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PREFACE

We thank God Almighty, because of His blessings and grace, we have succeeded in publishing the periodic Scientific Journal of Jurnal Info Kesehatan (Journal of Health Info) for Volume 19 Number 1, June 2021, for 10 articles. Journal of Health Info has officially used the Open Journal System (OJS) process so that publishing articles is also available in printed media with ISSN 0216-504X and available in electronic media with E-ISSN 2620-536X. The issue of the Journal of Health Info has included a Digital Object Identifier (DOI) in collaboration with the Indonesian Journal Volunteers with the prefix: 10.31965. Furthermore, the Journal of Health Info has been indexed by DOAJ and accredited by Sinta 3.

Journal of Health Info was developed with the aim of accommodating all scientific works, from lecturers, students, and other institutions from research results. Along with the development of technological advances such as the Open Journal System, every article submitted to the Journal of Health Info is sent through our online OJS which can be accessed on the web page: http://jurnal.poltekeskupang.ac.id/index.php/infokes.

As the editorial board, we would like to thank the Director of the Health Polytechnic of the Kupang Ministry of Health, who has supported and made a real contribution to the development of this journal, as well as to the authors who have contributed scientific articles and dear readers to be able to produce new works that we can publish in the next edition.

It is hoped that the existence of this Journal of Health Info increases the scientific repertoire and shares the scientific information, particularly the results of research in the health sector which provide numerous benefits, especially for health development in Kupang and Indonesia in general.

Kupang, June 30, 2021
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Ni Nyoman Yuliani, S.Si, S.Farm, Apt, M.Si

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The article is the result of a research study in health. The article should be written in English and Indonesian. The initial submission should be clean and complete but does not have to comply with all Jurnal Info Kesehatan (Journal of Health Info) specifications yet.

Manuscripts of insufficient priority or quality are promptly rejected. Manuscripts retained to undergo a review process for potential publication in the Journal will be submitted to a technical check. Authors will be informed immediately if their manuscripts need reformatting and will be given 14 days to make specific changes.

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WRITING GUIDE

Title

a) The title is written in English and informative, concise, and not too long or short (10- 25 words).
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c) A title does not contain abbreviations or formulas.
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An introduction is presented in an integrated manner without subtitle. It is written in the form of paragraphs with a contains:

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a) The study design.
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The results represent a major part of scientific articles containing:

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a) Contain conclusions and recommendations.
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a) Contain literature that is referenced in the content, arranged alphabetically, and written in the APA (*American Psychological Association*) 6th Edition system.
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RESEARCH **Open Access**

Finger Exoskeleton in Simple Motor Rehabilitation Therapy on Arm and Hand Muscle Ability of Post-Stroke Sufferers

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Abstract

Post-stroke sufferers will generally experience weakness on one side of the body, balance, vision, sensory, motor, and cognitive. In West Kalimantan, the estimated stroke sufferer in 2013 was 25,195 people. Based on data from the Public Hospital of Dr. Soedarso Pontianak shows a significant increase from January 2018 to December 2018 totaling 722 people. The research objective was to assess the effectiveness of the finger exoskeleton tool in simple motor therapy on the ability of the client's arm and hand muscles after a stroke. This study used a quantitative approach with a quasi-experimental design. Pre-test and Post-test Nonequivalent Control Group with two groups, which were the control group of 12 people and the intervention group of 12 people with finger exoskeleton tools. The statistical test used was the independent t test and paired t test. Measurement of muscle ability with the Action Research Arm Test. Analysis of the difference in total scores between before and after treatment in the intervention group using Paired T-Test obtained a p-value of 0.000 (p value <0.05) and in the control group using the Wilcoxon test a p-value of 0.016 (p value <0.05). It shows that there is a significant difference in the total score between before and after finger exoskeleton therapy and range of motion. Intervention of finger exoskeleton assistive devices in simple motor rehabilitation therapy is effective in increasing the ability of the client's arm and hand muscles after stroke. It is recommended to make another finger rehabilitation tool with a more optimal design according to the parameters, which are the severity of the client after stroke, subject kinematics, control of movement torque and adaptation between the subject and the robotic device used.

Keywords: Finger Exoskeleton, Muscle Ability, Post Stroke, Motor Rehabilitation.

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1. INTRODUCTION

In the world, stroke is a deadly disease after heart disease and cancer. WHO estimates that the number of stroke patients in several European countries will increase from 1.1 billion per year in 2000 to 1.5 billion per year in 2025. In Indonesia, according to data released by the Post-stroke Foundation Indonesia, it shows a trend that is continues to increase from year to year (Utomo, et al., 2018). Cerebrovascular disease is the second leading cause of death and the third most common cause of disability in the world (Feigin et al., 2017).

In West Kalimantan, the estimated stroke sufferer in 2013 was 25,195 people. Data from hospitals in Pontianak City specifically for Public Hospital of Dr. Soedarso shows an increase from January to December 2018 totaling 722 people (Public Hospital of Dr. Soedarso, 2018). The impact of stroke on sufferers, among others, can damage the body, movement and speech ability, influenced by the damaged part of the brain. The special impact of hemiparesis is loss of body control in part. This ability will usually weaken daily activities (Mohan, et al., 2013). If there is movement, all the structures in the joint will be affected, which are the muscles, joint surfaces, joint capsules, fascia, blood vessels, and nerves (Minagawa, et al., 2015).

The main protocol for rehabilitation of post-stroke patients is based on learning movements which cause dendrite growth, new synapses, and good changes (Takeuchi & Izumi, 2013). The occurrence of motor defects in the upper and lower limbs after a stroke and damage to the motor cortex is common. Hemiparesis, paralysis, weakness, abnormal muscle tone, spasm, abnormal posture, abnormal synergistic muscle function, and loss of inter-joint coordination are the most common injuries resulting from damage to the motor cortex due to stroke (Kato & Izumiyama, 2010). Eighty percent of patients who experience acute upper limb paresis after stroke, only a third achieve restoration of normal limb function back to normal (Carrera & Tononi, 2014)

Rehabilitation is a form of integrated therapy services which includes medical, psychosocial, educational, vocational approaches involving doctors, neurologists, medical rehabilitation doctors, nurses, physiotherapists, occupational therapy, medical social workers, psychologists and clients as well as family roles to achieve most functional abilities and prevent repeated stroke attacks (Utomo et al., 2018). Hand rehabilitation is essential for the restoration of independence in the activities of daily life for individuals who exhibit disability in the upper extremities. There is preliminary evidence that robotic devices with a force control-based strategy can assist in the effective rehabilitation of human limbs (Agarwal et al., 2015). Finger damage after stroke causes significant deficits in hand manipulation and daily task performance. Recent advances in rehabilitation robotics have demonstrated the increasing efficacy of rehabilitation. However, devices currently created do not have the capacity to accurately interact with the human finger at a level of speed and torque comparable to the performance of everyday hand manipulation tasks (Cafolla & Carbone, 2014).

Several recovery/rehabilitation therapies for stroke clients include ROM, Core Stability exercise, and CIMT (Constraint-Induced Movement Training) and robotic Arm (Exoskeleton active/passive) training has been used in physical therapy. However, the use of existing robotic-based therapies requires large funds, self-rehabilitation centers, specific operators, and difficult treatment for sensitive components (Rippun, et al., 2016).

The exoskeleton is a tool for physical therapy exercises which are generally used to help relieve a person's movement, especially in the world of construction, but exoskeleton is also used for medical purposes. Physical therapy exercises that are routinely conducted by stroke sufferers have successfully shown positive results in the

form of increased lower limb ability, functional mobility (balance and walking) and quality of life.

Starting from the above problems, the researchers took the initiative to create a simple tool that can be used to measure the client's gripping ability and help recover it. This simple tool is a prototype tool that has never been made before, so it is expected to be a new breakthrough in helping post stroke clients. A simple tool made with gloves using a battery or recharging the charger. In this study, the researchers took non-hemorrhagic stroke study material because it was possible for this patient to be given training with a finger exoskeleton in simple motor rehabilitation therapy using automatic gloves. It is hoped that in the future, the number of stroke sufferers will be increasing day by day, without knowing the socioeconomic status of the affected person will be able to improve the quality of life better with appropriate rehabilitation therapy and better than traditional therapy with the aim of improving movement function or maximum activity starting with hand movements. The method used in this study can easily be administered regularly in stroke patients by clients and families and it is easy to assess the progress of post-stroke patient health. The objective of this study was to determine the effectiveness of finger exoskeleton tools in simple motor rehabilitation therapy on the ability of arm and hand muscle function of post-stroke sufferers.

2. RESEARCH METHOD

The research method used in this research is a quasi-experimental with the pre-test approach and the post-test Nonequivalent Control Group approach. This research was conducted at the Public Hospital of Dr. Soedarso Pontianak from May to the end of October 2019. This research has received ethical approval from the ethics commission of the Health Polytechnic of the Ministry of Health Pontianak number: 186/KEPK-PK.PKP/V/2019. The population in a month of stroke sufferers is 60 people. Sampling is calculated based on the formula for estimating the sample size of the hypothesis test on the mean of two independent populations. The inclusion criteria in this study were patients diagnosed with non-hemorrhagic or hemorrhagic strokes who had physical disabilities in the upper extremities, while the exclusion criteria in this study were patients with severe stroke who experienced cognitive impairment. The sample size was 16 people divided into 2 groups, which were 8 people in the intervention group and 8 people in the control group.

The instrument used in this study was to measure the client's gripping ability after a stroke. Measurement/test of arm and hand function or measurement of grip function using the Action Research Arm Test instrument. This instrument consists of sub tests: a. Hold (grasp) with the highest score of 18 and each test is worth 3, b: Holds with the highest score of 12, with each test worth 3, c. Pinch with the highest score of 18 and each test is worth 3 d. Movement (Gross Movement) with the highest score of 9, with each test worth 3. The range of scores is 0-57 (Lesmana, 2014).

The univariate analysis in this study were variables of age, gender and variables of the arm and hand muscles of post-stroke patients. Nominal scale variable data (gender) is presented in the form of a percentage and the numerical scale variables (age) are presented in the form of mean and standard deviation. This univariate test was also conducted to determine the equality of age and sex characteristics of respondents between groups using the chi-square test. the equivalence test was administered to see the homogeneity of the two groups based on the characteristics of age and sex. The bivariate analysis in this study was the difference in the Action Research Arm Test scores between before and after exoskeletal finger intervention in the intervention and

control groups. The statistical test used in this study was the independent t-test which was used to analyze the difference in scores before the intervention between the two groups and the difference in scores after the intervention between the two groups (unpaired), while to test the difference in scores before and after the intervention was conducted. In both groups (paired data), the Paired t-test was used.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of respondents based on gender and age at the Public Hospital of Dr. Soedarso Pontianak in 2019 (n = 16)

Characteristic	Respondent based on genders				*p-value*
	Intervention group		Control group		
	F	%	F	%	
Gender					
Male	6	75	1	12,5	0.041
Female	2	25	7	87,5	
Age (Year)					
40-50	4	50	0	0	0,077
51-65	4	50	8	100	

** Chi-Square Test*

Table 1 shows the characteristics of the respondents based on gender and age mostly were men in the intervention group at 75% while the control group was mostly women at 87%. The results of the equivalence test obtained a p-value of 0.041, which means that there is no significant gender difference between the control and intervention groups. Meanwhile, based on age, the age group was dominated by 51-65 years old in the intervention and control group with the highest percentage in the control group, which is (100%).

Table 2. The ability of the arm and hand muscles of stroke patients at the Public Hospital of Dr. Soedarso Pontianak in 2019 (n= 16)

No	Indicator	Min		Max		Mean		SD	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1.	Holding	3	3	18	18	10,50	13,13	4,423	3,442
2.	Grasping	0	0	6	8	0,94	2,94	2,112	2,542
3.	Pinching	0	0	9	11	0,75	1,63	2,324	2,872
4.	Movement	0	0	9	12	0,94	1,31	2,620	3,281

Table 2 shows that the average holding ability has increased by 2.63, the grasping ability has increased by 0.88 and the hand movement has increased by 0.37.

Table 3. An overview of muscle ability scores before and after the intervention in the two groups (n=16)

Measurement	Mean	SD	Median (Min-Max)	*p-value**	Note
Pretest Intervention	12,00	4,24	12,00 (6,00-18,00)	0,273	Normal
Pretest Control	13,87	11,77	9,00 (6,00-39.00)	0,006	Not Normal
Posttest Intervention	16,87	4,22	16,50 (12,00-24,00)	0,557	Normal

Posttest Control	21,12	13,22	18,00 (6,00-49,00)	0.173	Normal

**Data Normality Test Using Saphiro-Wilk Test*

Based on table 3, it can be seen an overview of the muscle ability scores before and after being given to the two groups where the intervention group was given finger exoskeleton therapy and the control group was given Range of Motion therapy. In the intervention group, before being given treatment, the average value was 12.00 with SD 4.24 after being given the treatment, the average value was 16.87 with SD 4.22. In the control group, before being given the treatment, the average value was 13.87 with SD 11.77 and after being given treatment, the average value was 21.12 with SD 13.22.

Table 4. Analysis of Differences in Muscle Ability before and after treatment in the two groups (n=16)

Muscle ability	**Pretest**			**Post-test**			***p-value***
	Mean	**SD**	**CI 95%**	**Mean**	**SD**	**CI 95%**	
Group							
Intervention	12,00	4,24	8,45-15,54	16,87	4,22	17.32 -23.07	0.000
Control	13,87	11,77	4,02-23,72	21,12	13,22	10,06-32,18	0.016

Information:
1. Difference between pretest and posttest in the intervention group using Paired T-Test (0.000)
2. Difference between pretest and posttest in the control group using the Wilcoxon Test (0.016)

Table 4 shows the differences in muscle ability before and after treatment in the two groups. From statistical calculations to compare the pretest and posttest in the intervention group using Paired T-test, the p-value is 0.000, which means that the value is smaller than the significance value set by the researcher, which is 0.05 (p-value <0.05), so it can be concluded that there is differences in muscle ability in patients before and after being given finger exoskeleton therapy treatment.

Statistical calculations to compare the pretest and posttest in the control group using the Wilcoxon test obtained a p-value of 0.016, which means that this value is smaller than the significance value set by the researcher, which is 0.05 (p-value <0.05) so it can be concluded that there are differences in muscle ability. in patients before and after given range of motion therapy treatment.

Table 5. The Difference Difference in Increasing Muscle Ability Score Before and After being given treatment (n=16)

Measurement	**Mean Difference**	**Median**	**SD**	**Std Error**	**Shapiro-Wilk**	**Nilai p**
Intervention	4,87	6,00	1,55	0,548	0,000 (Normal)	0.161*
Control	7,25	6,00	4,30	1,520	0,367 (Not Normal)	

* Mann-Whitney Test, (p-value>0.05)

Based on table 5 above, it can be seen the difference in the difference in muscle ability scores using the Mann-Whitney test. The results of statistical calculations obtained p-value 0.161, which means that this value is greater than the significance value set by the researcher, which is 0.05 (p-value>0.05). It shows that there is no significant difference between the two groups' muscle ability scores, so it can be concluded that finger exoskeleton therapy and range of motion have a positive effect on increasing the ability of the hand and arm muscles.

The statistical test results of the difference between the total pre and post test scores in the control group obtained p value = 0.016 where p<α, so it can be concluded that there is a difference between the total pre and post scores in the control group Range of Motion (ROM), and after treatment in the intervention group which was conducted by statistical test paired t-test resulted in a probability value of 0.000 (p value <0.05). Meanwhile, the control group produced a probability value of 0.016 (p value <0.05). The results of this analysis indicate that both finger exoskeleton therapy and range of motion therapy have a significant effect on the process of strengthening the hand and arm muscles of stroke sufferers. These results indicate finger exoskeleton therapy is a fairly good therapy in increasing the strength of the arm and hand muscles of post-stroke sufferers. The statistical test using Mann Whitney showed that there was no significant difference in the total score difference between before and after treatment between groups which had a probability value of 0.161 (p value <0.05). The statistical test using the independent t-test resulted in a probability value of 0.401 (p value> 0.05), which indicates that there was no significant difference in the total score after treatment between the two groups. It is influenced by the inequality of the total score before treatment between the two groups which has a probability value of 0.000 (p value> 0.05). It is due to the short research time so that the researcher had difficulty getting respondents according to the inclusion criteria and the number was limited and the collection of respondents with treatment time that could not be estimated when a stroke occurred.

The analysis of the difference in the total score between before and after treatment in the intervention group was conducted by using the paired t-test statistical test resulting in a probability value of 0.000 (p value <0.05). It shows that there is a significant difference in the total score between before and after giving finger exoskeleton therapy in the intervention group. Meanwhile, the control group produced a probability value of 0.016 (p value <0.05), which indicates a significant difference in the total score between before and after treatment in the control group. The results of this analysis indicate that the implementation of range of motion therapy has an effect on the recovery process of arm and hand muscle strength for stroke sufferers.

Based on the results of this study, patients who experienced non-hemorrhagic stroke (NHS) based on gender were mostly men in the intervention group by 75%, while the control group had the highest number of women at 87.5%. Cumulatively, non-hemorrhagic stroke patients are almost equal between men and women. These results are in line with research conducted by (Haast, et al., 2012) which explains that the prevalence of stroke in the world was 3% in 2008, which was more common in men. However, with age, a person's risk of having a stroke increases, both for men and women. At the age under 84 years, stroke is more common in men. Meanwhile, at the age above 85 years, stroke is more common in women.

Research (Ghani, et al., 2016) gained different results, where the sample size of women is slightly more than men. However, the proportion looks the same between men and women, which is 1.2%. The results of this study are in accordance with what was conveyed (Kes, et al., 2016) that older stroke patients, especially women, had worse disability on discharge from the hospital possibly due to older age at stroke. Younger patients recover better, while older patients should seek secondary medical facilities more frequently, as might be expected. The most important in-hospital laboratory findings in young stroke patients are elevated lipid levels, while older patients have elevated serum glucose and C-reactive protein. Stroke attacks in younger patients most often present with sudden headache. Furthermore, the onset attacks were more frequent than expected. Analysis of stroke risk factors showed that women were more prone to

hypertension, chronic heart failure and atrial fibrillation, while men had carotid disease more frequently, smoked more frequently and had higher alcohol intake. Moreover, the age analysis showed that heart conditions and smoking were more common among older stroke patients. This condition is thought to be related to lifestyle and related to other risk factors, which are smoking, alcohol consumption and dyslipidemia.

The results of the paired t-test statistical test of this study indicate that the results of the study at Dr. Soedarso showed a significant condition with a value of p=0.000 between before and after finger exoskeleton therapy in the intervention group. It is in accordance with research by Unaizah (UNAIR, 2018) regarding the Finger Exoskeleton Portable (F-One) where the finger exoskeleton can help the fingers to perform basic movements according to movement patterns by utilizing an EMG sensor which can tap muscle signals. The muscle signal will be processed by an intelligent system using an Artificial Neural Network (ANN). Other research results related to this study are the results of research (McConnell, et al., 2017) which explains that there are deficiencies in hand stroke rehabilitation that can be conducted in a household environment and monitors physical and neurological progress. This exoskeleton finger uses two methods, which are active and passive. The passive method is performed by showing the client how to perform rehabilitation using a 3D screen while the active method, the patient tries to open their own hands with a predetermined time, and the BMI (Brain Machine Interface) system will provide additional energy for this movement.

Rehabilitation is important so that patients can continue to complete daily tasks (Pinter, & Brainin, 2012). As many patients have difficulty exercising their own damaged parts of the body, continuous passive motion is used in conjunction with physical therapy. Passive movements reduce muscle spasticity and activate the sensorimotor cortex in chronic stroke patients (Szameitat, et al., 2012). There are devices that use directed servomotors either directly attached to the exoskeleton joint (Taheri et al., 2014; Ueki, et al., 2012) or connected via tendons (Jones et al., 2014). However, research for the hand usually finds a number of difficulties due to mechanical characteristics which is complicated of the hand including its relatively small size, high degree of freedom and complex structure. To conduct many activities at hand, most hand rehabilitation devices have been used (Iqbal, et al., 2014). Clinical trials have shown robotic-assisted hand therapy results in improved hand motor function after chronic stroke, with increased activity of the sensorimotor cortex for trained tasks (Hwang, et al., 2012; Takahashi, et al., 2008).

Another type of rehabilitation that is commonly conducted is Range of Motion (ROM) exercises. ROM is a basic technique used to assess movement and for initial movement into a therapeutic neural intervention program. If there is movement, all the structures in the joint will be affected, which are the muscles, joint surfaces, joint capsules, fascia, blood vessels and nerves (Minagawa, et al., 2015). As soon as the medical condition stabilizes, it immediately provided passive ROM exercises to keep the joints from stiffening. Passive ROM is a joint exercise using the power of another person. Due to medical reasons, stroke patients in the acute phase will be limited in their activities. However, limiting the activity will result in the joint not moving, and the effect of not moving the joint for a certain time is joint stiffness or limited ROM. In this phase, the nurse will move the joints in the hands and feet of the stroke patient to prevent joint stiffness or limited ROM.

The design of the finger exoskeleton in this study was adjusted based on the anatomy of the human hand, the kinematic structure, and the limitations of the system design objectives. The working system design is based on finger flexion and extension

movements and is easy to operate and requires only on or turn. The off commands and finger flexion and extension data require no communication with the computer or with the patient. Meanwhile, the design/system of the tool used does not exceed 2 kg in weight. Stroke patients must be able to move their hands freely when wearing the system/device. It is hoped that with minimal design changes, the system should be suitable for a variety of hand sizes and be portable. The system needs to allow the hand to have a minimum of 15 degrees of freedom. The design of the device must be precise because the device must allow the patient to control the movement (flexion/extension) of the affected finger based on the motion of the finger that is not disturbed. The index, middle and pinky fingers have the same extension and flexion motion, and the same number of bones by the same movement mechanism (finger articulation).

