. 1–6. Available at: https://doi.org/10.1051/matecconf/201822904003.

Eni (1967) 'Tanah Longsor', *Angewandte Chemie International Edition, 6(11), 951–952.*, (Mi), pp. 5–24.

Government of Indonesia (2017) *Third National Communication of Indonesia under the UNFCCC*.

Isma, I. and Ananto, A. (2022) 'Edu Geography (2022) Edu Geography', *Edu Geography*, 10(1), pp. 59–65.

Jeon, H. and Kang, J. (2020) 'GIS based assessment and design for areas vulnerable to soil disasters: Case study of Namhyeun-dong, South Korea', *Sustainability (Switzerland)*, 12(6). Available at: https://doi.org/10.3390/su12062516.

Mukhlisin, M. *et al.* (2010) 'GIS based landslide hazard mapping prediction in Ulu Klang, Malaysia', *ITB Journal of Science*, 42 A(2), pp. 163–178. Available at: https://doi.org/10.5614/itbj.sci.2010.42.2.7.

Science, E. (2021) 'Preface', *IOP Conference Series: Earth and Environmental Science*, 683(1), pp. 15–19. Available at: https://doi.org/10.1088/1755-1315/683/1/011001.

Summary, P. (2015) 'Climate Adaptation and Disaster Resilience (CADRE) Stakeholder Coordination , Advocacy , Linkages and Engagement for Resilience – Phase 2 (SCALE - R) Adaptasi Perubahan Iklim dan Pengurangan Risiko Bencana untuk ' API Perubahan phase 2 ' FINAL REPORT', 2(September), pp. 1–64.