The results obtained from the intervention group research with the finger exoskeleton included the first stage of the ability to do finger extension including the index finger, middle finger, ring finger and little finger. Furthermore, if the 4 fingers are open, an object such as a tennis ball is given to hold it, the fingers do not flex again. The results of measurements with ARAT (Action Research Arm Test), the highest average progress that can be achieved by stroke patients is grasping the block which is a score of 18 (total score 18), and the hardest to hold a stone. As for the point of grasping, almost all stroke patients cannot grasp with a score of 0 and after intervention, the patient can hold a medium-sized tube (2.5 cm in diameter) with a total score of 12. The ability to pinch before the intervention was obtained a score of 0 and after the intervention, the highest score for stroke patients that could be achieved was 3 (total score 18). The results of the movement (gross movement) of all stroke patients got a point value of 0 out of a total score of 9. As for the control group with the provision of Range of motion (ROM) therapy, the ARAT measurement results for holding items (grasp) obtained an average value of 18 (able to hold a 7.5 cm beam). The item holding the highest score obtained by stroke patients was 8, the pinching item got a score of 11 (able to hold a marble with the middle finger and thumb. For movement items (gross movement), the highest score was 3 (bringing the hand closer to the mouth).

The results of the study (Kim, et al., 2014) stated that after a passive ROM was performed on 37 post-acute stroke patients, they showed a significant increase in range of motion, upper limb function and daily activities compared to clients who did not undergo ROM action. Many important factors in improving limb function include knowing the degree of paralysis. The ability to speak and other abilities are an easy first step in correcting permanent paralysis. Before permanent paralysis occurs, 15 minutes of routine passive ROM exercises should be performed twice a day, five times a week for 4 weeks. After a stroke, the nerve function improves between 6-12 months. What is more important is the prediction of stroke improvement and minimizing permanence in clients (Kim et al., 2014). Clients who did not undergo ROM therapy showed edema and restriction of blood flow and spleen flow during the first 72 hours of occurrence up to 2-4 weeks.

The results of this study are also likely to be influenced by various external stimulus factors, including environmental stimulus factors such as the influence of local culture, age, gender, occupation, and the client's psychological status.

Anatomical healing through a neuroplasticity mechanism which includes collateral sprouting, which is a condition in which the normal nerve axons around the lesion will form synaptic branches with nearby degenerated nerve fibers. This collateral sprouting only occurs in axons that have the same target cells as axons that undergo degeneration (Petrina, 2014). This phenomenon is also called reactive synaptogenesis and also unmasking of the pathway, which shows the process of activating the

multisynaptic latent pathway (which is not functioning in the previous state). lesions) but can be activated when the dominant pathway fails or is damaged (Petrina, 2014). Changes in neural plasticity are different from developing synapse rules. To be precise, information storage in neural networks is triggered by activities that continually alter synaptic efficacy. Taking into account the statements mentioned above, it can be concluded that motor experience, including rehabilitation interventions, greatly influences the post-stroke recovery rate.

4. CONCLUSION

The finger exoskeleton aid intervention in simple motor rehabilitation therapy is effective in increasing the ability of the client's arm and hand muscles after a stroke in Public Hospital of Dr. Soedarso Pontianak. It is recommended to make another finger rehabilitation tool with a more optimal design according to the parameters, which is the severity of the post-stroke client, subject kinematics, control of movement torque and adaptation between the subject and the robotic device used.

REFERENCES

Agarwal, P., Fox, J., Yun, Y., O'Malley, M. K., & Deshpande, A. D. (2015). An index finger exoskeleton with series elastic actuation for rehabilitation: Design, control and performance characterization. *The International Journal of Robotics Research*, *34*(14), 1747-1772. doi: https://doi.org/10.1177/0278364915598388

Cafolla, D., & Carbone, G. (2014). A study of feasibility of a human finger exoskeleton. In *Service Orientation in Holonic and Multi-Agent Manufacturing and Robotics* (pp. 355-364). Springer, Cham.

Carrera, E., & Tononi, G. (2014). Diaschisis: past, present, future. *Brain*, *137*(9), 2408-2422. doi: https://doi.org/10.1093/brain/awu101

Feigin, V., Norrving, B., & Mensah, G. (2017). Global Burden of Stroke. *Circulation Research*, *120*, 439–448. doi: https://doi.org/10.1161/CIRCRESAHA.116.308413

Ghani, L., Mihardja, L., & Delima, D. (2016). Faktor Risiko Dominan Penderita Stroke di Indonesia. Buletin Penelitian Kesehatan, 44(1), 49-58. doi: https://10.22435/bpk.v44i1.4949.49-58

Haast, R. A., Gustafson, D. R., & Kiliaan, A. J. (2012). Sex differences in stroke. *Journal of Cerebral Blood Flow & Metabolism*, *32*(12), 2100-2107. doi: https://doi.org/10.1038/jcbfm.2012.141

Hwang, C. H., Seong, J. W., & Son, D.-S. (2012). Individual finger synchronized robot-assisted hand rehabilitation in subacute to chronic stroke: a prospective randomized clinical trial of efficacy. *Clinical Rehabilitation*, *26*(8), 696–704. doi: https://doi.org/10.1177/0269215511431473

Iqbal, J., Khan, H., Tsagarakis, N. G., & Caldwell, D. G. (2014). A novel exoskeleton robotic system for hand rehabilitation–conceptualization to prototyping. *Biocybernetics and biomedical engineering*, *34*(2), 79-89. doi: https://doi.org/10.1016/j.bbe.2014.01.003

Jones, C. L., Wang, F., Morrison, R., Sarkar, N., & Kamper, D. G. (2014). Design and development of the cable actuated finger exoskeleton for hand rehabilitation following stroke. *IEEE/ASME Transactions on Mechatronics*, *19*(1), 131–140. doi: https://doi.org/10.1109/TMECH.2012.2224359

Kato, H., & Izumiyama, M. (2010). *Restorative and Compensatory Changes in the Brain During Early Motor Recovery from Hemiparetic Stroke: a Functional MRI Study*. doi: https://doi.org/10.5772/9884

Kes, V., Jurasic, M.-J., Zavoreo, I., Lisak, M., Jelec, V., & Matovina, L. (2016). Age and Gender Differences in Acute Stroke Hospital Patients. *Acta Clinica Croatica*, *55(1)*, 69–77. doi: https://doi.org/10.20471/acc.2016.55.01.11

Kim, B. J., Kang, H. G., Kim, H.-J., Ahn, S.-H., Kim, N. Y., Warach, S., & Kang, D.-W. (2014). Magnetic Resonance Imaging in Acute Ischemic Stroke Treatment. *Journal of Stroke*. 16(3): 131-145. doi: https://doi.org/10.5853/jos.2014.16.3.131

Lesmana, S. I. (2014). Hubungan Antara Karakteristik Atlet Dengan Masa Pemulihan Setelah Cidera Olahraga. *Fisioterapi: Jurnal Ilmiah Fisioterapi.* 15(1), 45-51.

McConnell, A. C., Vallejo, M., Moioli, R. C., Brasil, F. L., Secciani, N., Nemitz, M. P., ... & Stokes, A. A. (2017). SOPHIA: soft orthotic physiotherapy hand interactive aid. *Frontiers in Mechanical Engineering*. doi: https://doi.org/10.3389/fmech.2017.00003

Minagawa, T., Tamura, A., Ichihara, T., Hisaka, Y., & Nagahiro, S. (2015). Increasing upper-limb joint range of motion in post-stroke hemiplegic patients by daily hair-brushing. *British Journal of Neuroscience Nursing*, *11*(3), 112-117. doi: https://doi.org/10.12968/bjnn.2015.11.3.112

Mohan, U. (2013). Effectiveness of mirror therapy on lower extremity motor recovery, balance and mobility in patients with acute stroke: a randomized sham-controlled pilot trial. *Annals of Indian Academy of Neurology*, *16*(4), 634-639. doi: https://doi.org/10.4103/0972-2327.120496

Petrina, A. B. (2014). Motor Recovery in Stroke. *Medscape*.

Pinter, M. M., & Brainin, M. (2012). Rehabilitation after stroke in older people. *Maturitas*, *71*(2), 104-108. doi: https://doi.org/10.1016/j.maturitas.2011.11.011

Public Hospital of Dr. Soedarso. (2018). *Medical Record*. Pontianak: Public Hospital of Dr. Soedarso.

Rippun, F., Sudiyono, N., & Liang, D. E. (2016). Desain Alat Bantu Rehabilitasi Motorik Sederhana (ABRAMS). *Jurnal Elektro Unika Atma Jaya*, *9*(1), 45-54.

Szameitat, A. J., Shen, S., Conforto, A., & Sterr, A. (2012). Cortical activation during executed, imagined, observed, and passive wrist movements in healthy volunteers and stroke patients. *Neuroimage*, *62*(1), 266-280. doi: https://doi.org/10.1016/j.neuroimage.2012.05.009

Taheri, H., Rowe, J. B., Gardner, D., Chan, V., Gray, K., Bower, C., ... & Wolbrecht, E. T. (2014). Design and preliminary evaluation of the FINGER rehabilitation robot: controlling challenge and quantifying finger individuation during musical computer game play. *Journal of neuroengineering and rehabilitation*, *11*(1), 10. doi: https://doi.org/10.1186/1743-0003-11-10

Takahashi, C. D., Der-Yeghiaian, L., Le, V., Motiwala, R. R., & Cramer, S. C. (2008). Robot-based hand motor therapy after stroke. *Brain*, *131*(2), 425-437. doi: https://doi.org/10.1093/brain/awm311

Takeuchi, N., & Izumi, S. I. (2013). Rehabilitation with Poststroke Motor Recovery: a Review With a Focus on Neural Plasticity. *Stroke Research and Treatment*. doi: https://doi.org/10.1155/2013/128641

Ueki, S., Kawasaki, H., Ito, S., Nishimoto, Y., Abe, M., Aoki, T., ... & Mouri, T. (2010). Development of a hand-assist robot with multi-degrees-of-freedom for rehabilitation therapy. *IEEE/ASME Transactions on mechatronics*, *17*(1), 136-146. doi: https://doi.org/10.1109/TMECH.2010.2090353

UNAIR. (2018). *Mahasiswa UNAIR Menciptakan Inovasi Alat Rehabilitasi Paska Stroke*. UNAIR NEWS. Retrieved from : http://news.unair.ac.id/2018/07/19/mahasiswa-unair-menciptakan-inovasi-alat-

rehabilitasi-paska-stroke/

Utomo, B., Triwiyanto, Suhartini, Luthfiyah, S., & Mudjiono, U. (2018). Impact of robotic exoskeleton based on electromyography for rehabilitation of post stroke patient. *AIP Conference Proceedings*. AIP Publishing LLC. doi: https://doi.org/10.1063/1.5054509

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RESEARCH **Open Access**

Finger Exoskeleton in Simple Motor Rehabilitation Therapy on Arm and Hand Muscle Ability of Post-Stroke Sufferers

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Abstract

Post-stroke sufferers will generally experience weakness on one side of the body, balance, vision, sensory, motor, and cognitive. In West Kalimantan, the estimated stroke sufferer in 2013 was 25,195 people. Based on data from the Public Hospital of Dr. Soedarso Pontianak shows a significant increase from January 2018 to December 2018 totaling 722 people. The research objective was to assess the effectiveness of the finger exoskeleton tool in simple motor therapy on the ability of the client's arm and hand muscles after a stroke. This study used a quantitative approach with a quasi-experimental design. Pre-test and Post-test Nonequivalent Control Group with two groups, which were the control group of 12 people and the intervention group of 12 people with finger exoskeleton tools. The statistical test used was the independent t test and paired t test. Measurement of muscle ability with the Action Research Arm Test. Analysis of the difference in total scores between before and after treatment in the intervention group using Paired T-Test obtained a p-value of 0.000 (p value <0.05) and in the control group using the Wilcoxon test a p-value of 0.016 (p value <0.05). It shows that there is a significant difference in the total score between before and after finger exoskeleton therapy and range of motion. Intervention of finger exoskeleton assistive devices in simple motor rehabilitation therapy is effective in increasing the ability of the client's arm and hand muscles after stroke. It is recommended to make another finger rehabilitation tool with a more optimal design according to the parameters, which are the severity of the client after stroke, subject kinematics, control of movement torque and adaptation between the subject and the robotic device used.

Keywords: Finger Exoskeleton, Muscle Ability, Post Stroke, Motor Rehabilitation.

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1. INTRODUCTION

In the world, stroke is a deadly disease after heart disease and cancer. WHO estimates that the number of stroke patients in several European countries will increase from 1.1 billion per year in 2000 to 1.5 billion per year in 2025. In Indonesia, according to data released by the Post-stroke Foundation Indonesia, it shows a trend that is continues to increase from year to year (Utomo, et al., 2018). Cerebrovascular disease is the second leading cause of death and the third most common cause of disability in the world (Feigin et al., 2017).

In West Kalimantan, the estimated stroke sufferer in 2013 was 25,195 people. Data from hospitals in Pontianak City specifically for Public Hospital of Dr. Soedarso shows an increase from January to December 2018 totaling 722 people (Public Hospital of Dr. Soedarso, 2018). The impact of stroke on sufferers, among others, can damage the body, movement and speech ability, influenced by the damaged part of the brain. The special impact of hemiparesis is loss of body control in part. This ability will usually weaken daily activities (Mohan, et al., 2013). If there is movement, all the structures in the joint will be affected, which are the muscles, joint surfaces, joint capsules, fascia, blood vessels, and nerves (Minagawa, et al., 2015).

The main protocol for rehabilitation of post-stroke patients is based on learning movements which cause dendrite growth, new synapses, and good changes (Takeuchi & Izumi, 2013). The occurrence of motor defects in the upper and lower limbs after a stroke and damage to the motor cortex is common. Hemiparesis, paralysis, weakness, abnormal muscle tone, spasm, abnormal posture, abnormal synergistic muscle function, and loss of inter-joint coordination are the most common injuries resulting from damage to the motor cortex due to stroke (Kato & Izumiyama, 2010). Eighty percent of patients who experience acute upper limb paresis after stroke, only a third achieve restoration of normal limb function back to normal (Carrera & Tononi, 2014)

Rehabilitation is a form of integrated therapy services which includes medical, psychosocial, educational, vocational approaches involving doctors, neurologists, medical rehabilitation doctors, nurses, physiotherapists, occupational therapy, medical social workers, psychologists and clients as well as family roles to achieve most functional abilities and prevent repeated stroke attacks (Utomo et al., 2018). Hand rehabilitation is essential for the restoration of independence in the activities of daily life for individuals who exhibit disability in the upper extremities. There is preliminary evidence that robotic devices with a force control-based strategy can assist in the effective rehabilitation of human limbs (Agarwal et al., 2015). Finger damage after stroke causes significant deficits in hand manipulation and daily task performance. Recent advances in rehabilitation robotics have demonstrated the increasing efficacy of rehabilitation. However, devices currently created do not have the capacity to accurately interact with the human finger at a level of speed and torque comparable to the performance of everyday hand manipulation tasks (Cafolla & Carbone, 2014).

Several recovery/rehabilitation therapies for stroke clients include ROM, Core Stability exercise, and CIMT (Constraint-Induced Movement Training) and robotic Arm (Exoskeleton active/passive) training has been used in physical therapy. However, the use of existing robotic-based therapies requires large funds, self-rehabilitation centers, specific operators, and difficult treatment for sensitive components (Rippun, et al., 2016).

The exoskeleton is a tool for physical therapy exercises which are generally used to help relieve a person's movement, especially in the world of construction, but exoskeleton is also used for medical purposes. Physical therapy exercises that are routinely conducted by stroke sufferers have successfully shown positive results in the

form of increased lower limb ability, functional mobility (balance and walking) and quality of life.

Starting from the above problems, the researchers took the initiative to create a simple tool that can be used to measure the client's gripping ability and help recover it. This simple tool is a prototype tool that has never been made before, so it is expected to be a new breakthrough in helping post stroke clients. A simple tool made with gloves using a battery or recharging the charger. In this study, the researchers took non-hemorrhagic stroke study material because it was possible for this patient to be given training with a finger exoskeleton in simple motor rehabilitation therapy using automatic gloves. It is hoped that in the future, the number of stroke sufferers will be increasing day by day, without knowing the socioeconomic status of the affected person will be able to improve the quality of life better with appropriate rehabilitation therapy and better than traditional therapy with the aim of improving movement function or maximum activity starting with hand movements. The method used in this study can easily be administered regularly in stroke patients by clients and families and it is easy to assess the progress of post-stroke patient health. The objective of this study was to determine the effectiveness of finger exoskeleton tools in simple motor rehabilitation therapy on the ability of arm and hand muscle function of post-stroke sufferers.

2. RESEARCH METHOD

The research method used in this research is a quasi-experimental with the pre-test approach and the post-test Nonequivalent Control Group approach. This research was conducted at the Public Hospital of Dr. Soedarso Pontianak from May to the end of October 2019. This research has received ethical approval from the ethics commission of the Health Polytechnic of the Ministry of Health Pontianak number: 186/KEPK-PK.PKP/V/2019. The population in a month of stroke sufferers is 60 people. Sampling is calculated based on the formula for estimating the sample size of the hypothesis test on the mean of two independent populations. The inclusion criteria in this study were patients diagnosed with non-hemorrhagic or hemorrhagic strokes who had physical disabilities in the upper extremities, while the exclusion criteria in this study were patients with severe stroke who experienced cognitive impairment. The sample size was 16 people divided into 2 groups, which were 8 people in the intervention group and 8 people in the control group.

The instrument used in this study was to measure the client's gripping ability after a stroke. Measurement/test of arm and hand function or measurement of grip function using the Action Research Arm Test instrument. This instrument consists of sub tests: a. Hold (grasp) with the highest score of 18 and each test is worth 3, b: Holds with the highest score of 12, with each test worth 3, c. Pinch with the highest score of 18 and each test is worth 3 d. Movement (Gross Movement) with the highest score of 9, with each test worth 3. The range of scores is 0-57 (Lesmana, 2014).

The univariate analysis in this study were variables of age, gender and variables of the arm and hand muscles of post-stroke patients. Nominal scale variable data (gender) is presented in the form of a percentage and the numerical scale variables (age) are presented in the form of mean and standard deviation. This univariate test was also conducted to determine the equality of age and sex characteristics of respondents between groups using the chi-square test. the equivalence test was administered to see the homogeneity of the two groups based on the characteristics of age and sex. The bivariate analysis in this study was the difference in the Action Research Arm Test scores between before and after exoskeletal finger intervention in the intervention and

control groups. The statistical test used in this study was the independent t-test which was used to analyze the difference in scores before the intervention between the two groups and the difference in scores after the intervention between the two groups (unpaired), while to test the difference in scores before and after the intervention was conducted. In both groups (paired data), the Paired t-test was used.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of respondents based on gender and age at the Public Hospital of Dr. Soedarso Pontianak in 2019 (n = 16)

Characteristic	Respondent based on genders				*p-value*
	Intervention group		Control group		
	F	%	F	%	
Gender					
Male	6	75	1	12,5	0.041
Female	2	25	7	87,5	
Age (Year)					
40-50	4	50	0	0	0,077
51-65	4	50	8	100	

** Chi-Square Test*

Table 1 shows the characteristics of the respondents based on gender and age mostly were men in the intervention group at 75% while the control group was mostly women at 87%. The results of the equivalence test obtained a p-value of 0.041, which means that there is no significant gender difference between the control and intervention groups. Meanwhile, based on age, the age group was dominated by 51-65 years old in the intervention and control group with the highest percentage in the control group, which is (100%).

Table 2. The ability of the arm and hand muscles of stroke patients at the Public Hospital of Dr. Soedarso Pontianak in 2019 (n= 16)

No	Indicator	Min		Max		Mean		SD	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
1.	Holding	3	3	18	18	10,50	13,13	4,423	3,442
2.	Grasping	0	0	6	8	0,94	2,94	2,112	2,542
3.	Pinching	0	0	9	11	0,75	1,63	2,324	2,872
4.	Movement	0	0	9	12	0,94	1,31	2,620	3,281

Table 2 shows that the average holding ability has increased by 2.63, the grasping ability has increased by 0.88 and the hand movement has increased by 0.37.

Table 3. An overview of muscle ability scores before and after the intervention in the two groups (n=16)

Measurement	Mean	SD	Median (Min-Max)	*p-value**	Note
Pretest Intervention	12,00	4,24	12,00 (6,00-18,00)	0,273	Normal
Pretest Control	13,87	11,77	9,00 (6,00-39.00)	0,006	Not Normal
Posttest Intervention	16,87	4,22	16,50 (12,00-24,00)	0,557	Normal

Posttest Control	21,12	13,22	18,00 (6,00-49,00)	0.173	Normal

**Data Normality Test Using Saphiro-Wilk Test*

Based on table 3, it can be seen an overview of the muscle ability scores before and after being given to the two groups where the intervention group was given finger exoskeleton therapy and the control group was given Range of Motion therapy. In the intervention group, before being given treatment, the average value was 12.00 with SD 4.24 after being given the treatment, the average value was 16.87 with SD 4.22. In the control group, before being given the treatment, the average value was 13.87 with SD 11.77 and after being given treatment, the average value was 21.12 with SD 13.22.

Table 4. Analysis of Differences in Muscle Ability before and after treatment in the two groups (n=16)

Muscle ability	**Pretest**			**Post-test**			***p-value***
	Mean	**SD**	**CI 95%**	**Mean**	**SD**	**CI 95%**	
Group							
Intervention	12,00	4,24	8,45-15,54	16,87	4,22	17.32 -23.07	0.000
Control	13,87	11,77	4,02-23,72	21,12	13,22	10,06-32,18	0.016

Information:
1. Difference between pretest and posttest in the intervention group using Paired T-Test (0.000)
2. Difference between pretest and posttest in the control group using the Wilcoxon Test (0.016)

Table 4 shows the differences in muscle ability before and after treatment in the two groups. From statistical calculations to compare the pretest and posttest in the intervention group using Paired T-test, the p-value is 0.000, which means that the value is smaller than the significance value set by the researcher, which is 0.05 (p-value <0.05), so it can be concluded that there is differences in muscle ability in patients before and after being given finger exoskeleton therapy treatment.

Statistical calculations to compare the pretest and posttest in the control group using the Wilcoxon test obtained a p-value of 0.016, which means that this value is smaller than the significance value set by the researcher, which is 0.05 (p-value <0.05) so it can be concluded that there are differences in muscle ability. in patients before and after given range of motion therapy treatment.

Table 5. The Difference Difference in Increasing Muscle Ability Score Before and After being given treatment (n=16)

Measurement	**Mean Difference**	**Median**	**SD**	**Std Error**	**Shapiro-Wilk**	**Nilai p**
Intervention	4,87	6,00	1,55	0,548	0,000 (Normal)	0.161*
Control	7,25	6,00	4,30	1,520	0,367 (Not Normal)	

* Mann-Whitney Test, (p-value>0.05)

Based on table 5 above, it can be seen the difference in the difference in muscle ability scores using the Mann-Whitney test. The results of statistical calculations obtained p-value 0.161, which means that this value is greater than the significance value set by the researcher, which is 0.05 (p-value>0.05). It shows that there is no significant difference between the two groups' muscle ability scores, so it can be concluded that finger exoskeleton therapy and range of motion have a positive effect on increasing the ability of the hand and arm muscles.

The statistical test results of the difference between the total pre and post test scores in the control group obtained p value = 0.016 where p<α, so it can be concluded that there is a difference between the total pre and post scores in the control group Range of Motion (ROM), and after treatment in the intervention group which was conducted by statistical test paired t-test resulted in a probability value of 0.000 (p value <0.05). Meanwhile, the control group produced a probability value of 0.016 (p value <0.05). The results of this analysis indicate that both finger exoskeleton therapy and range of motion therapy have a significant effect on the process of strengthening the hand and arm muscles of stroke sufferers. These results indicate finger exoskeleton therapy is a fairly good therapy in increasing the strength of the arm and hand muscles of post-stroke sufferers. The statistical test using Mann Whitney showed that there was no significant difference in the total score difference between before and after treatment between groups which had a probability value of 0.161 (p value <0.05). The statistical test using the independent t-test resulted in a probability value of 0.401 (p value> 0.05), which indicates that there was no significant difference in the total score after treatment between the two groups. It is influenced by the inequality of the total score before treatment between the two groups which has a probability value of 0.000 (p value> 0.05). It is due to the short research time so that the researcher had difficulty getting respondents according to the inclusion criteria and the number was limited and the collection of respondents with treatment time that could not be estimated when a stroke occurred.

The analysis of the difference in the total score between before and after treatment in the intervention group was conducted by using the paired t-test statistical test resulting in a probability value of 0.000 (p value <0.05). It shows that there is a significant difference in the total score between before and after giving finger exoskeleton therapy in the intervention group. Meanwhile, the control group produced a probability value of 0.016 (p value <0.05), which indicates a significant difference in the total score between before and after treatment in the control group. The results of this analysis indicate that the implementation of range of motion therapy has an effect on the recovery process of arm and hand muscle strength for stroke sufferers.

Based on the results of this study, patients who experienced non-hemorrhagic stroke (NHS) based on gender were mostly men in the intervention group by 75%, while the control group had the highest number of women at 87.5%. Cumulatively, non-hemorrhagic stroke patients are almost equal between men and women. These results are in line with research conducted by (Haast, et al., 2012) which explains that the prevalence of stroke in the world was 3% in 2008, which was more common in men. However, with age, a person's risk of having a stroke increases, both for men and women. At the age under 84 years, stroke is more common in men. Meanwhile, at the age above 85 years, stroke is more common in women.

Research (Ghani, et al., 2016) gained different results, where the sample size of women is slightly more than men. However, the proportion looks the same between men and women, which is 1.2%. The results of this study are in accordance with what was conveyed (Kes, et al., 2016) that older stroke patients, especially women, had worse disability on discharge from the hospital possibly due to older age at stroke. Younger patients recover better, while older patients should seek secondary medical facilities more frequently, as might be expected. The most important in-hospital laboratory findings in young stroke patients are elevated lipid levels, while older patients have elevated serum glucose and C-reactive protein. Stroke attacks in younger patients most often present with sudden headache. Furthermore, the onset attacks were more frequent than expected. Analysis of stroke risk factors showed that women were more prone to

hypertension, chronic heart failure and atrial fibrillation, while men had carotid disease more frequently, smoked more frequently and had higher alcohol intake. Moreover, the age analysis showed that heart conditions and smoking were more common among older stroke patients. This condition is thought to be related to lifestyle and related to other risk factors, which are smoking, alcohol consumption and dyslipidemia.

The results of the paired t-test statistical test of this study indicate that the results of the study at Dr. Soedarso showed a significant condition with a value of p=0.000 between before and after finger exoskeleton therapy in the intervention group. It is in accordance with research by Unaizah (UNAIR, 2018) regarding the Finger Exoskeleton Portable (F-One) where the finger exoskeleton can help the fingers to perform basic movements according to movement patterns by utilizing an EMG sensor which can tap muscle signals. The muscle signal will be processed by an intelligent system using an Artificial Neural Network (ANN). Other research results related to this study are the results of research (McConnell, et al., 2017) which explains that there are deficiencies in hand stroke rehabilitation that can be conducted in a household environment and monitors physical and neurological progress. This exoskeleton finger uses two methods, which are active and passive. The passive method is performed by showing the client how to perform rehabilitation using a 3D screen while the active method, the patient tries to open their own hands with a predetermined time, and the BMI (Brain Machine Interface) system will provide additional energy for this movement.

Rehabilitation is important so that patients can continue to complete daily tasks (Pinter, & Brainin, 2012). As many patients have difficulty exercising their own damaged parts of the body, continuous passive motion is used in conjunction with physical therapy. Passive movements reduce muscle spasticity and activate the sensorimotor cortex in chronic stroke patients (Szameitat, et al., 2012). There are devices that use directed servomotors either directly attached to the exoskeleton joint (Taheri et al., 2014; Ueki, et al., 2012) or connected via tendons (Jones et al., 2014). However, research for the hand usually finds a number of difficulties due to mechanical characteristics which is complicated of the hand including its relatively small size, high degree of freedom and complex structure. To conduct many activities at hand, most hand rehabilitation devices have been used (Iqbal, et al., 2014). Clinical trials have shown robotic-assisted hand therapy results in improved hand motor function after chronic stroke, with increased activity of the sensorimotor cortex for trained tasks (Hwang, et al., 2012; Takahashi, et al., 2008).

Another type of rehabilitation that is commonly conducted is Range of Motion (ROM) exercises. ROM is a basic technique used to assess movement and for initial movement into a therapeutic neural intervention program. If there is movement, all the structures in the joint will be affected, which are the muscles, joint surfaces, joint capsules, fascia, blood vessels and nerves (Minagawa, et al., 2015). As soon as the medical condition stabilizes, it immediately provided passive ROM exercises to keep the joints from stiffening. Passive ROM is a joint exercise using the power of another person. Due to medical reasons, stroke patients in the acute phase will be limited in their activities. However, limiting the activity will result in the joint not moving, and the effect of not moving the joint for a certain time is joint stiffness or limited ROM. In this phase, the nurse will move the joints in the hands and feet of the stroke patient to prevent joint stiffness or limited ROM.

The design of the finger exoskeleton in this study was adjusted based on the anatomy of the human hand, the kinematic structure, and the limitations of the system design objectives. The working system design is based on finger flexion and extension

movements and is easy to operate and requires only on or turn. The off commands and finger flexion and extension data require no communication with the computer or with the patient. Meanwhile, the design/system of the tool used does not exceed 2 kg in weight. Stroke patients must be able to move their hands freely when wearing the system/device. It is hoped that with minimal design changes, the system should be suitable for a variety of hand sizes and be portable. The system needs to allow the hand to have a minimum of 15 degrees of freedom. The design of the device must be precise because the device must allow the patient to control the movement (flexion/extension) of the affected finger based on the motion of the finger that is not disturbed. The index, middle and pinky fingers have the same extension and flexion motion, and the same number of bones by the same movement mechanism (finger articulation).

The results obtained from the intervention group research with the finger exoskeleton included the first stage of the ability to do finger extension including the index finger, middle finger, ring finger and little finger. Furthermore, if the 4 fingers are open, an object such as a tennis ball is given to hold it, the fingers do not flex again. The results of measurements with ARAT (Action Research Arm Test), the highest average progress that can be achieved by stroke patients is grasping the block which is a score of 18 (total score 18), and the hardest to hold a stone. As for the point of grasping, almost all stroke patients cannot grasp with a score of 0 and after intervention, the patient can hold a medium-sized tube (2.5 cm in diameter) with a total score of 12. The ability to pinch before the intervention was obtained a score of 0 and after the intervention, the highest score for stroke patients that could be achieved was 3 (total score 18). The results of the movement (gross movement) of all stroke patients got a point value of 0 out of a total score of 9. As for the control group with the provision of Range of motion (ROM) therapy, the ARAT measurement results for holding items (grasp) obtained an average value of 18 (able to hold a 7.5 cm beam). The item holding the highest score obtained by stroke patients was 8, the pinching item got a score of 11 (able to hold a marble with the middle finger and thumb. For movement items (gross movement), the highest score was 3 (bringing the hand closer to the mouth).

The results of the study (Kim, et al., 2014) stated that after a passive ROM was performed on 37 post-acute stroke patients, they showed a significant increase in range of motion, upper limb function and daily activities compared to clients who did not undergo ROM action. Many important factors in improving limb function include knowing the degree of paralysis. The ability to speak and other abilities are an easy first step in correcting permanent paralysis. Before permanent paralysis occurs, 15 minutes of routine passive ROM exercises should be performed twice a day, five times a week for 4 weeks. After a stroke, the nerve function improves between 6-12 months. What is more important is the prediction of stroke improvement and minimizing permanence in clients (Kim et al., 2014). Clients who did not undergo ROM therapy showed edema and restriction of blood flow and spleen flow during the first 72 hours of occurrence up to 2-4 weeks.

The results of this study are also likely to be influenced by various external stimulus factors, including environmental stimulus factors such as the influence of local culture, age, gender, occupation, and the client's psychological status.

Anatomical healing through a neuroplasticity mechanism which includes collateral sprouting, which is a condition in which the normal nerve axons around the lesion will form synaptic branches with nearby degenerated nerve fibers. This collateral sprouting only occurs in axons that have the same target cells as axons that undergo degeneration (Petrina, 2014). This phenomenon is also called reactive synaptogenesis and also unmasking of the pathway, which shows the process of activating the

multisynaptic latent pathway (which is not functioning in the previous state). lesions) but can be activated when the dominant pathway fails or is damaged (Petrina, 2014). Changes in neural plasticity are different from developing synapse rules. To be precise, information storage in neural networks is triggered by activities that continually alter synaptic efficacy. Taking into account the statements mentioned above, it can be concluded that motor experience, including rehabilitation interventions, greatly influences the post-stroke recovery rate.

4. CONCLUSION

The finger exoskeleton aid intervention in simple motor rehabilitation therapy is effective in increasing the ability of the client's arm and hand muscles after a stroke in Public Hospital of Dr. Soedarso Pontianak. It is recommended to make another finger rehabilitation tool with a more optimal design according to the parameters, which is the severity of the post-stroke client, subject kinematics, control of movement torque and adaptation between the subject and the robotic device used.

REFERENCES

Agarwal, P., Fox, J., Yun, Y., O'Malley, M. K., & Deshpande, A. D. (2015). An index finger exoskeleton with series elastic actuation for rehabilitation: Design, control and performance characterization. *The International Journal of Robotics Research*, *34*(14), 1747-1772. doi: https://doi.org/10.1177/0278364915598388

Cafolla, D., & Carbone, G. (2014). A study of feasibility of a human finger exoskeleton. In *Service Orientation in Holonic and Multi-Agent Manufacturing and Robotics* (pp. 355-364). Springer, Cham.

Carrera, E., & Tononi, G. (2014). Diaschisis: past, present, future. *Brain*, *137*(9), 2408-2422. doi: https://doi.org/10.1093/brain/awu101

Feigin, V., Norrving, B., & Mensah, G. (2017). Global Burden of Stroke. *Circulation Research*, *120*, 439–448. doi: https://doi.org/10.1161/CIRCRESAHA.116.308413

Ghani, L., Mihardja, L., & Delima, D. (2016). Faktor Risiko Dominan Penderita Stroke di Indonesia. Buletin Penelitian Kesehatan, 44(1), 49-58. doi: https://10.22435/bpk.v44i1.4949.49-58

Haast, R. A., Gustafson, D. R., & Kiliaan, A. J. (2012). Sex differences in stroke. *Journal of Cerebral Blood Flow & Metabolism*, *32*(12), 2100-2107. doi: https://doi.org/10.1038/jcbfm.2012.141

Hwang, C. H., Seong, J. W., & Son, D.-S. (2012). Individual finger synchronized robot-assisted hand rehabilitation in subacute to chronic stroke: a prospective randomized clinical trial of efficacy. *Clinical Rehabilitation*, *26*(8), 696–704. doi: https://doi.org/10.1177/0269215511431473

Iqbal, J., Khan, H., Tsagarakis, N. G., & Caldwell, D. G. (2014). A novel exoskeleton robotic system for hand rehabilitation–conceptualization to prototyping. *Biocybernetics and biomedical engineering*, *34*(2), 79-89. doi: https://doi.org/10.1016/j.bbe.2014.01.003

Jones, C. L., Wang, F., Morrison, R., Sarkar, N., & Kamper, D. G. (2014). Design and development of the cable actuated finger exoskeleton for hand rehabilitation following stroke. *IEEE/ASME Transactions on Mechatronics*, *19*(1), 131–140. doi: https://doi.org/10.1109/TMECH.2012.2224359

Kato, H., & Izumiyama, M. (2010). *Restorative and Compensatory Changes in the Brain During Early Motor Recovery from Hemiparetic Stroke: a Functional MRI Study*. doi: https://doi.org/10.5772/9884

Kes, V., Jurasic, M.-J., Zavoreo, I., Lisak, M., Jelec, V., & Matovina, L. (2016). Age and Gender Differences in Acute Stroke Hospital Patients. *Acta Clinica Croatica*, *55(1)*, 69–77. doi: https://doi.org/10.20471/acc.2016.55.01.11

Kim, B. J., Kang, H. G., Kim, H.-J., Ahn, S.-H., Kim, N. Y., Warach, S., & Kang, D.-W. (2014). Magnetic Resonance Imaging in Acute Ischemic Stroke Treatment. *Journal of Stroke*. 16(3): 131-145. doi: https://doi.org/10.5853/jos.2014.16.3.131

Lesmana, S. I. (2014). Hubungan Antara Karakteristik Atlet Dengan Masa Pemulihan Setelah Cidera Olahraga. *Fisioterapi: Jurnal Ilmiah Fisioterapi.* 15(1), 45-51.

McConnell, A. C., Vallejo, M., Moioli, R. C., Brasil, F. L., Secciani, N., Nemitz, M. P., ... & Stokes, A. A. (2017). SOPHIA: soft orthotic physiotherapy hand interactive aid. *Frontiers in Mechanical Engineering*. doi: https://doi.org/10.3389/fmech.2017.00003

Minagawa, T., Tamura, A., Ichihara, T., Hisaka, Y., & Nagahiro, S. (2015). Increasing upper-limb joint range of motion in post-stroke hemiplegic patients by daily hair-brushing. *British Journal of Neuroscience Nursing*, *11*(3), 112-117. doi: https://doi.org/10.12968/bjnn.2015.11.3.112

Mohan, U. (2013). Effectiveness of mirror therapy on lower extremity motor recovery, balance and mobility in patients with acute stroke: a randomized sham-controlled pilot trial. *Annals of Indian Academy of Neurology*, *16*(4), 634-639. doi: https://doi.org/10.4103/0972-2327.120496

Petrina, A. B. (2014). Motor Recovery in Stroke. *Medscape*.

Pinter, M. M., & Brainin, M. (2012). Rehabilitation after stroke in older people. *Maturitas*, *71*(2), 104-108. doi: https://doi.org/10.1016/j.maturitas.2011.11.011

Public Hospital of Dr. Soedarso. (2018). *Medical Record*. Pontianak: Public Hospital of Dr. Soedarso.

Rippun, F., Sudiyono, N., & Liang, D. E. (2016). Desain Alat Bantu Rehabilitasi Motorik Sederhana (ABRAMS). *Jurnal Elektro Unika Atma Jaya*, *9*(1), 45-54.

Szameitat, A. J., Shen, S., Conforto, A., & Sterr, A. (2012). Cortical activation during executed, imagined, observed, and passive wrist movements in healthy volunteers and stroke patients. *Neuroimage*, *62*(1), 266-280. doi: https://doi.org/10.1016/j.neuroimage.2012.05.009

Taheri, H., Rowe, J. B., Gardner, D., Chan, V., Gray, K., Bower, C., ... & Wolbrecht, E. T. (2014). Design and preliminary evaluation of the FINGER rehabilitation robot: controlling challenge and quantifying finger individuation during musical computer game play. *Journal of neuroengineering and rehabilitation*, *11*(1), 10. doi: https://doi.org/10.1186/1743-0003-11-10

Takahashi, C. D., Der-Yeghiaian, L., Le, V., Motiwala, R. R., & Cramer, S. C. (2008). Robot-based hand motor therapy after stroke. *Brain*, *131*(2), 425-437. doi: https://doi.org/10.1093/brain/awm311

Takeuchi, N., & Izumi, S. I. (2013). Rehabilitation with Poststroke Motor Recovery: a Review With a Focus on Neural Plasticity. *Stroke Research and Treatment*. doi: https://doi.org/10.1155/2013/128641

Ueki, S., Kawasaki, H., Ito, S., Nishimoto, Y., Abe, M., Aoki, T., ... & Mouri, T. (2010). Development of a hand-assist robot with multi-degrees-of-freedom for rehabilitation therapy. *IEEE/ASME Transactions on mechatronics*, *17*(1), 136-146. doi: https://doi.org/10.1109/TMECH.2010.2090353

UNAIR. (2018). *Mahasiswa UNAIR Menciptakan Inovasi Alat Rehabilitasi Paska Stroke*. UNAIR NEWS. Retrieved from : http://news.unair.ac.id/2018/07/19/mahasiswa-unair-menciptakan-inovasi-alat-

rehabilitasi-paska-stroke/

Utomo, B., Triwiyanto, Suhartini, Luthfiyah, S., & Mudjiono, U. (2018). Impact of robotic exoskeleton based on electromyography for rehabilitation of post stroke patient. *AIP Conference Proceedings*. AIP Publishing LLC. doi: https://doi.org/10.1063/1.5054509

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RESEARCH **Open Access**

Medication Error at the Prescribing Phase

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Abstract
Medication errors are accidental failures in a therapeutic process that lead to and have the potential to cause or harm the patient. Medication errors can endanger patient safety, inconvenience and economic burdens. Medication errors can occur at the prescribing, recording, issuing, and administering stages. Reducing the risk of medication errors is a shared responsibility among patients, healthcare professionals, regulators and the pharmaceutical industry at all levels of healthcare delivery. This research is a quantitative research with a descriptive approach. The population taken was 912 prescriptions written by general practitioners at the PKU Muhammadiyah Cepu Hospital in March-May 2019. The sampling technique used was non-probability sampling, which was total sampling. The instrument used in this study was an observation sheet, then the collected data were processed by editing, coding, scoring, and tabulating stages which were then concluded descriptively. The results showed that the incidence of drug prescribing errors in inpatients at PKU Muhammadiyah Cepu Hospital in March 2019 found that all written prescriptions were 100% administratively incomplete. The incidence of prescription medication errors, especially the doctor's name, was 65.9%, the doctor's practice license number was 100%, the date of the prescription was 48.9%, the sign of R/70.9%, the doctor's initial 48.7% and the patient's address 97.4%. Incomplete administrative prescription writing can result in medication errors that are detrimental to health and add to the economic burden of patients.

Keywords: Medication Error, Prescription, Administration.

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1. INTRODUCTION

Medication error is an accidental failure in the therapy process that leads and has the potential to cause or harm the patient. Reducing the risk of medication errors is a shared responsibility among patients, healthcare professionals, regulators and the pharmaceutical industry at all levels of healthcare delivery (Goedecke, et al., 2016). Medication errors occur every day leading to injury to patients and even death. Health workers are not fully aware of the problems caused by medication errors causing discomfort and economic burden on patients (Riaz, et. al., 2017). Medication errors can not only be detrimental to patients but can also endanger patient safety by health workers, especially in terms of preventable patient treatment services. Medication errors can occur at the stages of prescribing, transcribing, dispensing, and administering (Khairurrijal & Putriana, 2018). In accordance with the Regulation of the Minister of Health of the Republic of Indonesia, errors in prescribing and dispensing are two things that often occur in medication errors.

Maalangen, et., al., (2019) revealed that there is still a Medication Error in the prescribing and dispensing phases in a hospital in Manado. A similar study was also conducted by Küng et al., (2013), at the University Hospital of Bern, Switzerland which reported 288 Medication Errors from a total of 24,617 treatments given to patients, of which 29% of the Medication Error was prescribing error, 13 % transcribing errors, and 58% in the form of administration errors.

In screening pharmaceutical technician prescriptions and pharmacists, it must pay attention to the standardization of administration completeness of prescriptions so as to minimize the occurrence of medication errors. Therefore, the authors are interested in examining the frequency of medication errors in the prescribing stage that occur in hospital pharmacy installations. In this case, the authors conducted research at the PKU Muhammadiyah Cepu Hospital with the objective of monitoring inpatient prescriptions written by general practitioners to inpatients. The researcher's consideration for choosing the hospital was based on the results of the initial survey conducted in the second week of February 2019 on 4 prescriptions. It is known that all of them (100%) did not meet the requirements of the prescribing stage such as not writing the prescribing date which could affect the prescribing administration process if one day occurred tracking prescriptions, not including the patient's weight so that the pharmaceutical technician and the pharmacist is difficult to determine the dose to be given, does not include medical record numbers which will affect the entry of drugs and there is a concern that errors will occur.

Treatment errors can occur in each treatment process, both in the prescribing process, in the reading of prescriptions (transcribing), preparation to delivery of drugs (dispensing), and in the process of drug use (administering). Errors in prescribing and dispensing are two things which often occur in medication errors (Romdhoni, 2020). The objective of this study is to identify the incidence of medication errors in the prescribing process written by general practitioners for inpatients at PKU Muhammadiyah Cepu Hospital. The results of this study are expected to provide information to medical officers to be more thorough in writing prescriptions to minimize the incidence of medication errors in the prescribing phase.

2. RESEARCH METHOD

The research design used is quantitative with a descriptive approach which is a research design that aims to describe important events that occur in the present.

Description of events is performed systematically and emphasizes factual data rather than conclusions (Nursalam, 2016). Meanwhile, the approach technique used in this study was a survey approach, which is a design used to provide information related to prevalence, distribution, and relationships between variables in a population (Nursalam, 2016). The research was conducted from January 2019 to May 2019 at the Pharmacy Installation of PKU Muhammadiyah Cepu Hospital, Blora Regency. The population in this study were inpatient prescriptions written by general practitioners at PKU Muhammadiyah Cepu Hospital in March-May 2019, totaling 912 prescriptions. In this study, the sampling used was non-probability sampling with a total sampling technique of 912 recipes. The variable in this study was the prescribing stage Medication error written by general practitioners in inpatients. The completeness of writing a prescription includes: doctor's name, doctor's license number, date of prescription writing, R/sign on the left side of each prescription writing, name of each drug and its composition, written drug usage rules (*signatura)*, signature or initials of the prescribing doctor, patient identity and patient address. The instrument used in this study was an observation sheet to identify incidents of medication errors in the prescribing stage. The collected data was then processed with the editing, coding, scoring, and tabulating stages and then concluded descriptively.

3. RESULTS AND DISCUSSION

Research that has been conducted on 912 prescriptions written by general practitioners at PKU Muhammadiyah Cepu Hospital for the period March-May 2019 shows that all written prescriptions are administratively incomplete (100%).

Table 1. Distribution of Administrative Completeness of Prescriptions Written by General Practitioners in Inpatients at PKU Muhammadiyah Cepu Hospital in 2019.

Administrative Completeness of Prescription	Frequency	Percentage (%)
Complete	0	0
Incomplete	912	100
	912	100

Source: Seconder Data of the Research on March 2019

Based on table 1, it can be seen that all written recipes are incomplete. The medication error in the prescribing stage includes 9 indicators, which are the written name of the doctor, the number of the doctor's practice license, the date of writing the prescription, the R/sign on the left of each prescription, the name of each drug and its composition, the written drug use rules (signatura), signature or initials of the prescribing doctor, patient identity and patient address.

A prescription is a written request from a doctor, dentist, or veterinarian to a pharmacist to make and deliver medicine to a patient. A person who is authorized to write a prescription is a doctor, dentist (limited to dental and oral medicine), veterinarian (limited to veterinary medicine). The prescription consists of six parts, which is the Incriptio which includes the doctor's name, address, and practice license number and the date of writing the prescription. Narcotics drugs only apply to one city within the province. Invocatio is an R/sign on the left side of each prescription. A doctor's written request in the Latin acronym "R/=resipe" means take or give functioned as an opening word for communication between the prescribing doctor and the pharmacist in a pharmacy. Prescription/ordinatio consists of the name of the drug desired, the dosage form of the drug, the dosage of the drug, and the amount of the drug

requested. Signatura is a drug use guide for patients consisting of a sign for how to use it, the dosage regimen, route and time interval of administration. The writing of the signatura should be clear for the safety of the use of the drug and the success of therapy. Subscriptio is the signature/initials of the prescribing doctor which acts as the legality and validity of the prescription. Pro (intended) consists of the name, address, age, gender, and weight of the patient (Dina & Sukohar, 2014).

Table 2. Distribution of medication errors in the prescribing stage based on indicators on inpatient drug prescriptions at PKU Muhammadiyah Cepu Hospital in 2019.

Medication eroron the step of prescribing	**Percentage (%)**
Doctor's name	65,9
Practice license number	100
Date of prescribing	48,9
Sign R/ in the left corner of the prescription	70,9
Name of each drug and the composition	0
Written drug use rules (*signatura*)	0
Signature or initials of the prescribing doctor	48,7
Patient's name	0
Patient's address	97,4

Source: Seconder Data of Research

Based on the results of observations on 912 writing prescriptions for inpatients at the PKU Muhammadiyah Cepu Hospital in March 2019, it is known that all written prescriptions are incomplete. The incompleteness of writing a prescription is especially on the indicators for the doctor's license number, patient's address, and the absence of an R/ sign on the left side of each prescription was written. Meanwhile, there were 3 indicators that were written completely on 912 prescriptions, which are the name of each drug and its composition, the written rules for drug use (*signatura*), and the name of the patient.

The incompleteness of prescription writing in this study was not much different from previous studies conducted by Pratiwi, et. al., (2017), which is research on outpatient prescriptions that were entered at Bhumi Bunda pharmacies and revealed that 75.79% of prescriptions were incomplete administratively, particularly the doctor's practice license number of 77.9% and the patient's address 70.53 and only 35.78% mentioned the patient's weight. Administratively, incomplete prescriptions have the potential to cause medication errors. Another study conducted at the Sthira Dhipa clinic revealed that administratively incomplete prescriptions had a negative impact on patient health.

Writing incomplete prescriptions can result in incomplete information received by patients about drugs, both those given by doctors and pharmacists, and can lead to improper use of drugs. The disadvantages experienced by patients are due to errors in writing prescriptions, which are the possibility of unwanted effects so that patients need longer treatment, higher costs, even death.

The research results shown in table 2 show that of the 912 *inscriptio* recipes the recipe is incomplete. *Inscriptio* in the prescription includes the name of the doctor, practice license number, address/telephone/cell phone/city/place, date of writing the prescription. *Inscriptio* serves as the identity of the prescribing doctor. The *inscriptio* format of a prescription from a hospital is slightly different from a prescription in private practice (Kementerian Kesehatan, R. I., 2016).

The results of the prescribing stage medication error observation showed that most of the doctors' names were not written, as many as 601 prescriptions (65.9%). Writing prescriptions from hospitals was slightly different from prescriptions in private practice. Most of the drug prescriptions at the hospital are not written with the doctor's name because the format of the prescription used is the letterhead of the hospital where the doctor is practicing. Besides, the number of patients has to be served so that the doctor does not have time to write his name in the recipe given to the patient. The absence of the doctor's name on the prescription can cause difficulties for pharmacists to verify the prescription if there is unclear information on the prescribing to the doctor who wrote the prescription.

Further identification of the doctor's practice license number can be seen that of the 912 prescriptions, all (100%) do not have the doctor's license number written. The writing of the doctor's practice license number in the prescription is necessary to ensure the safety of the patient, that the doctor concerned has the right and is protected by law in providing medication for his patient. It is because in the writing of a prescription to a doctor in the hospital, it does not need to be written because the doctor's license has been legalized by the hospital permit.

Observations on the date of prescription were written, it was found that out of 912 prescriptions, 446 of the prescriptions were written (48.9%). The date of prescription was given priority for prescriptions containing narcotics and other strong drugs. The prescription date indicates the time the patient made contact with the prescription. Through the prescription writing date, pharmacists can determine whether a prescription can be handled or not. For instance, when an opiate is prescribed for severe pain, a can serve the prescription if the writing date is not more than two weeks (Athijah, 2011). Writing the prescription date determines when the prescription is written and served according to the medicine requested. The results of this study are in line with the results of research conducted by Ismaya, et. al., (2019), which stated that there are still 7% unwritten prescription on the date of prescribing. Prescription date inclusion is required as it relates to patient safety. Pharmacists or personnel from North Sulawesi can determine whether the patient is still fit to use the prescription or recommended to return to the doctor.

The results showed that most of the written R/ sign was not written on the left side of each prescription, as many as 647 prescriptions (70.9%). *Invocatio* is a doctor's written request in the Latin abbreviation "R/= *resipe*" which means take or give, as an opening word for communication with a pharmacist in a pharmacy (Kementerian Kesehatan, R. I., 2016). The results of observations on 912 writing prescriptions for inpatients at the PKU Muhammadiyah Cepu Hospital in March 2019, it is known that most of them do not have an R/ sign written on the left side of each prescription writing. The incompleteness of writing the R/ sign on the left side of each prescription does not really have an impact on patient safety because the R/ sign means take or give it, as an opening word for communication between the prescribing doctor and the pharmacist. This R/ sign serves as a marking in the prescription to indicate the number of medicinal items used. It is caused by the large number of patients and the need for fast treatment by doctors so that they forget to write down the prescription correctly, because patients, especially in the Emergency Room, require a fast response time.

A total of 912 prescriptions were studied, all (100%) had the name of each drug and its composition and drug use (*signatura*) written on it. *Prescription/Ordonatio* is *the* name of the drug and the amount and desired dosage. Writing drug names that are unclear or difficult to read has the potential to cause medication errors, considering that many drugs have almost the same names, especially if the drugs have the same route of

drug administration (Kementerian Kesehatan, R. I., 2016). Based on the results of observations on 912 writing prescriptions for inpatients at the PKU Muhammadiyah Cepu Hospital in March 2019, it is known that all (100%) written the names of each drug and its composition. Drug requests must be confirmed correctly so that the officer who receives the request is absolutely clear about the type of drug requested (Khairurrijal & Putriana, 2018). In writing the name of each drug and its composition on the prescription, it should be written completely and clearly to ensure the safety of the patient. Signatura is a sign of how to use it, the dosage regimen, route and time interval of administration must be appropriate so that the safety of using the drug and the success of therapy can be achieved (Sari & Oktarlina, 2017).

The results of the research on doctor's initials showed that of the 912 prescriptions, most of them had signatures or initials of the doctors who wrote the prescriptions, as many as 444 prescriptions (48.7%). Subscriptio is the signature/initials of the doctor who wrote the prescription which is useful as the legality and validity of the prescription (Sari & Oktarlina, 2017).

Observation of the patient's name revealed that of the 912 prescriptions, all (100%) were written the name of the patient. Pro (intended) includes the name, age and address of the patient. For narcotic drugs, the patient's address must also be included (for reporting to the local health office) (Megawati & Santoso, 2017). Writing the patient's name completely and clearly can prevent the accident of receiving drugs or confusing drugs with other patients. As many as 97.4% or almost entirely not written the patient's address. The patient's address can also be a differentiator when there is the same patient name when redeeming a prescription. If there is the same patient name or the patient's name is not included on the prescription, the pharmacist can ask directly based on the patient's address, thus the medicine prescribed by the doctor will not be confused and if the drug is wrongly administered, it can be addressed to that address.

Prescribing is a complex and high-risk task (Lloyd, et. al., 2017). Prescription errors often occur in hospitals. Prescription-writing interventions require evaluation and feedback on one potential intervention to improve prescribing practice. Doctors have reported a lack of feedback on their previous prescriptions so that the evaluation is limited (Lloyd, et. al., 2017). A good prescription must meet sufficient information so that the pharmacist and nurse concerned understand what drugs will be given to patients (Katzung, et., al., 2014). Prescription writing must be done correctly with respect to accuracy and completeness. Every mistake in prescribing must be eliminated. Irrationality in prescribing leads to medication errors leading to increased morbidity or length of stay and economic losses. Rational use of drugs must be practiced starting with determining the therapeutic goal, selecting the right and specific drug for the patient's needs, followed by monitoring the response to drug therapy (Batta & Singh, 2018).

At each stage of the prescription service flow, efforts are made to prevent medication errors. Prescription assessment is performed to analyze any drug-related problems. If a drug-related problem is found, it is necessary to consult the doctor who wrote the prescription. Pharmacists must conduct a prescription review according to administrative requirements, pharmaceutical requirements, and clinical requirements for both inpatients and outpatients (Kementerian Kesehatan, R. I., 2016).

An Institute of Medicine report on quality of care in the United States found, more than one million injuries and at least 44,000 deaths occur each year as a result of medication errors. Medication errors are the main category of medical errors that cause more than 7,000 deaths per year. Medication error is a type of medical error which often

causes harm to patient treatment, especially in the use of inappropriate drugs, thus, causing harm to patients. Medication errors are associated with increased length of stay and higher hospitalization costs (Odukoya, et. al., 2014). Mistakes during the prescribing process can cause problems for the patient. The results of this study are in line with those reported by Reed-Kane, et. al., (2014) which revealed that the prescription error rate was 63%. When prescribing errors occur, patient care and workflow is interrupted.

Other researchers also revealed that errors in treatment occurred mostly in the prescribing phase with a total of 58.07% and was the highest number of other stages in the treatment process. Potential errors in the form of illegible prescription writing, abbreviated drug names, no dosage given, no amount given, no dosage unit written down, no usage rules, no route of administration, no dosage form, no prescription request date, and incomplete patient identity (no written medical record number, height, gender of the patient, age, and body weight). One of the problem points in prescribing error is the prescription maker or doctor as a health worker, for that rational prescribing needs to be applied (Sari & Oktarlina, 2017). The results of this study are also in line with those expressed by Yusuf, et., al., 2019 in Tasikmalaya that the prescribing stage of Medication error which meets the standards of Health Ministry Rules number 58 of 2014 administratively is 12%, while pharmaceutically is 44%. Prescription review is a very important aspect in prescribing because it can help reduce the occurrence of medication errors.

4. CONCLUSION

Incidence of medication errors in prescribing stage in inpatients at PKU Muhammadiyah Cepu Hospital in March 2019, it is known that all written prescriptions are 100% incomplete administratively. The incidence of medication error in the prescribing stage, especially the doctor's name was 65.9%, the doctor's practice license number 100%, the date of prescription 48.9%, the sign of R/ 70.9%, the doctor's initial 48.7% and the patient's address 97.4%.

REFERENCES

Athijah, U., Pristianty, L., & Puspitasari, H. P. (2011). *Buku Ajar Preskripsi: Obat dan Resep Jilid 1*. Surabaya: Airlangga University Press.

Batta, A., & Singh, B. (2018). Rational approach to prescription writing: A preview. *Neurology India*, *66*(4), 928-933. doi: https://doi.org/10.4103/0028-3886.236960

Dina, T. A., & Sukohar, A. (2014). Rational Drug Prescription Writing. *Jurnal Kedokteran*, *4*(7), 1-30.

Goedecke, T., Ord, K., Newbould, V., Brosch, S., & Arlett, P. (2016). Medication errors: new EU good practice guide on risk minimisation and error prevention. *Drug safety*, *39*(6), 491-500. doi: https://doi.org/10.1007/s40264-016-0410-4

Ismaya, N. A., La Tho, I., & Fathoni, M. I. (2019). Gambaran Kelengkapan Resep Secara Administratif dan Farmasetik di Apotek K24 Pos Pengumben. *Edu Masda Journal*, *3*(2), 148-157. doi: http://dx.doi.org/10.52118/edumasda.v3i2.36

Katzung, B. G., Masters, S. B., & Trevor, A. J. (2014). Farmakologi Dasar & Klinik, Vol. 2, Edisi 12. *Editor Bahasa Indonesia Ricky Soeharsono et al., Jakarta*: *Penerbit Buku Kedokteran EGC.*

Kementerian Kesehatan, R. I. (2016). *Standar Pelayanan Farmasi Di RS Tahun 2016*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Khairurrijal, M. A. W., & Putriana, N. A. (2018). Medication Erorr Pada Tahap Prescribing, Transcribing, Dispensing, dan Administration. *Majalah Farmasetika*, *2*(4), 8-13. doi: https://doi.org/10.24198/farmasetika.v2i4.15020

Küng, K., Carrel, T., Wittwer, B., Engberg, S., Zimmermann, N., & Schwendimann, R. (2013). Medication errors in a swiss cardiovascular surgery department: a cross-sectional study based on a novel medication error report method. *Nursing Research and Practice*, *2013*. Article ID 671820, 6 pages. doi: https://doi.org/10.1155/2013/671820

Lloyd, M., Watmough, S. D., O'Brien, S. V., Hardy, K., & Furlong, N. (2017). Exploring the impact of feedback on prescribing error rates: a pilot study. *International journal of clinical pharmacy*, *39*(5), 1013-1017. doi: https://doi.org/10.1007/s11096-017-0503-x

Maalangen, T., Citraningtyas, G., & Wiyono, W. I. (2019). Identifikasi Medication Error Pada Resep Pasien Poli Interna di Instalasi Farmasi Rumah Sakit Bhayangkara Tk. III Manado. *PHARMACON*, *8* (2), 434-441. doi: https://doi.org/10.35799/pha.8.2019.29310

Megawati, F., & Santoso, P. (2017). Pengkajian Resep Secara Administratif Berdasarkan Peraturan Menteri Kesehatan RI No 35 Tahun 2014 Pada Resep Dokter Spesialis Kandungan di Apotek Sthira Dhipa. *Jurnal Ilmiah Medicamento*, *3*(1), 12-16. doi: https://doi.org/10.36733/medicamento.v3i1.1042

Nursalam, S. (2013). Metodologi penelitian ilmu keperawatan pendekatan praktis. *Jakarta: Salemba Medika*.

Odukoya, O. K., Stone, J. A., & Chui, M. A. (2014). E-prescribing errors in community pharmacies: exploring consequences and contributing factors. *International journal of medical informatics*, *83*(6), 427-437. doi: https://doi.org/10.1016/j.ijmedinf.2014.02.004

Pratiwi, D., Mukhlishah. N. R. I., Pratiwi, D. R. (2017). Analisis Kelengkapan Administratif Resep di Apotek Bhumi Bunda Ketejer Praya, Lombok Tengah. *Jurnal Kesehatan Qamarul Huda*, *6*(1), 6-11.

Reed-Kane, D., Kittell, K., Adkins, J., Flocks, S., & Nguyen, T. (2014). E-prescribing errors identified in a compounding pharmacy: a quality-improvement project. *International journal of pharmaceutical compounding*, *18*(1), 83-86.

Riaz, M. K., Riaz, M., & Latif, A. (2017). Medication errors and strategies for their prevention. *Pakistan journal of pharmaceutical sciences*, *30*(3).921-928.

Romdhoni, M. F. (2020). *Kaidah Penulisan Resep Obat*.Yogyakarta: Deepublish.

Sari, D. D., & Oktarlina, R. Z. (2018). Peresepan Obat Rasional dalam Mencegah Kejadian Medication Error. *Jurnal Medula*, *7*(5), 100-105.

Yusuf, A. L., Fitria, V., Nugraha, D., Mentari, N. (2019). Kajian Administrasi dan Farmasetik Resep Pasien Rawat Jalan di RSUD dr. Soekardjo Kota Tasikmalaya Periode 10 Maret–10 April 2017 Berdasarkan Permenkes Nomor 58 Tahun 2014. *Pharmed: Journal of Pharmaceutical Science and Medical Research*, *2*(1), 24-41.

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RESEARCH **Open Access**

Factors Influencing Poor Postnatal Care in Sangihe Regency

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Abstract
Postpartum mothers from the first day of childbirth up to six weeks will undergo changes both physically and psychologically making intensive care indispensable. Conditions in which the postpartum mother does not get the correct and timely postnatal care lead to postpartum complications that can cause death. The objective of the study is to identify factors related to poor postnatal care in Sangihe Regency, North Sulawesi. This research was a correlation cross-sectional study. The population was postpartum mothers in the working area of The Kuma Health Center of Sangihe Regency. In this study, researchers sampled 62 respondents. The variables included age, culture, mode of delivery, support, and knowledge. The relationship between age, culture, mode of delivery, support, and knowledge with poor postnatal care was measured less using the chi-square test. In contrast, the determinants of poor postnatal care were identified employing logistics regression. The results showed that factors influencing poor postnatal care were age, culture, mode of delivery, support, and knowledge. Mode of delivery was discovered as the most dominant variable influencing poor postnatal care. This research concluded that age, culture, mode of delivery, support and knowledge had a correlation with poor postnatal care, and the most dominant variable was the mode of delivery. Researcher hopes that these findings could help health workers and local governments to direct appropriate postpartum care, especially other postnatal care requiring further research.

Keywords: Factors, Influence, Postnatal Care.

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1. INTRODUCTION

Postpartum mothers from the first day of childbirth up to six weeks undergo changes both physically and psychologically, which makes intensive care indispensable. Conditions in which the postpartum mother does not get the correct and timely postnatal care lead to postpartum complications that can cause death. According to WHO, every day in the world, Maternal Mortality Rate (MMR) reaches 830 cases of mothers dying from diseases/complications related to pregnancy and childbirth (WHO, 2018). In 2015, MMR in Indonesia reached 305 deaths per 100,000 live births, and every day, 38 mothers died (Archadi, 2019). Referring to the 3rd Sustainable Development Goal (SDGs), the maternal mortality rate should be below 70 per 100,000 births (WHO, 2018). There were 71 cases for health profile of North Sulawesi province in 2015, while in the Sangihe Regency, there were 6 cases (Dinas Kesehatan Sulawesi Utara, 2017) and there was one case in the working area of the Kuma Health Center (Dinas Kesehatan Kepulauan Sangihe, 2017).

Various attempts have been conducted to reduce MMR. One of which was through outreach activities to residents related to postpartum care (Dinas Kesehatan Kepulauan Sangihe, 2017). Based on the results of the study completed at Srikaban Binjai Maternity House in 2016, it is revealed that 19 respondents (63.3%) had sufficient knowledge on postpartum maternal, especially the basic needs during the postpartum period, 4 respondents (13.3%) had good knowledge, while the other 7 respondents (23.3%) had less knowledge (Seniorita, 2017). Various examples of postpartum treatment actions performed in miri Sragen sub-district are as follows; mothers should always bring objects (scissors, nail clippers, and pins) outdoors or indoors, they should sleep in a half-sitting position with straight feet for 40 days, they should consume nutrients by drinking herbal medicine, abstain from food consumption, as well as apply self-care by doing body massage (Yuliyanti, 2014). The results of the study revealed that knowledge, culture, and support are closely related to postpartum care (Yuliyanti, 2014); (Nurhabibi & Rahayuningsih, 2018); (Rahayu, et. al., 2017); (Marmi, et. al., 2011).

The amount of research on postpartum care in Sangihe Regency is still relatively minimal. Based on observations made to one of the postpartum mothers in the Kuma area, it was discovered that postpartum mothers had performed postpartum care by consuming traditional herbal medicine and replacing their sanitary napkins when they were full. It indicates that mother has not made optimal efforts in implementing postnatal care. Nurhabibi & Rahayuningsih, 2018 argued that suboptimal postpartum care may cause infections or complications which leads to death in postpartum mothers. Therefore, this study aims to identify factors related to poor postnatal care in Sangihe District.

2. RESEARCH METHOD

This study was quantitative research employing analytical survey research method. The design of this study used cross-sectional correlation studies. This study was conducted in the working area of Kuma Health Center in July 2019. The population of this study was postpartum mothers in the working area of Kuma Health Center. The sampling method was purposive sampling, with the following inclusion criteria: (1) postpartum mothers living in the working area of Kuma Health Center, (2) mothers who could read and write, and (3) mothers who were willing to be respondents. The

exclusion criteria belong to mothers who had not been living in the working area of Kuma Health Center for less than a month. The total sample size was obtained by formula, as follow: $NZ(1- \alpha/2)^2 P (1 - P) / Nd2 + Z(1 - \alpha/2)^2 P (1 - P)$ with n= sample size, N= population size a number 74, $Z^(1-\alpha/2)$ = 1.96, P= proportion(0.5), 1-P= 0.5, d= desired level of precision (0.05) (Riyanto, 2019). The number of samples in this study was 62 respondents.

The instrument was in form of questionnaires. The knowledge-focused questionnaire consisted of 20 question items. This questionnaire was organized in the form of a statement with choices of "right or wrong" answers. As for the favorable statement, if the choice of answer was "correct", it would be given a value of 1, and if the choice of answer was "wrong," it would be given a value of 0. Meanwhile, on the unfavorable statement, the choice of the answer "wrong" is given a value of 0, and the choice of the answer is "correct", would be given a value of 1. The knowledge assessment was categorized as good if the respondent met the score of ≥10, while the respondent was categorized as having bad knowledge if it met the score of <10. Questionnaires regarding poor postnatal care consisted of 20 item questions. Poor postnatal care questionnaires were organized in the form of statements with the following choice of answers: "completely disagree", "disagree", "agree", or "strongly agree". The choice of a completely disagreed answer was given a value of 1, the choice of a disapproval answer was given a value of 2, the choice of an agreed answer was given a value of 3, and the choice of a strongly agreed answer was given a value of 4. Assessment on postnatal care was categorized as poor if the respondent met the score of ≥40, while postnatal care was categorized poor if respondent met the score of <40. Other variables such as maternal age, culture, mode of childbirth and support were measured using demographic questionnaires. Age was measured based on the respondents' number of years of birth calculated per year by age category ≤19 years, >19-35 years, or ≥35 years. Culture was assessed based on respondents' classification of ethnicity. Respondents were categorized using Sangihe culture when answering Sangihe tribe as an answer to questions about tribe, respondents were categorized using Minahasa culture as an answer to questions about ethnicity, apart from these options, respondents were categorized in the category of 'using other cultures'. Delivery mode was measured based on the classification of delivery actions performed by respondents. Delivery mode was categorized as vaginal delivery if childbirth was through the birth canal per vagina and caesarean section delivery if the delivery by sectio caesarean. Support was measured by family members who assisted respondents in performing postpartum care which were then divided into categories; husband, mother-in-law, mother, or friend.

The forms of data analysis used to include univariate, bivariate, and multivariate analysis. Univariate analysis aims to identify the distribution of data on all variables. The bivariate analysis aims to look at the relationship between independent and dependent variables using the chi-square test with a significance level of $p < 0.05$. Multivariate analysis aims to identify which variables affect dependent variables the most. Variables analyzed in multivariate analysis, which are variables with a value of $p < 0.25$ in bivariate analysis. Multivariate analysis employed logistics regression analysis with stepwise reverse method with significance level α= confidence level 0.05 and 95%. This research was approved by the Committee for The Ethics of Health Polytechnic of Manado, with the number: 01/08/041/2020. The researchers ensured that all respondents obtained proper information approval.

3. RESULTS AND DISCUSSION

Table 1. Bivariate analysis by age, culture, education, mode of delivery.

Variable	Poor postnatal Care				Total		p-value
	No		Yes				
	n	%	n	%	N	%	
Age							
<19 years	5	45.5	6	54.5	11	100	0.020*
≥ 19-35 years	12	46.2	14	53.8	26	100	
>35 years	3	12	22	88	25	100	
Culture							
Sangihe	3	12.5	21	87.5	24	100	0.005*
Minahasa	4	26.7	11	73.3	15	100	
Other	13	56.5	10	43.5	23	100	
Mode of delivery							
Vaginal delivery	9	60	6	40	15	100	0.008*
Caesarea section delivery	11	23.4	36	76.6	47	100	
Support							
Husband	12	46.2	14	53.8	26	100	0.130
Mother-in-law	1	8.3	11	91.7	12	100	
Mother	5	31.3	11	68.7	16	100	
Friend	2	25	6	75	8	100	
Knowledge							
Poor	13	59	9	41	22	100	0.001*
Good	7	17.5	33	82.5	40	100	

** Statistically significant (p<0.05)*

Table 1 reveals that the variables significantly related to poor postnatal care are age with p-value of 0.020, culture with p-value 0.005, mode of delivery with p-value 0.008, support with p-value 0.130, and knowledge with p-value 0.001.

Table 2. Dominant factors influencing poor postnatal care using logistic regression test.

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Mother's age		
<19 years		
≥ 19-35 years	0.124 (0.009-1.783)	0.259 (0.033-2.027)
>35 years	0.372 (0.047-2.922)	0.350 (0.60-2.051)
Culture		
Sangihe		
Minahasa	0.000 (0.000)	
Other	0.000 (0.000)	
Mode of delivery		
Vaginal delivery		
Caesarea section delivery	2.627 (0.448-15.421)	3.951 (0.806-19.369)
Support		
Husband		
Mother-in-law	0.143 (0.009-2.215)	0.144 (0.012-1.740)
Mother	0.330 (0.007-15.024)	0.361 (0.013-10.225)
Friend	0.111 (0.006-1.960)	0.180 (0.013-2.470)
Knowledge		
Poor		
Good	0.046 (0.006-0.357)	0.057 (0.009-0.351)
R Square	0.560	0.478
-2log likelihood	46.221	52.013

The results of the data analysis in table 2 reveal that age, culture, mode of delivery, support, and knowledge had a significant correlation with poor postnatal care. Model 2 was selected with higher R2 (0.478), lower -2log likelihood (52.013), and with a significant 95% confident interval. Logistic regression test discovered that the dominant variable influencing poor postnatal care was the mode of delivery (OR 3.951).It indicates that caesarean section had a probability of 3.951 times at poor postnatal care with vaginal delivery, with minimum risk of 0.806-19.369 times.

The results of this study present that the majority of respondents belong to the category of poor postnatal care. It was because respondents were still mistaken in answering questions about the benefits of taking vitamin A, doing pregnancy exercise, good contraception for postpartum mothers, the benefits of postpartum visitation, clinical symptoms of postpartum harmful signs, such as infection, bleeding, as well as problems in breastfeeding. The results of previous studies revealed that mothers who do not understand about postpartum care may increase the risk of maternal death during puerperal (Eldawati, 2015). One of the leading causes of maternal death is bleeding and postpartum infection (Archadi, 2019).

The lack of good postnatal care in this study was due to the fact that there were still respondents aged <19 years and >35 years who were at risk. Age affects the use of the mother to perform postpartum care (Tolera, et. al., 2020). The ideal age during the postpartum period is ≥19-35 years (Kumalasari, et. al., 2020). Young mothers are considered less experienced in providing care during childbirth compared to mothers who are of age (Trisna, 2016).

The results reveal that there was a correlation between age factors and poor postnatal care. Mothers aged > 35 are at risk of postnatal care 0.350 times higher than

mothers aged < 19. The results of previous studies also present that age was related to complications in childbirth. In the case of mothers with a risky age, they tend to possess a 2,203 times higher risk of childbirth complications than mothers without risk (Astutik, 2018). In line with the study of Tolera, et. al, (2020), it was discovered that maternal age factors were associated with non-utilization of puerperal care, in which the risk of experiencing postpartum care visits was 3.4 times higher than women aged 15-19 years.

The result of this study discovered that there is a correlation between knowledge and poor postnatal care. Previous research also revealed that age affected a person's level of knowledge. The majority of people in the study were in the adult category which meaning that they had been able to receive information. Kumalasari, (2020) stated that the higher a person's age, the easier they absorb information. The results of this study were also in line with previous research that discovered a correlation between the science possessed by postpartum mothers and postpartum care practices (Eldawati, 2015; Olajubu, et. al., 2019; Beraki, et. al., 2020). Good knowledge of postpartum mothers is influenced by their interests in following counseling from health workers on postpartum care (Seniorita, 2017).

The result of this study shows that there was a correlation between support factors in poor postnatal care respondents (postpartum mothers) who received support from their birth mothers which were 0.361 times more at risk of poor postnatal care than postpartum mothers who received support from their husbands. The results of previous research revealed that the presence of husband support contributes greatly to the tendency of postpartum depression (Amalia, et. al., 2019).

This study also discovered that there was a correlation between culture and postnatal care. The majority of respondents used Sangihe culture and some did other postnatal treatments such as Baraho and Bakera. Baraho was completed by burning coconut shells or wood until charcoal appears. Furthermore, the palm of the mother hand was used as a heat conductor from the coals to the body to warm up. It is intended to make the mother's body warm. There is no research on baraho's benefits for postpartum mothers.

Another postpartum treatment performed in Sangihe culture was Bakera. Bakera is another method of postpartum treatment by steam bathing employing traditional ingredients which have been passed down from generation to generation performed by the mother during the postpartum period. This traditional method was performed by people in North Sulawesi (Sampouw, 2015). Therapeutic effects of thermotherapy and aromatherapy contribute to the effectiveness of Bakera (Zumsteg & Weckerle, 2007).

The multivariate analysis in this study revealed that the dominant variable affecting poor postnatal care was delivery mode. It explains that caesarean section delivery had a 3,951 probability of poor postnatal care with vaginal delivery, with a minimum risk of 0.806 -19.369 times. This discovery is in line with the research of Wardani, et. al., (2012), which explained that postpartum care for postpartum mothers had a significant relationship both in the treatment group with a value of p 0.015 and in the control group with a value of p 0.017. Respondents who conducted a caesarean section but were not careful in postpartum efforts were those who did not eat food that accelerated wound healing and did not keep the wound dry and clean. There was a possibility in mothers who gave birth by caesarean section to experience a decrease in self-care efforts after childbirth. It happens because the patient's need for self-care outweighs the patient's ability to perform self-care.

The research instrument was written in Indonesian as the language of instruction so that respondents did not have difficulty in filling out the questionnaires. Furthermore,

the content of the question was large enough to allow information bias in this study. This research provides information for postpartum mothers about the right care after childbirth.

4. CONCLUSION

Based on the results of the study, it can be concluded that the majority of postnatal care in Sangihe District was based on poor postnatal care. There is a significant correlation between age, culture, maternal labor, support, and poor level of knowledge of postnatal care. The dominant factor associated with poor postnatal care was delivery mode. These findings may help health officials and local governments to direct appropriate postpartum care, primarily other postnatal care requiring more research. Health workers need to reactivate the postpartum class in order for the mother's knowledge of postpartum care to increase.

REFERENCES

Amalia, A., Ramadhana, M., & Faradiba, A. T. (2019). Peran Dukungan Suami Terhadap Kecenderungan Depresi Paska Melahirkan. *Jurnal Psikogenesis*, *7*(1), 13-17. doi: https://doi.org/10.24854/jps.v7i1.872

Achadi, E. L. (2019). Kematian maternal dan neonatal di indonesia. Tangerang: *Rapat Kerja Kesehatan Nasional Kementerian Kesehatan RI.*

Astutik, W., Dasuki, D., & Kurniawati, H. F. (2018). Factors Influencing Maternal Labor Complication In Kutai Kartanegara Region. *Belitung Nursing Journal*, *4*(5), 510-517.doi: https://doi.org/10.33546/bnj.364

Beraki, G. G., Tesfamariam, E. H., Gebremichael, A., Yohannes, B., Haile, K., Tewelde, S., & Goitom, S. (2020). Knowledge on postnatal care among postpartum mothers during discharge in maternity hospitals in Asmara: a cross-sectional study. *BMC pregnancy and childbirth*, *20*(1), 1-10. doi: https://doi.org/10.1186/s12884-019-2694-8

Dinas Kesehatan Kepulauan Sangihe. (2017). *Profil Kesehatan Kepulauan Sangihe Tahun 2017*. Sangihe: Dinas Kesehatan Sangihe.

Dinas Kesehatan Sulawesi Utara. (2017). *Profil Kesehatan Provinsi Sulawesi Utara Tahun 2017*. Manado: Dinas Kesehatan Sulawesi Utara.

Eldawati, S. (2015). Hubungan Pengetahuan dan Sikap Ibu Nifas dengan Praktik Perawatan Masa Nifas Di Kecamatan Gunungpati Kota Semarang Bulan Januari-Maret 2015. *Jurnal Kesehatan Masyarakat (Undip)*, *3*(3), 228-237. Retrieved from https://ejournal3.undip.ac.id/index.php/jkm/article/view/12151

Kumalasari, D., Dewinataningtyas, C., & Soyanita, E. (2020). The Influence Of Prenatal Class Participation Towards Maternal Behavior During Postnatal In Kediri District. *Siklus: Journal Research Midwifery Politeknik Tegal*, *9*(1), 80-85. doi: http://dx.doi.org/10.30591/siklus.v9i1.1625

Marmi, S. A., Retno, M., & Fatmawati, E. (2011). *Asuhan Kebidanan Patologi*. Yogyakarta: Pustaka Pelajar.

Nurhabibi, F., & Rahayuningsih, F. B. (2019). Pengaruh Pendidikan Kesehatan Tentang Perawatan Nifas Dengan Metode Take And Give Dalam Meningkatka Pengetahuan. *Proceeding of The URECOL*, 152-166.

Olajubu, A. O., Olowokere, A. E., Ogundipe, M. J., & Olajubu, T. O. (2019). Predictors of Postnatal Care Services Utilization Among Women in Nigeria: A Facility-Based Study. *Journal of Nursing Scholarship*, *51*(4), 408-416.doi: https://doi.org/10.1111/jnu.12473

Rahayu, I. S., Mudatsir, M., & Hasballah, K. (2017). Faktor budaya dalam perawatan ibu nifas. *Jurnal Ilmu Keperawatan*, *5*(1), 36-49.

Riyanto, A. (2019). *Statistik Deksriptif Untuk Kesehatan.* Yogyakarta: Nuha Medika.

Sampouw, N. L. (2015). Efektivitas Budaya Bakera Sebagai Media Pengetahuan Ibu Nifas Tentang ASI Eksklusif di Kota Bitung Provinsi Sulawesi Utara. *JIKMU*, *5*(3), 202-209.

Seniorita, D., & Ratna, S. (2017). Gambaran Pengetahuan Ibu Post Partum Tentang Kebutuhan Dasar Selama Masa Nifas Di Rumah Bersalin Srikaban Binjai Tahun 2016. *Jurnal Ilmiah Kohesi*, *1*(1), 32-42.

Tolera, H., Gebre-Egziabher, T., & Kloos, H. (2020). Risk factors for women's non-utilization of decentralized primary health care facilities for postnatal care in rural western Ethiopia. *Therapeutic Advances in Reproductive Health, 14*, 1-19. doi: https://doi.org/10.1177/2633494120928340

Trisna, A. (2016). Praktik Perawatan Masa Nifas Di Kecamatan Pecangaan Kabupaten Jepara Terkait Dengan Faktor Sosial Budaya. *Skripsi* . Surakarta: Program Studi Sarjana Keperawatan, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta.

Wardani, T. A.P., Nursalam, & Has, E. M. M. (2012). Kemandirian Perawatan Ibu Post Sectio Caesarea Dengan Menggunakan Pendekatan Discharge Planning Berdasarkan Teori Self Care Orem. *fundamental & Management Nursing Journal, 1*(1), 1-10. doi: http://dx.doi.org/10.20473/fmnj.v1i1.12126

WHO. (2018). *Maternal Mortality*. Geneva: World Health Organization. Retrieved from http://www.who.int/news-room/fact-sheets/detail/maternal-mortality

Yuliyanti, L. (2014). Gambaran Perawatan Ibu Nifas Di Wilayah Kecamatan Miri Sragen. *Skripsi.* Surakarta: Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta. Retrieved from http://eprints.ums.ac.id/31094/

Zumsteg, I. S., & Weckerle, C. S. (2007). Bakera, a herbal steam bath for postnatal care in Minahasa (Indonesia): Documentation of the plants used and assessment of the method. *Journal of ethnopharmacology*, *111*(3), 641-650. doi: https://doi.org/10.1016/j.jep.2007.01.016

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RESEARCH Open Access

Innovation of Dental X-Ray Holder Using Silicone Rubber Coating in Posterior Dental Periapical Intraoral Examination

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Abstract
The major drawback of the parallel periapical examination technique is that the holder used can damage the oral tissues and cause discomfort to the patient. The objective of this study is to determine the work efficiency and radiographic quality of the innovative dental x-ray holder which has been made by adding synthetic rubber or silicone to the part of the holder that is in direct contact with the patient. This research is an experimental with a post-test only design. The analysis was performed based on filling out the questionnaire on a Likert scale ranging from 1 to 4. With the criteria 1. Disagree, 2. Sometimes, 3. Agree and 4. Strongly Agree. The test was administered by comparing the holder made with the commonly used Aphrodite holder as a control group. There were 16 repetitions of exposure to the cadaveric skull in obtaining research data for each treatment group. The results of statistical work efficiency testing on the control group resulted in a value of B = 0.125 with a significance of 0.071 and an effect of 10.5%. Meanwhile, for testing the quality of radiographic image, the value of B = 0.125 with a significance of 0.014 and an effect of 18.5% was obtained. The innovative dental x-ray holder using a silicone rubber layer is efficient and the resulting radiographic image quality is good when used in the intraoral examination.

Keywords: Periapical, Parallel Technique, Holder, Silicon.

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1. INTRODUCTION

Premolar teeth are one of the teeth of the posterior tooth group located in the posterior region of the oral cavity (Arx & Lozanoff, 2016). Many conditions or diseases cause pain in these premolar teeth. As a result, in certain conditions, the tooth that is experiencing the problem must be pulled out. The first premolar teeth are the teeth most frequently performed (Dardengo, et. al., 2016). To support the extraction procedure, generally, a dental radiographic examination is required.

The dental radiographic examination is a medical procedure performed to diagnose trauma, inflammation, abscess, fracture, or tooth injury in the area of the tooth being examined using x-rays (Whitley, et. al., 2015). In dental radiographic examination, there are two film placement techniques which are generally used, that is placing the film outside the oral cavity known as extra-oral radiographic examination and placing the film in the oral cavity known as intraoral radiographic examination (Iannucci & Howerton, 2016).

Intraoral radiographic examination is an examination used for examining teeth and adjacent structures in the oral cavity. The intraoral radiographic examination is the basic examination of dental radiographs. Intraoral radiographs require a receptor device such as a film, IP (Imaging Plate) or detector. The receptors used in intraoral radiographs are placed in the oral cavity to obtain images of the teeth and their supporting tissue structures. In intraoral radiographic examinations, in general, dental examinations are performed separately between parts including the incisor, caninuas, premoral or molars (Whaites & Drage, 2013). There are several types of intraoral radiographs such as occlusal, bitewing, and periapical.

Periapical examination represents an intraoral radiographic technique designed to present the individual teeth and tissue around the apex. Each image can typically show two to four teeth and provide detailed information about the teeth and surrounding alveolar bone (Whaites & Drage, 2013). There are two methods which can be used to obtain periapical images, that are the bisecting technique and the parallel technique (Iannucci & Howerton, 2016).

Parallel technique is used to obtain dimensionally accurate periapical images based on the concept of parallelism. The concept of parallelism used in this parallel technique is the position of the receptor and the teeth, arranged parallel to each other in the direction of the x-ray perpendicular to the receptor used. Furthermore, the parallel technique also requires a tool to support the receptors in the oral cavity which is usually called a holder (Reynolds, 2016).

The advantage of using the parallel technique is it is able to produce radiographic images without dimensional distortion. The parallel technique produces images that have dimensional accuracy which is very representative of the actual condition of the teeth and shows maximum detail and information. The parallel technique is simple and easy to learn and use. The use of a holder eliminates the need to determine horizontal and vertical angulation and also eliminates the possibility dimensional distortion. Parallel technique has great validity, thus, it is easy to use for periodic or serial examinations (Iannucci & Howerton, 2016; Monika, et al., 2020).

The drawback of the parallel technique is its receptor placement. Because this technique uses a holder, receptor placement may be difficult for the radiographer. The difficulty can be found in pediatric patients or adult patients who have a small oral cavity or a shallow palate. However, the main drawback of the parallel technique is that

the holder used to position the receptors in the parallel technique can damage the oral tissues and cause discomfort to the patient (Whaites & Drage, 2013).

In order to anticipate the lack of comfort when used, the authors made a change towards innovation in the holder employed for periapical intraoral examination with this parallel technique. The holder is made with a synthetic rubber or silicone coated on the part that is in direct contact with the patient. Silicone is generally tolerable and safe for the human body because it is non-toxic to both the human body and the environment. Hence, silicone can be used as a material for manufacturing medical equipment (Mojsiewicz-Pienkowska, et al., 2016). By layering the holder with a silicone material that has a soft texture, it is hoped that the patient will feelmore comfortable. Therefore, the authors are interested in conducting a study compiled under the title "Innovation of Dental X-ray Holder Using Silicone Rubber Coating in Posterior Dental Periapical Intraoral Examination".

2. RESEARCH METHOD

This type of research is an experimental with a post-test only design. Research data was collected at the Dental and Oral Hospital, Muhammadiyah University of Semarang in October 2020. The independent variable in this study was the innovation of the dental x-ray holder employing a silicone rubber coating. The dependent variable in this study is the efficiency of the holder uses of radiology officers and the quality of the resulting radiographic image. The control variables in this study were the exposure factor, the tooth region of the examined phantom and the FFD (Focus-Film Distance).

This study has a post-test only research design with control group design. The results of the innovative dental x-ray holder were examined on the cadaveric skull with radiographic imaging, then compared with controls, which was the holder commonly used in hospitals with the Aphrodite type. The object of this study is a periapical radiographic examination holder that has been designed and equipped with a silicone rubber protector on a portion of the image receptor support surface and the bite block.

The sample size is 16, the sample size in this study was determined by Federer's formula. Federer's formula is used to determine the number of repetitions in order to obtain valid data. In this study, because the object of research was an x-ray holder tested on cadaveric skull, the number of repetitions could be interpreted by the number of samples in each group.

The tools and materials in this study were cadaveric skull and dental modalities for GNATUS Periapical X-ray Unit with the RAIOS X TIME 70 E PANT Series. The research instrument employed a questionnaire on a Likert scale with a range of 1–4. With criteria 1. Disagree, 2. Sometimes, 3. Agree, and 4. Strongly Agree. The questionnaire was distributed and filled out by radiographers and dental specialists which had experience in interpreting the results of periapical intraoral radiographs.

The procedure for collecting and processing research data was conducting the Dental Holder Design, starting with the design and manufacture of the holder followed by testing the dental holder. The research data analysis was performed with a Generalized Linear Model with a 95% confidence level (p-value = 0.05) in order to analyze the efficiency of the resulting innovation holder when compared with the control.

3. RESULTS AND DISCUSSION

a. Design Plane

The three-dimensional design of the holder in this study was performed in several stages. The steps which have been taken were starting from performing basic two- and three-dimensional sketches, determining the size and thickness, analyzing three-dimensional geometry, and simulating virtually every part which is designed in three dimensions. The three-dimensional design was mostly conducted on the On Shape application. The output of the design performed is a document or file of the design in the STEP (Standard for the Exchange of Product Data) and STL (Stereo-lithography) format.

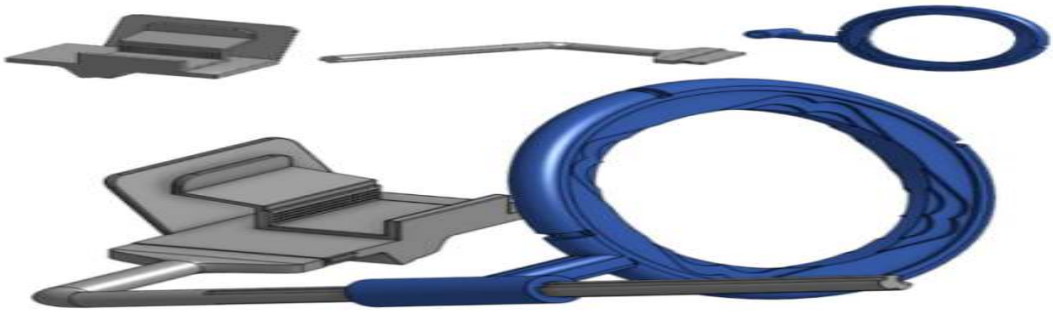

Figure 1. Dental X-ray Holder is the result of innovation employing a graphic processing application.

b. Holder Making

The manufacture of dental holders in this study was administered by a three-dimensional printing process using a three-dimensional printing tool. The printing was performed on a document file with the STL file type. Molding is made with PLA (Polylactic Acid). The PLA material used was food grade PLA, thus, it is safe for use in the oral cavity.

Then, after getting the print results, it was proceeded with the process of making a protective silicone layer on the bite block. The manufacture of this silicone layer was largely through the molding and casting stages. Molding is intended to make food grade silicone molds using molded silicone. Then, the molding results were performed casting, that was inserting food grade silicone material into the molded silicone mold. After that, the print was tidied up and attached to the dental holder which has been made.

After the silicone layer was considered to be in accordance with the design made, it was proceeded to the stage of molding the dental holder with 4 sets of PLA material and then assembling and tidying the print results. Here is Figure 2, which is a set of holders equipped with a silicone layer on the bottom of the holder.

Figure 2. One set of holder + silicone lining on the bottom of the holder

c. Testing

Tests were administered to determine that the holder which has been made efficient is mainly viewed based on the radiographic image displayed. The test was performed employing a cadaveric skull as shown in Figure 3 below.

Figure 3. Position of the test holder against the cadaver of the skull

The test was conducted by exposing the second and third molars to the upper left of the cadaveric skull. The exposition was performed 16 times in each treatment group. The groups given treatment in this study were the innovation group and the control group. The innovation group is the result of an image from the exposure employing a dental holder. Meanwhile, the control group is the image result of exposure using a holder usually used in the Department of Radiology, Dental and Oral Hospital,Muhammadiyah University of Semarang, which is a dental holder with the Aphrodite brand. Furthermore, the results of the radiographic images generated from the exposure are shown in Figure 4 below.

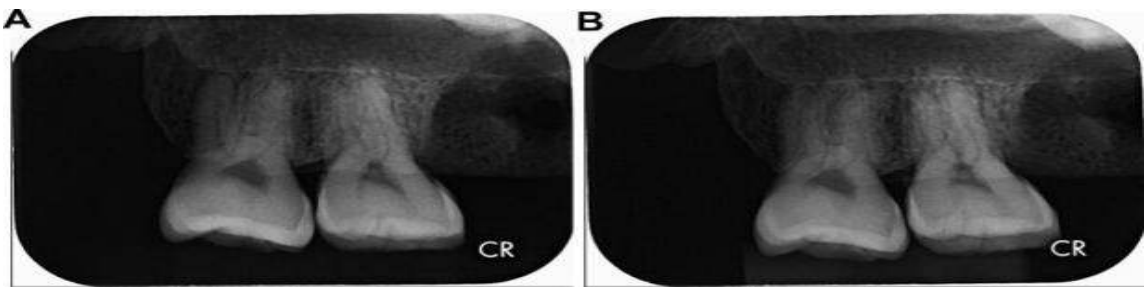

Figure 4. The dental radiographic were produced using (A) Dental holder innovated and (B) Dental aphrodite holder which is commonly used in Department of Radiology, Dental and Oral Hospital, Muhammadiyah University of Semarang.

From the results of the radiographic images produced, then it was assessed by a questionnaire method by a dental radiologist. The assessment by the radiographer was performed to determine the efficiency of using the dental holder. Meanwhile, an assessment by a dental radiologist was performed to determine the quality of the radiographic images produced. In addition, an assessment was also administered on the dental Aphrodite holder which is commonly used in the Department of Radiology, Dental and Oral Hospital, Muhammadiyah University of Semarang. The following is table 1 which is a statistical description of the test results using the questionnaire method.

Table 1. Statistical description of the questionnaire result data.

Testing	Group	Mean	Standard Deviation	N
Work efficiency	Innovation	3.85	0.14	16
	Control	3.72	0.23	16
	Total	3.79	0.19	32
Radiography Image	Innovation	3.80	0.16	16
	Control	3.67	0.10	16
	Total	3.74	0.15	32

Table 1. Shows a statistical description of the data from the questionnaire results of work efficiency testing and radiographic images in the innovation and control groups. Each of which has a sample size of 16, so that the overall average work efficiency and radiographic images are obtained, respectively,3.79 ± 0.19 and 3.74 ± 0.15. In the assessment of work efficiency, the mean results of the questionnaire assessment in the innovation and control groups were 3.85 ± 0.14 and 3.72 ± 0.23, respectively. Based on this value, the average value of the innovation group is greater than the control group.

It shows that the dental holders were made more efficient when usedthe compared to the control group. In the radiographic image assessment, the mean results of the questionnaire assessment in the innovation and control groups were 3.80 ± 0.16 and 3.67 ± 0.10, respectively. Based on this value, the average value of the innovation group is greater than the control group. It shows that the dental holder is better than the control group. However, to assess how much influence and contribution the dental holder made to the work efficiency and radiographic images produced, it is necessary to conduct the further testing.

From the data obtained, the Multivariate General Linear Mode test was then performed to determine how much the percentage of influence and contribution of the dental holder to work efficiency and radiographic images. The following is table 2. the results of the multivariate general linear test data mode questionnaire results.

Table 2. Multivariate General Linear Mode Test Results on Work Efficiency.

Testing	B	Std. Error	Sig.	95% CI	Partial Eta Squared
Dental Holder Innovations	0.125	0.067	0.071	-0.011-0.261	10.5%
Control Group (Aphrodite)					

In table 2, It reveals that the exposed cadaveric skull using the innovative dental x-ray holder with silicone material has a work efficiency value of 0.125 which is more

efficient than the usual holder used in the Department of Radiology, Dental and Oral Hospital, Muhammadiyah University of Semarang. The increase in efficiency is close to significant (p-value 0.071).The use of innovative dental x-ray holders using silicone materials was able to have an effect on the work efficiency value for the radiographer by 10.5% even though this effect was relatively low.

Based on the results of statistical tests, the dental x-ray holder which equipped with a silicone rubber layer had an average value of 3.85 ± 0.14, which means that the radiographer strongly agreed that the dental holder made was very efficient to use. By using this dental holder, the radiographer does not need to intervene too much with the arrangement of x-ray films and tubes. There are several advantages which can be obtained by minimizing intervention during periapical examination. The first is that the radiographer will complete the examination faster.

Cowan, et al., (2013), explained that this shorter examination time can reduce the radiographer's workload and the quantity of examinations which can be performed can increase. It of course provides a very good advantage, considering that the more examinations that can be completed, the more income the hospital will obtain.

Second, the radiographer does not need to intervene too much in the patient's oral cavity. It is in accordance with Ilhan, et al., (2020) that reduced the possibility of disease transmission to or from the radiologist's hand in the patient's oral cavity. Moreover, by reducing interventions in the patient's oral cavity, the patient feels more comfortable and less uncomfortable. The use of dental holders is relatively acceptable. Hence patients do not feel pain. Thus, dental holders are made of environmentally friendly materials and are safe for use in the patient's oral cavity.

The statistical test results also show that the dental holder made a contribution of 0.125 to work efficiency. It means that the innovation applied to the manufacture of dental holders which include the tilt of the film support on the bite block was equipped with a telescopic feature and the use of a silicon coating contributed 0.125 to the great work efficiency of the radiographer. Furthermore, there is also a statistically significant effect on the work efficiency of dental holders made with dental holders which are commonly used in Department of Radiology, Dental and Oral Hospital, Muhammadiyah University of Semarang with a large effect value of 10.5%.

Table 3. Multivariate General Linear Mode Test Results on Radiographic Image Quality.

Testing	B	Std. Error	Sig.	95% CI	Partial Eta Squared
Dental Holder Innovations	0.125	0.048	0.014	0.027-0.223	18.5%
Control Group (Aphrodite)					

In table 3, the results show that the exposed cadaveric skull using the innovative dental x-ray holder with silicone material has a clearer dental radiographic quality value of 0.125 compared to the usual holder used in the Department of Radiology, Dental and Oral Hospital, Muhammadiyah University of Semarang. The improvement in the quality of the dental radiographic is significant (p-value 0.014).The use of innovative dental x-ray holders using silicone materials was able to have an impact on the quality of radiographic images for radiographers by 18.5% even though this effect was classified as low.

Based on the results of statistical tests, the dental x-ray holder equipped with a silicone rubber layer has an average value of 3.80 ± 0.16, which means that radiology specialists strongly agree that the dental holder produces excellent radiographic images. In this study, the assessment of the quality of radiography was performed by assessing the clarity of the apex, crown and pulp anatomy of the teeth as well as the sharpness and shape of the resulting anatomy. The results of this study indicate that the resulting radiographic images show clear dental anatomy with good sharpness and no distortion and elongation when using the dental holder. This provides an advantage for the radiology specialist who performs the interpretation, the sending doctor, as well as for the patient himself (Aps, et al., 2020).

Good quality radiographic images will make it easier for a radiologist to interpret the results. Moreover, good quality radiographic images can reduce the occurrence of errors in making a diagnosis (Aps, et al., 2020). It also affects the sending doctors and the patient being examined. The sending doctor will find it easy to see the results of the radiology specialist's interpretation by seeing the results of the radiographic images. The results of the interpretation made will then be employed to determine the next action to be performed on the patient(Gupta, et al., 2014). Especially in patients who require precise action such as root canal treatment which requires precise measurement of the depth of the tooth root. The measurements will not produce accurate data if the resulting radiographic image experiences distortion and elongation or changes in shape and size (El-Angbawi, et al., 2012; Pando, et al., 2019; Manja & Fransiari, 2018; Khorasani, & Ebrahimnejad, 2017).

If the resulting radiographic image is of good quality, it is possible that errors in interpretation will be minimized. Hence, the sending doctor will also take appropriate action on the problems experienced by patients and are expected to be able tosolve the problems. It gives an advantage to the patient, if the quality of the radiographic images produced is not good, the patient may get inappropriate actions that result in losses for the patient himself.

The advantages of radiographic images generated from the use of this dental holder can be seen from the statistical test results. The results of the statistical test showed that the dental holder made a contribution of 0.125 to the resulting radiographic image. It means that the innovation applied to the manufacture of dental holders which include the slope of the film support on the bite block was equipped with telescopic features and the use of a silicon coating contributed 0.125 to the quality of the resulting radiographic images. In addition, there is also a statistically significant effect on the radiographic image of the dental holder made with the dental holder which is commonly used in the Department of Radiology, Dental and Oral Hospital, Muhammadiyah University of Semarang with a large effect value of 18.5%.

This study provides an innovation for dental radiography examination where the dental holder used for periapical examination is coated with food grade siliconewhich isrelativelysafeforpatient use. This holder is also designed with eco-friendly PLA material so that the price is relatively cheaper compared to market products. The weakness of this study is that the dental holder was designed to be tested on the cadaveric skull only. For further research, a patient can test the comfort of using this dental holder.

4. CONCLUSION

The innovative dental x-ray holder employs a silicone rubber coating which is efficient to use and has good radiographic image quality for intraoral examination of posterior teeth periapical. The authors recommend the use of the dental holder which has been made for intraoral examination of the posterior teeth periapical. However, testing is needed to see how comfortable the dental holder for the patient. Furthermore, it is necessary to develop the design, especially the telescopic system of the beam paralleling ring to make it easier to operate and manufacture of a smaller size dental holder for pediatric patients.

REFERENCES

Aps, J. K. M., Lim, L. Z., Tong, H. J., Kalia, B., & Chou, A. M. (2020). Diagnostic efficacy of and indications for intraoral radiographs in pediatric dentistry: a systematic review. *European Archives of Paediatric Dentistry*, *21*, 429-462. doi: https://doi.org/10.1007/s40368-020-00532-y

Arx, T. V., & Lozanoff, S. (2016). Clinical oral anatomy: A comprehensive review for dental practitioners and researchers. *Clinical Oral Anatomy: A Comprehensive Review for Dental Practitioners and Researchers*. Switzerland: Springer International Publishing. doi: https://doi.org/10.1007/978-3-319-41993-0

Cowan, I. A., MacDonald, S. L., & Floyd, R. A. (2013). Measuring and managing radiologist workload: Measuring radiologist reporting times using data from a Radiology Information System. *Journal of Medical Imaging and Radiation Oncology*, *57*(5), 558–566. doi: https://doi.org/10.1111/1754-9485.12092

Dardengo, C. D. S., Fernandes, L. Q. P, & Júnior, J. C. (2016). Frequency of orthodontic extraction. *Dental press journal of orthodontics*, *21*(1), 54-59. doi: https://doi.org/10.1590/2177-6709.21.1.054-059.oar

El-Angbawi, A. M. F., McIntyre, G. T., Bearn, D. R., & Thomson, D. J. (2012). Film and digital periapical radiographs for the measurement of apical root shortening. *Journal of Clinical and Experimental Dentistry*, *4*(5), e281. doi:https://doi.org/10.4317/jced.50872

Gupta, A., Devi, P., Srivastava, R., & Jyoti, B. (2014). Intra oral periapical radiography - basics yet intrigue: A review. *Bangladesh Journal of Dental Research & Education*, *4*(2), 83–87. doi: https://doi.org/10.3329/bjdre.v4i2.20255

Iannucci, J., & Howerton, L. J. (2016). *Dental Radiography-E-Book: A Workbook and Laboratory Manual*. St. Louis, Missouri: Elsevier.

Ilhan, B., Bayrakdar, İ. S., & Orhan, K. (2020). Dental radiographic procedures during COVID-19 outbreak and normalization period: recommendations on infection control. *Oral Radiology*, *36*(4), 395–399. doi: https://doi.org/10.1007/s11282-020-00460-z

Khorasani, M. M. Y., & Ebrahimnejad, H. (2017). Comparison of the accuracy of conventional and digital radiography in root canal working length determination: An invitro study. *Journal of dental research, dental clinics, dental prospects*, *11*(3), 161-165. doi: https://doi.org/10.15171/joddd.2017.029

Manja, C. D., & Fransiari, M. E. (2018). A comparative assessment of alveolar bone loss using bitewing, periapical, and panoramic radiography. *Bali Medical Journal*, *7*(3). doi: https://doi.org/10.15562/bmj.v7i3.1191

Mojsiewicz-Pieńkowska, K., Jamrógiewicz, M., Szymkowska, K., & Krenczkowska, D. (2016). Direct human contact with siloxanes (silicones)–safety or risk part 1. Characteristics of siloxanes (silicones). *Frontiers in pharmacology*, *7*, 132. doi: https://doi.org/10.3389/fphar.2016.00132

Monika, A. P. W., Astuti, E. R., & Mulyani, S. W. M. (2020). The Quality of The Lollipops Use in The Making of The Anterior Upper Teeth Periapical Radiography of in Paediatric Patients. *Eurasian Journal of Biosciences*, *14*, 4049–4053. Retrieved from http://ejobios.org/download/the-quality-of-the-lollipops-use-in-the-making-of-the-anterior-upper-teeth-periapical-radiography-of-8047.pdf

Pando, J.A.G., Sainz, Z. de la C. T., Reyes, J. C., Concepcion, J. A. C., Santos, I. F. (2019). Effectiveness of Periapical Radiographic Methods by Parallelism and Bisection. *Rev Ciencias Médicas*, *23*(5), 654–663.Retrieved from https://www.medigraphic.com/pdfs/pinar/rcm-2019/rcm195h.pdf

Reynolds, T. (2016). *Basic Guide to Dental Radiography*. Wiley Blackwell.

Whaites, E., & Drage, N. (2013). *Essentials of dental radiography and radiology (5th ed.)*. Churchill Livingstone.

Whitley, A. S., Jefferson, G., Holmes, K., Sloane, C., Anderson, C., & Hoadley, G. (2015). *Clark's Positioning in Radiography* (A. D. Moore (ed.); 13th ed.). CRC Press.

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RESEARCH **Open Access**

Factors Associated with Providing the Basic Immunization to Infants

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Abstract
Basic immunization is the first providing immunization to acquire the immune level on the verge of protection given to baby before one year which was aimed to get a full set of basic immunization for each baby with a good indicator that is full immunization (IDL). The indicator was influenced by several independent variables such as mother's job status, education, knowledge, attitude, perception, and support from cadre and family. From total 89 villages in Lamandau district since 2015 to 2018, there were 82 villages of Universal Child Immunization (UCI) (92.1%) increased by 22.78% than 2016 is 69.32%. However, there was Drop Out (DO) of 2.83% from the village thathad not reached a full set of basic immunization of infants in Kujan Village. The objective of this study is to determine the factors associated with providing a full set of basic immunization of infants in Kujan village, Bulik district, Lamandau Regency, Central Kalimantan Province. The research employed cross sectional design. Data was collected from 80 mothers who had children aged 12-24 months during February 2020. The study samples was conducted with total sampling (80 respondents). The results of study used chi square test with levels of trust that is 95%. It showed a significant relationship between education by providing a full set of basic immunization of infants with p-value = 0.000. Meanwhile, employment status, knowledge, attitudes, family support, perceptions, support from cadres were not related to complete immunization. Therefore, based on the results of this study, it is suggested to the Lamandau Regency Government in the long term to improve the education of healthy mothers and also massive education related to the importance of immunization to increase the complete basic immunization coverage in Kujan Village.

Keywords: Basic Immunization, Education.

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1. INTRODUCTION

Health development aims to increase awareness, willingness, and apply healthy lifestyle for people so that it can obtain the degree of quality public health as an investment for productive human resources development in social and economic. Improving the degree of public health and preserving the health status for the general public need preventive action or prevention of disease by immunization. Immunization is the best way to protect a person from a specific disease which is dangerous and deadly especially for infants and children. Based on regulation of Ministry of Health of Republic Indonesia number 12 of 2017, Immunization is an attempt to stimulate a person's immunity which is able to protect the body from the disease by immunization (PD3I) (Kementerian Kesehatan, R. I., 2017).

This immunization program is execution to prevent diseases such as tuberculosis, diphtheria, pertussis, tetanus, Hepatitis B, polio, and measles. Providing immunization was focused to early childhood because their immunity system is still weak from all kinds of diseases. The indicator of immunization program used to measure the coverage of Indonesia Sehat is the percentages of village which was reached UCI (Universal Child Immunization) (Dinas Kesehatan Provinsi Kalimantan Tengah, 2016).

Based on data from 2017, complete basic immunization indicator coverage in Central Kalimantan was 75% in 2016,bigger than the coverage in 2015 which was 64.76%, but did not the target in 2016 that was set up to 90% (Dinas Kesehatan Provinsi Kalimantan Tengah, 2017). Meanwhile, from total 89 villages in Lamandau district in 2015-2018, UCI village coverage was 82 villages (92.1%) increased by 22.78% compared with 69.32% in 2016.However, if observed from immunization in village level at the work area of Bulik Public Health Center, there was still drop out (DO)/were not immunized at allabout2.83%, partially immunized at village level in the work area of Bulik Public Health Center (Dinas Kesehatan Lamandau, 2018).

The results of preliminary study by interview were 10 mothers as respondents in Kujan village who had children aged 12 to 24 months,5 (50%) of respondents said that their children did not receive a full set of basic immunization, while 5 (50%) of respondents said their children received a full set of basic immunization. With description: mothers aged less than 21 were 4 (40%),more than 21 were 6 (60%), 4 respondents (40%) did not know about basic immunization, 6 respondents (60%) knew about basic immunization,3 respondents (30%) were graduated from elementary school, 3 respondents (30%) were graduated from junior high school and 4 respondents (40%) were graduated from senior high school. There were 4 husbands (40%) of respondents who banned or disagreed their children immunized, 6 husbands (60%) of respondents agreed their children immunized, the respondents said that they have not been visited by cadre to their house for counseling who were 5 (50%) and the respondents said that they had been visit their house by 5 (50%). Therefore, the researcher wanted to observe the factors associated with providing a full set of basic immunization to infants. The objective of this study is to determine the factors associated with providing a full set of basic immunization to infants in Kujan village, Bulik district, Lamandau, Central Kalimantan Province.

2. RESEARCH METHOD

The design of the study used a cross-sectional method. Data was collected from 80 mothers who had children aged 12-24 months in Kujan village, Bulik district,

Lamandau, Central Kalimantan Province. Secondary data was obtained by literature study of Lamandau Health Service of 2016-2018, data from Bulik Public Health Center period of 2017-2019, and primary data from respondents in Kujan village at February 2020. Primary Data was collected by interview and documentation of KMS or KIA books. Data analysis used chi-square test. Sample study was with total sampling (80 respondents). Ethical Approval was provided by the Ethics Committee of Muhammadiyah University No. 03/KEPK-FIKES/KET/2020.

3. RESULTS AND DISCUSSION

The results of the study associated with Univariate analysis were mothers' educational level which were mostly from elementary, junior and senior high school (86.25%). Most of whom were diploma up to master (13.75%) and worked as farmer, private employees and civil servant (45%), and unemployment (55%). Mother knowledge level were much less (57.5%) and well-knowledge (42.5%). Mothers' attitude, family and cadre support, perception and basic immunization status were part of the factors associated with providing a full set of basic immunization of infants in Kujan village, Bulik district, Lamandau, Central Kalimantan Province that can be seen in the tables below:

Table 1. Socio demographic data of respondents.

Variable	Total (f)	Percentage (%)
Education		
Higher Education	11	13,75
Secondary Primary Education	69	86,25
Job Status		
Worked	36	45
Unemployed	44	55
Knowledge		
Good	34	42,5
Poor	46	57,5
Attitude		
Supportive	40	50
Unsupportive	40	50
Family Support		
Supportive	34	42,5
Unsupportive	46	57,5
Perception		
Good	33	41,25
Poor	47	58,75
Cadre Support		
Supportive	32	40
Unsupportive	48	60
Basic Immunization Status		
Completed	36	45
Uncompleted	44	55

Source: Primary Data,2020

The results of bivariate analysis were obtained the job variable with *p value* = 0,557, knowledge by *p value* = 0,317, attitude by *p value* = 0,822, family support by *p value* = 0,146, perception by *p value* = 0,538 and cadre support *p value* = 0,614. The results of bivariate analysis were showed a significant relationship between education

with providing a full set of basic complete immunization in infants with *p value* = 0,000.

Table 2. The variables related with giving basic complete immunization.

Variable	Basic Immunization				Total		PR (95%CI)	*p* value
	Completed		Uncompleted					
	n	%	n	%	n	%		
Education								
Higher Education	11	100	0	0,0	11	100	2,760 (2,018-3,774)	0,000
Secondary Primary Education	25	36,2	44	63,8	69	100		
Job Status								
Worked	18	50	18	50	36	100	1,222 (0,754-1,980)	0,557
Unemployed	18	40,9	26	59,1	44	100		
Knowledge								
Good	18	52,9	16	47,1	34	100	1,353 (0,837-2,186)	0,317
Poor	18	39,1	28	60,9	46	100		
Attitude								
Supportive	17	42,5	23	57,5	40	100	0,895 (0,550-1,454)	0,822
Unsupportive	19	47,5	21	52,5	40	100		
Family Support								
Supportive	19	55,9	15	44,1	34	100	1,512 (0,934-2,447)	0,146
Unsupportive	17	37	29	63	46	100		
Perception								
Good	13	39,4	20	60,6	33	100	0,805 (0,481-1,346)	0,538
Poor	23	48,9	24	51,1	47	100		
Cadre Support								
Supportive	16	50	16	50	32	100	1,200 (0,741-1,943)	0,614
Unsupportive	20	41,7	28	58.3	48	100		

Source: Primary Data, 2020

The results above showed that all respondents with higher education had a full set of basic immunization (100%) compared to middle-education respondents (elementary, junior high school), just reached (36.2%). Based on the statistical test result by *p value* = 0.000 (< α = 0.05),it can be concluded that there was significant relationship between education with providing a full set of basic immunization in infants.

Based on job status above, it can be identified that mother who worked had been full-immunized status (50%) a few more than mother who did not work by full-immunized status (40.9%). According to the statistical test result of *p-value* 0.557 (> α = 0.05),it means that there was no significant relationship between mother's job status with providing a full set of basic immunization in infants.

Based on mother education, it can be seen that mother with good knowledge had more a full set of basic immunization (52.9%) bigger than poor knowledge (39.1%), and the statistic test result of *p-value* 0.317 (> α = 0.05).It means that there was no relationship between knowledge with providing a full set of basic immunization in infants.

Meanwhile, the respondents support had fewer a full set of basic immunization (42.5%) than unsupported mother (47.5%). Based on the statistic test result by *p value* = 0.822 (> α = 0.05), it can be concluded that there was no significant relationship between mothers' support with providing a full set of basic immunization in infants.

The factor of family support had a full set of basic immunization (55.9%) than the unsupported family (37%). The results of analysis data were obtained by *p value* = 0.146 (>α=0.05). It can be concluded that there was no significant relationship between the family support with providing a full set of basic immunization in infants.

The respondents with good perception had more a full set of basic immunization status (39.4%) less than the respondent with poor perception (48.9%). The result of statistical test was obtained by *p value* = 0.538 (> α= 0.05). It can be concluded that there was no significant relationship between mothers' perception with providing a full set ofbasic immunization in infants.

Mother claimed that cadre support by a full set of basic immunization status (50%),while the unsupported cadres by a full set of basic immunization status about (41.7%). The result of the statistical test was obtained by *p value* = 0.614 (> α = 0.05).It can be concluded that there was no significant relationship between cadre support with providing a full set of basic immunization in infants.

Based on the results of this study, In terms of the factors associated with providing a full set of basic immunization in Kujan village, there was some independent variables in this study which had no relationship with basic immunization of infants, such as: job status, knowledge, mother attitude, perception, cadre and family support.

The results of this study, in statistically showing, there was significant relationship between educational level with providing a full set of basic immunization in infants by *p value* = 0.000 in Kujan village. This result as studied by Suhaid & Faranita, (2018) explained that educational level was related to a full set of basic immunization of infants in Alamendah village, Rancabali, Bandung. Furthermore, the results of study by Maiwada, et. al., (2019) revealed that there was a significant relationship between mothers' educational status with providing a full set of basic immunization to children in Kebbi Nigeria, and it was the main factor that contributed to the attitude of mothers for providing immunization to their child. Similarly, the results of study by Girmay & Dadi, (2019) in Ethiopia explained that the low educational is very influential and adverse for achieving the immunization status of infants, and the results of study by Maharani & Kuroda, (2018) stated that improving the quality of education is the most important factor in component quality of health service in general and immunizations. However, different from the study previously, in the result of the study by Hafid, et. al., (2016) revealed that there was no influence between mothers' educational level with full immunized of infants by a *p value* = 0.177.

In this study, mother's job status had no significant relationship with mother's job after the statistical test, as with previous study that mother's job had no statistical influence to full immunized in infants with *p value*= 0.404 by Hafid, et. al., (2016). As the study by Triana, (2016) explained that there was no meaningful relationship between parent's job with providing full immunized of infants in Kuranji district, Padang, 2015,thus, there was no spread of the respondent's job status by *p value* = 0.66 (> 0.05). Meanwhile, different from the study by Suhaid & Faranita, (2018), it is stated that there was relationship of job factor with full immunization in infant.

The result of the statistical test in this study showed that the respondents with poor knowledge did not have a significant relationship with providing a full set of basic immunization in infants, as study by Rahmi & Husna, (2018) stated that mother

knowledge has no influence with full immunization of infants by *p value* (0.05). The same results of study were conducted by Rahmawati & Wahjuni, (2014) and Risnawati (2014), which revealed that the level of mother knowledge has no influence with basic immunization status of infants.

Different research from Emilya, et. al., (2014) stated that there was a relationship between knowledge with full immunization of infants in Lambung village, Bukit Padang. It is supported by the results of study by Suhaid & Faranita, (2018), which stated that there was a relationship between knowledge with full immunization status of infant in Alamendah village, Rancabali, Bandung. Furthermore, the results of the study Sari, et. al., (2016) added that there was also a significant relationship between mothers' knowledge about basic immunization with full immunization of infants in the work area of Bendo Health Center, Magetan. The same research by Girmay & Dadi, (2019) in Ethiopia indicating that the level of mother knowledge with a poor life was very influential in full immunization of children aged 12-23 months in difficult reachable area in Ethiopia.

The results of this analysis revealed that unsupported respondents to the basic immunization in infants is higher than the respondents support, thus, there was no significant relationship between mothers' attitude with providing a full set of basic immunization in Kujan village. Inversely, proportional to the results of the study by Hudhah & Hidajah, (2017) and Saifuddin, (2013), it has the same statement that there was an influence of mother's attitude to her rejection and readiness due to personal experience and influence from other which was important, because of cultural and emotional factor that influenced the full immunization of infants. The study by Emilya, et. al., (2014) explained that there was a relationship between mother attitudes with providing a full set of basic immunization to infants in Lambung, Bukit Kota Padang. Similarly, the study of Maiwada, et. al., (2019), stated that there was a significant relationship between mothers' attitude with full immunization to children in the state of Kebbi Nigeria.

Based on the result of statistical test for the family support variable, it can be concluded that there was no significant relationship between family support variable with full immunization of infants. The results were not in line with the study by Ritonga, et. al., (2015). It explained that there was an emotional support relationship of mother compliance toper form basic immunization to their child. The emotional support should be provided by the family such as empathy, caring and attention to other. Hence, it becomes motivated to immunize their children.

Similarly, the results of previous study by Rahmawati & Wahjuni, (2014), in line with this study explained that there was relationship between family support with full immunization of infants by *p value* = 0.000 (< 0.05). The results of this study was also in line with the results of statistical tests on previous study by Hafid, et. al., (2016), from the result of analysis and statistical test by*p-value* = 0.000, it indicates that there was a significant influenced between family support with full immunization of infants in Konang and Geger Health Center.

Based on the results of this study, the analysis result indicated that mothers' perception was not a significant relationship with providing full basic immunization of infants. The result of this study is in line with the study by Ahmad, et. al, (2017) in

Malaysia which explained that the children did not receive a full primary immunization at 12 months, most girls were from urban areas, the mothers did not trust that the vaccine can prevent the spread of disease and get treatment in private facilities. Hence, this study identified the challenges and gaps to make sure high immunization coverage in Malaysia in reducing the number of child illness and death because there are many mothers with low perception.

The results of this study also showed the statistical test. There was no significant relationship between cadre supports with full immunization of infants. It is in line with the results of previous study by Septianingtyas, (2018) which revealed that there was no relationship between the implementation of cadre role with full basic immunization in infants. Different with the research by Septianingtyas, (2018), the results of data analysis employing the logistic regression test showed *p value*= 0.013 ($p< 0.05$),which means that there was a significant influence from cadre support with full basic immunization in the work area of Jelbuk and Klatakan Health Center, Jember.

The study result of Meleko, et. al., (2017), in Mizan Aman city, Bench Maji Zone, Southwest Ethiopia, Immunization remains one of the most important and cost-effective public health interventions to reduce child mortality and morbidity. Globally, it is estimated to avert between 2 and 3 million deaths each year. In Ethiopia, immunization coverage rates have stagnated and remained very low for many years. The bigger proportion occurred in Sub-Saharan Africa, about 4.4 million. It is caused by inadequate immunization coverage due to the infrastructure which is not optimal, especially for routine vaccination that identified as the primary factors of less vaccinations.

From the results of the research by Noh, et. al., (2018) in Pakistan, it was discovered that the immunization level coverage among children aged 0-23 months in Pakistan has increased since EPI program was initiated by WHO in 1978, but still lower than the countries with low- and middle-income level as the goal of WHO and UNICEF. The low vaccination coverage and delay to immunize have aroused the loss of immunity causing the disease epidemic that can be prevented by vaccines in infants who had not been vaccinated in Pakistan.

Based on study by Girmay & Dadi, (2019) in Ethiopia, it is indicated that the full immunization coverage of the district was higher than the national and regional coverage, but lower than World Health Organization target. The mileage to public health center, mothers who did not have self-checking during ANC (Ante Natal Care) and a very poor life also affect to infants immunization status. Hence, it is expected to relevant parties strengthening the outreach of immunization service, cooperating actively with the local community-based on health services to increase the number of children vaccinate**.**

Thus, the research concluded that the family support is not only from husband but also from other family members such as grandmother, grandfather, parents and siblings. The successful of basic complete immunization in infants is not only from one factor but also from other important factors, because the success of the coverage or basic immunization target depends also from a government program so that all infants in Indonesia reach the status of IDL (basic complete immunization). Hence, there is a

cooperation between medical officers like midwife or nurse with *Posyandu* (Maternal & Child Health Centre) cadres in the local village area by approaching people and family. Thus, it will be easy to tell information about the benefits of immunization for healthy xinfant. To reach WHO standards of immunization coverage and also to improve the quality of health and education, policymakers have to design programs for further socialization about immunizations to baby's mother and their family who have a low education (Maharani & Kuroda, 2018).

4. CONCLUSION

There is a significant relationship between the education variable and complete basic immunization for infants. Based on the results of this study, it is suggested to the Lamandau Regency Government in the long term to improve maternal education and also massive education related to the importance of immunization to increase the complete basic immunization coverage in Kujan Village.

REFERENCES

Ahmad, N. A., Jahis, R., Kuay, L. K., Jamaluddin, R., & Aris, T. (2017). Primary immunization among children in malaysia: Reasons for incomplete vaccination. *Journal of Vaccines & Vaccination*, *8*(3), 1-8. doi: https://doi.org/10.4172/2157-7560.1000358

Dinas Kesehatan Lamandau. (2018). Profil Dinas Kesehatan Lamandau Tahun 2018. Nanga Bulik: Dinas Kesehatan Lamandau.

Dinas Kesehatan Provinsi Kalimantan Tengah. (2016). *Profil Dinas Kesehatan Provinsi Kalimantan Tengah Tahun 2016*. Palangkaraya: Dinas Kesehatan Provinsi Kalimantan Tengah.

Dinas Kesehatan Provinsi Kalimantan Tengah. (2017). *Profil Dinas Kesehatan Provinsi Kalimantan Tengah Tahun 2017*. Palangkaraya: Dinas Kesehatan Provinsi Kalimantan Tengah.

Emilya, S., Lestari, Y., & Asterina, A. (2017). Hubungan Pengetahuan dan Sikap Ibu Balita terhadap Tindakan Imunisasi Dasar Lengkap di Kelurahan Lambung Bukit Kota Padang Tahun 2014. *Jurnal Kesehatan Andalas*, *6*(2), 386-390. doi: https://doi.org/10.25077/jka.v6i2.709

Girmay, A., & Dadi, A. F. (2019). Full immunization coverage and associated factors among children aged 12-23 months in a hard-to-reach areas of Ethiopia. *International journal of pediatrics*, *2019*, ID 1924941, 8 pages, doi: https://doi.org/10.1155/2019/1924941

Hafid, W., Martini, S., & Devy, S. R. (2016). Faktor determinan status imunisasi dasar lengkap pada bayi di Puskesmas Konang dan Geger. *Jurnal Wiyata: Penelitian Sains dan Kesehatan*, *3*(1), 38-45.

Hudhah, M., & Hidajah, A. (2017). Perilaku Ibu Dalam Imunisasi Dasar Lengkap Di Puskesmas Gayam Kabupaten Sumenep. Jurnal Promkes: The Indonesian Journal of Health Promotion and Health Education, 5(2), 167-180. doi: http://dx.doi.org/10.20473/jpk.V5.I2.2017.167-180

Kementerian Kesehatan, R. I. (2017). *Data and Informasi: Profil Kesehatan Indonesia*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Maharani, A., & Kuroda, Y. (2018). Determinants of immunization status among 12-to 23-month-old children in Indonesia (2008–2013): a multilevel analysis. *BMC Public Health*, *18*, (288), 1-11. doi: https://doi.org/10.1186/s12889-018-5193-3

Maiwada, A. A., Dahiru, S., & Onwuka, G. I. (2019). A Survey on Attitude of Mothers towards Immunization of Their Children in Nigeria (A Case Study of Zuru Metropolis). *The International Journal of Engineering and Science (IJES)*, *8 (11) 31-38*.

Meleko, A., Geremew, M., & Birhanu, F. (2017). Assessment of child immunization coverage and associated factors with full vaccination among children aged 12–23 months at Mizan Aman town, bench Maji zone, Southwest Ethiopia. *International journal of pediatrics*, *2017*, *ID 7976587, 11 pages. doi:* https://doi.org/10.1155/2017/7976587

Noh, J. W., Kim, Y. M., Akram, N., Yoo, K. B., Park, J., Cheon, J., ... & Stekelenburg, J. (2018). Factors affecting complete and timely childhood immunization coverage in Sindh, Pakistan; A secondary analysis of cross-sectional survey data. *PloS one*, *13*(10), e0206766. doi: https://doi.org/10.1371/journal.pone.0206766

Rahmawati, A., & Wahjuni, C. (2014). Factors Affecting Completeness Basic Immunization Village District of North Krembangan. Jurnal Berkala Epidemiologi, 2(1), 59-70. doi: http://dx.doi.org/10.20473/jbe.V2I12014.59-70

Rahmi, N., & Husna, A. (2018). Faktor yang Mempengaruhi Kelengkapan Imunisasi Dasar pada Bayi di Wilayah Kerja Puskesmas Peukan Bada Kabupaten Aceh Besar. *Journal of Healthcare Technology and Medicine*, *4*(2), 209-222. doi: https://doi.org/10.33143/jhtm.v4i2.222

Risnawati, D. (2014). Pengaruh Pengetahuan, Pendidikan, Pendapatan, dan Budaya Ibu Terhadap Kelengkapan Imunisasi Dasar Lengkap di Kelurahan Pacarkembang. *Skripsi*. Surabaya: Faculty of Public Health, Universitas Airlangga.

Ritonga, M., Syarifah, M. S., & Tukiman, M. K. M. (2015). Hubungan Antara Dukungan Keluarga Terhadap Kepatuhan Ibu Melaksanakan Imunisasi Dasar Pada Anak Di Desa Tigabolon Kecamatan Sidamanik Kabupaten Simalungun Tahun 2014. *Kebijakan, Promosi Kesehatan dan Biostatistika*, *1*(2).

Saifuddin, A. (2013). *Sikap manusia teori dan pengukurannya.* Yogyakarta: Pustaka Pelajar Offset.

Sari, D. N. I., Basuki, S. W., Triastuti, N. J. (2016). Hubungan pengetahuan ibu tentang imunisasi dasar dengan kelengkapan imunisasi dasar bayi di wilayah kerja puskesmas bendo Kabupaten Magetan. *Biomedika, 8 (2), 6-12,* doi: https://doi.org/10.23917/biomedika.v8i2.2910

Septianingtyas, W. R., & Soesetijo, F. A., Yani, R. W. E. (2018). Pengaruh Dukungan Kader dalam Imunisasi Dasar Lengkap di wilayah kerja Puskesmas Jelbuk dan Klatakan, Kabupaten Jember. *Multidisciplinary Journal*, *1*(1), 21-24. doi: https://doi.org/10.19184/multijournal.v1i1.8593

Suhaid, D. N., & Faranita, F. (2018). Factors Associated with Basic Immunization Status of Infants. *SEAJOM: The Southeast Asia Journal of Midwifery*, *4*(1), 32-39. doi: https://doi.org/10.36749/seajom.v4i1.26

Triana, V. (2016). Faktor yang berhubungan dengan pemberian imunisasi dasar lengkap pada bayi tahun 2015. *Jurnal kesehatan masyarakat Andalas*, *10*(2), 123-135. doi: https://doi.org/10.24893/jkma.v10i2.196

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RESEARCH **Open Access**

Passive Smokers Pregnant Women with Low Birth Weight

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Abstract
The number of cases of low-birth-weight babies at dr. Doris Sylvanus Regional General Hospital, Palangka Raya in 2017 was as many as 378 cases. One of the causes of low birth weight was mothers who smoke actively or passively during pregnancy. The objective of this study is to determine the relationship between passive smoking pregnant women and the incidence of low birth weight at the dr. Doris Sylvanus Regional General Hospital, Palangka Raya. This research is an observational study using a cross-sectional research design and a retrospective approach with a sample of 45 mothers obtained using purposive sampling technique. Data analysis used Chi-Square statistical test. The results of the study found that pregnant women with heavy passive smokers gave birth to babies with low birth weight as many as 28 people (62.2%) and 1 person who did not have low birth weight babies (2.2%). Meanwhile, pregnant women with light passive smokers who gave birth to low birth weight were 12 people (26.7%) and 4 people did not have low birth weight (8.9%). Thus, there is a significant relationship between passive smoking pregnant women and the incidence of low birth weight at dr. Doris Sylvanus Regional General Hospital, Palangka Raya with p = 0.047, OR = 9.33. For further researchers, it is recommended to examine the factors that cause pregnant women to smoke passively with the incidence of low-birth-weight babies.

Keywords: Pregnant Women, Passive Smokers, Low Birth Weight.

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1. INTRODUCTION

Neonatals with complications are neonates with diseases and/or abnormalities that can cause disability and/or death, such as asphyxia, jaundice, hypothermia, neonatal tetanus, infection/sepsis, birth trauma, Low Birth Weight Babies (LBW), respiratory distress syndrome, and congenital abnormalities as well as those included in the yellow and red classification on examinations with the Integrated Management of Young Infants (Kementerian Kesehatan, R. I., 2016).

Low birth weight (LBW) is associated with increased morbidity and mortality in neonates. Premature birth also causes some complications, such as respiratory distress, feeding intolerance, or below-normal neurodevelopment compared to full-term babies. Many factors contribute to low birth weight and preterm birth, and one of the important factors is exposure to cigarettes, such as maternal smoking and exposure to secondhand smoke. Maternal active smoking during pregnancy causes decreased birth weight and significantly increases the risk of low birth weight. Decreased birth weight was discovered to be poorly correlated with maternal smoking rates during pregnancy (Ko, et al., 2014).

According to the World Health Organization (WHO), exposure to cigarette smoke in pregnancy is also associated with a risk of about 22% of babies being born with low birth weight (<2500g) (World Health Organization, 2013). In Indonesia, the prevalence of men who smoke is around 67% and the prevalence of passive smokers who are exposed to secondhand smoke at home is around 78.4%. Meanwhile, the prevalence of low birth weight in Indonesia based on the results of Basic Health Research 2013 is around 10.2% (Kementerian Kesehatan, R. I., 2013).

However, the number of cases of low birth weight in Central Kalimantan in 2014 was 535 cases or 491.6% of the number of live births, an increase compared to 2015 as many as 556 cases or 1.2% of the number of live births (Dinas Kesehatan Provinsi Kalimantan Tengah, 2015). Meanwhile, the number of cases of babies with low birth weight at dr. Doris Sylvanus Regional General Hospital, Palangka Raya in 2016 as many as 378 cases and in 2017 as many as 332 cases (Rumah Sakit Umum Daerah dr. Doris Sylvanus, 2017).

One of the causes of low birth weight is mothers who smoke actively or passively during pregnancy. Research conducted by Titisari, (2011), discovered that pregnant women with passive smoking status have a significantly 5 times greater risk than pregnant women who are not passive smokers to give birth to low-birth-weight babies. Pregnant women who are exposed to cigarette smoke can adversely affect pregnancy and the fetus in the mother's womb. Chemical compounds contained in cigarettes can enter the body of a pregnant mother and poison the fetus.

Disruption of oxygen delivery to the fetus is the main cause of various adverse effects due to smoking in pregnant women. Pathological evaluation of the placentas of pregnant women who smoke demonstrates structural changes, including decreased capillary volume fraction and increased vitelline membrane immunity when compared to nonsmokers. Both of these factors may contribute to the abnormal gas exchange in the placenta. Acute exposure to cigarette smoke also reduces intervillous perfusion, possibly through nicotine-induced vasospasm (Bachok & Salinah, 2014).

Passive smoking is a combination of side stream smoke that comes from the tip of a cigarette that is burned and mainstream smoke exhaled by smokers. Environmental Tobacco Smoke (ETS) is a carcinogen along with asbestos, benzene and radon gas (Goel, et al., 2004). Cigarettes contain nicotine which is a toxic chemical. In addition to nicotine, in cigarettes, there are also sugar compounds, additives, sauces, flavors, aromas, and others, so as to form a taste that meets the tastes of consumers (smokers).

Nicotine can cause addiction in both active and passive smokers. Exposure to carbon monoxide from smoking causes the formation of carboxyhemoglobin, which has multiple effects on both systemic and fetal oxygen delivery. Nicotine exposure to the fetus results in sympathetic activation that causes an accelerated fetal heart rate and decreased fetal respiration. Human infants who have significant nicotine levels at birth have a limited ability to maximize heart rate during the first hour of life (Bachok & Salinah, 2014). The objective of this study is to determine the relationship of passive smoking pregnant women with the incidence of low-birth-weight babies at dr. Doris Sylvanus Regional General Hospital, Palangka Raya.

2. RESEARCH METHOD

This research is an analytic observational study with a Cross Sectional approach. This research has been conducted at dr. Doris Sylvanus Regional General Hospital, Palangka Raya and performed in July - September 2018. The sample in this study were 45 pregnant women who were taken using the Purposive Sampling technique.

The instruments used in this study were interviews and fill-in formats. Data on the frequency of mothers exposed to cigarette smoke were obtained through interviews with mothers using data collection forms and data on the number of babies with low birth weight were known from the register book of the perinatology room at the dr. Doris Sylvanus Regional General Hospital, Palangka Raya.

The data analysis technique in this study used univariate analysis and bivariate analysis using the Chi-Square statistical test. To determine the odds ratio (OR) with 95% confidential interval (CI), it employed the risk test. This research has also received ethical approval by the Health Research Ethics Commission of the Health Polytechnic of the Ministry of Health of Palangka Raya with Number: 02 B/XI/KE.PE/2018.

3. RESULTS AND DISCUSSION

Table 1. Frequency Distribution of Respondents.

Variable	Frequency (n)	Percentage (%)
Baby Birth Weight		
<2500 gram	40	88,9
>2500 gram	5	11,1
Status of passive smoking mothers		
Moderate	16	35,6
Severe	29	64,4
Age of passive smoking mothers		
<20 years old	3	6,7
20-35 years old	41	91,1
>35 years	1	2,2
Parity of passive smoking mothers		
Primipara	13	28,9
Multipara	31	68,9
Grandemultipara	1	2,2
Complications during pregnancy		
Severe anemia	1	2,2
Antepartum hemorrhage	2	4,4
Severe Preeclampsia	18	40,0

Premature Rupture of Amniotic fluid	24	53,3
Education of passive smoking mothers		
Elementary School	14	31,1
Junior High School	7	15,6
Senior High School	17	37,8
University	7	15,6
Passive smoking mother's occupation		
Housewife	36	80,0
Private employees	4	8,9
Civil Servant	5	11,1
Smoker family income		
Low	2	4,4
Medium	27	60,6
High	13	28,9
Very high	3	6,7

Based on table 1, it is known that the most birth weights were <2500 grams as many as 40 babies (88.9%).The status of mothers who were heavy passive smokers was 29 mothers (64.4%).The most passive smoking mothers were 20-35 years old with 41 mothers (91.1%).The highest parity of smoking mothers was multiparous with 31 mothers (68.9%).The highest number of complications during pregnancy was premature rupture of membranes with 24 cases. The highest education of passive smoking mothers was high school with 17 mothers (37.8 %). The occupation of the most mothers, which was Housewives amounted to 36 mothers (80%) and the status of the highest family income, that was low income, amounted to 7 families (60.6%).

Table 2. Relationship of Pregnant Women with Passive Smokers with Low-Birth-Weight Babies.

Passive Smoking Mothers	**BBLR**				**Total**	**%**	***P Value***	**OR**
	Yes	**%**	**No**	**%**				
Heavy	28	62,2	1	2,2	29	64,4		
Light	12	26,7	4	8,9	16	35,6	0,047	9,33
Total	40	88,9	5	11,1	45	100		

Based on table 2, it is presented the results of pregnant women with heavy passive smokers giving birth to babies with low birth weight as many as 28 mothers (62.2%) and those who did not have low birth weight as many as 1 mother (2.2%). Meanwhile, pregnant women with light passive smokers who gave birth to babies with low birth weight were 12 mothers (26.7%) and 4 mothers did not have low birth weight (8.9%). The results of statistical tests that obtained a significant value of 0.047. Therefore, the *p* value was <0.05. It shows that there is a significant relationship between passive smoking pregnant women and the incidence of low birth weight at dr. Doris Sylvanus Regional General Hospital, Palangka Raya and the results of statistical calculations also obtained an OR number of *p-value* = 9.33 (95% CI).

Birth of low birth weight in passive smoking mothers is caused by continuous exposure to carbon monoxide (CO) during pregnancy. Carbon monoxide (CO) can be bound in the mother's hemoglobin, resulting in decreased oxygen-carrying capacity (O2) in the mother's blood and in the end the fetus's body will receive less oxygen. In addition to carbon monoxide (CO), nicotine produced from cigarette smoke from active smokers and then inhaled by pregnant women can also reduce placental perfusion.

The results of research conducted by Rufaridah, (2012), showed that pregnant women with passive smokers had 7.06 times the possibility of giving birth to babies with low birth weight compared to pregnant women who were not passive smokers. Nicotine is a vasoconstrictor. Thus, it constricts the blood vessels of the placenta and smoke increases the viscosity of the blood, making the blood a little thicker, thereby further impeding blood flow. Smoke from cigarette burning can enter through the placenta which increases the risk of low birth weight. The impact of the influence of these substances is below normal fetal growth.

Research conducted by Irnawati, (2011), showed that 90% of the most common sources of exposure to cigarette smoke for pregnant women were family members who smoked at home. The results of research conducted by Nurjanah, et al., (2014), showed that the factors associated with low birth weight are the duration of exposure to cigarette smoke in pregnant women in a day or per day. The results of research conducted by Noraini, et al., (2015), in Denpasar revealed that exposure to cigarette smoke in the house increases the risk of premature birth in Denpasar City.

Pramono and Muzakkiroh (2011), with measurements of continine levels (primary nicotine metabolism) found to be 80% in passive smokers. Meanwhile, in the Ramadhan research, (2012), 57% of women exposed to cigarette smoke gave birth to babies with low body weight.

Research conducted by Chelchowska, (2013), stated that pregnant women with passive smoking status had a significantly 5 times greater risk than pregnant women who were not passive smokers to give birth to low-birth-weight babies. The results of research conducted by Rasyid, (2012), showed that there were 3 variables that were important determinants of the risk of giving birth to babies with low birth weight and one of the variables was exposure to cigarette smoke. Hence, the incidence of babies with low birth weights was 4.2 times greater compared to unexposed mothers.

The results of research conducted by Ko, et al., (2014), found that all groups of mothers who smoked had a higher incidence of low birth weight and premature birth, particularly if the mother smoked >20 cigarettes/day. Mothers who smoke are responsible for the increased incidence of low birth weight and therefore, smoking cessation or reduction should be advised to pregnant women to reduce morbidity in their neonates.

This study is not in line with research conducted by Zulardi, (2014), which stated that the highest incidence of low birth weight was in mothers aged <20 years or more than 35 years. Pregnancy over 35 years of reproductive organs is less fertile and increases the risk of birth with congenital abnormalities and is at risk for premature birth. A good age for pregnant women is 20-35 years. Babies born prematurely are also due to the mother's age being too young or too old, for young people less than 20 years old and too old for over 35 years. The age factor can affect the condition of the cervix because it is too weak, thus, the baby is born prematurely.

Research conducted by Hanum and Wibowo, (2016), showed that of the 48 mothers in the high-risk age category, the majority gave birth to babies with low birth weight, that were 39 mothers (81.25%). It is possible that pulmonary function impairment has not occurred so that smokers still do not feel the effects of cigarette smoke which results in smoking behavior being carried out and influencing people around to become passive smokers. However, with the increasing age, the possibility of pulmonary function abnormalities will be greater and receive longer exposure to pollutants, including exposure to other people's cigarette smoke.

The results of research conducted by Takziah, et al., (2013), examined that the incidence of low birth weight was more common in risk parity mothers, while normal birth weight babies were more likely to be born to non-risk parity mothers. Hence, the more parity of the mother, the more the risk with the incidence of low birth weight. Grandemultipara pregnancy causes a decline in the flexural power (elasticity) of tissues that have been repeatedly stretched by pregnancy, Thus, it tends to arise abnormalities in the location or abnormalities of placental growth and fetal growth so that they give birth to babies with low birth weight. It can affect the supply of nutrients from the mother to the fetus and the higher the parity, the higher the risk of giving birth to a baby with low birth weight.

The causes of low-birth-weight babies are generally multifactorial, one of which is maternal factors who experience complications during pregnancy such as severe anemia, antepartum bleeding, hypertension, severe preeclampsia, urinary tract infection (UTI) and premature rupture of membranes, and also socio-economic factors, culture related to education level, mother's occupation, and family economy. Education will indirectly affect the outcome of a pregnancy, especially the incidence of babies with low birth weight. It is related to the mother's knowledge in maintaining the condition of pregnancy as well as efforts to get service and health checks during pregnancy (Proverawati & Ismawati, 2010).

The results of this study show that not only mothers with low education give birth to babies with low birth weight, but also mothers with higher education are still at risk of giving birth to babies with low birth weight. Similar to the results of research conducted by Irnawati, et al., (2011), mothers who have an education level of Elementary School are 1.6 times more likely to give birth to babies with low birth weight compared to mothers who have an education level of Junior High School.

In Indonesia, which is a developing country, the prevalence of people exposed to secondhand smoke is very high due to the high prevalence of smokers. The low level of awareness of a person and the weak enforcement of non-smoking area regulations cause the prevalence of active and passive smoking in Indonesia to continue to increase from year to year. Zuladri's research, (2014), showed that pregnant women with moderate smoking environments had a 3.25 greater risk of giving birth to babies with low birth weight than pregnant women with light smokers.

4. CONCLUSION

Based on the results of the study above, it shows that there is a significant relationship between passive smoking pregnant women and the incidence of low birth weight at dr. Doris Sylvanus Regional General Hospital, Palangka Raya with p = 0.047, OR = 9.33. For further researchers, it is recommended to examine the factors that cause passive smoking pregnant women with the incidence of low-birth-weight babies.

REFERENCES

Bachok, N. A., & Salinah, O. (2014). The effect of second-hand smoke exposure during pregnancy on the newborn weight in Malaysia. *The Malaysian Journal of Medical Sciences: MJMS*, *21*(2), 44-53.

Chelchowska, M., Ambroszkiewicz, J., Jablonka-Salach, K., Gajewska, J., Maciejewski, T. M., Bulska, E., ... & Leibschang, J. (2013). Tobacco smoke exposure during pregnancy increases maternal blood lead levels affecting neonate birth weight. *Biological Trace Element Research*, *155*(2), 169-175. doi: https://doi.org/10.1007/s12011-013-9775-8

Dinas Kesehatan Provinsi Kalimantan Tengah. (2015). *Profil Kesehatan Provinsi Kalimantan Tengah Tahun 2015*. Palangka Raya: Dinas Kesehatan Provinsi Kalimantan Tengah.

Goel, P., Radotra, A., Singh, I., Aggarwal, A., & Dua, D. (2004). Effects of passive smoking on outcome in pregnancy. *Journal of postgraduate medicine*, *50*(1), 12-16.

Hanum, H., & Wibowo, A. (2016). Pengaruh paparan asap rokok lingkungan pada ibu hamil terhadap kejadian berat bayi lahir rendah. *Jurnal Majority*, *5*(5), 22-26.

Irnawati, I., Hakimi, M., & Wibowo, T. (2011). Ibu hamil perokok pasif sebagai faktor risiko bayi berat lahir rendah. Jurnal Gizi Klinik Indonesia, 8(2), 54-59. doi: http://dx.doi.org/10.22146/ijcn.17769

Kementerian Kesehatan, R. I. (2013). *Riset Kesehatan Dasar Tahun 2013*. Jakarta: Badan Penelitian dan Pengembangan Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan, R. I. (2016). *Profil Kesehatan Indonesia Tahun 2015*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Ko, T. J., Tsai, L. Y., Chu, L. C., Yeh, S. J., Leung, C., Chen, C. Y., ... & Hsieh, W. S. (2014). Parental smoking during pregnancy and its association with low birth weight, small for gestational age, and preterm birth offspring: a birth cohort study. *Pediatrics & Neonatology*, *55*(1), 20-27. doi: https://doi.org/10.1016/j.pedneo.2013.05.005

Noriani, N. K., Putra, I. A. E., & Karmaya, M. (2015). Paparan asap rokok dalam rumah terhadap risiko peningkatan kelahiran bayi prematur di kota denpasar. *Public Health and Preventive Medicine Archive*, *3*(1), 68-73.

Nurjanah, N., Kresnowati, L., & Mufid, A. (2014). Gangguan Fungsi Paru Dan Kadar Cotinine Pada Urin Karyawan Yang Terpapar Asap Rokok Orang Lain. *KEMAS: Jurnal Kesehatan Masyarakat*, *10*(1), 43-52.

Proverawati, A., & Ismawati, C. (2010). *BBLR (Berat Badan Lahir Rendah)*. Yogyakarta: Nuha Medika.

Pramono, M. S., & Muzakkiroh, U. (2011). Pola Kejadian Bayi Berat Lahir Rendah Dan Faktor Yang Memengaruhinya Di Indonesia Tahun 2010. *Buletin Penelitian Sistem Kesehatan*, 14(3), 209-17.

Ramadhan, N. (2012). Hubungan ibu hamil perokok pasif dengan kejadian bayi berat lahir rendah di badan layanan umum daerah RSU Meuraxa Banda Aceh. *Jurnal Ilmiah STIKES U'Budiyah*, *1*(2). 27-34.

Rasyid, P. S. (2012). Faktor Risiko Kejadian Bayi Berat Lahir Rendah Di RSUD Prof. Dr. H. Aloei Saboe Kota Gorontalo Provinsi Gorontalo Tahun 2012. *Thesis*. Makassar: Universitas Hassanuddin.

Rufaridah, A. (2012). Pengaruh perokok pasif terhadap plasenta, berat badan lahir, apgar score bayi baru lahir pada ibu hamil di Kabupaten Padang Pariaman Tahun 2011. *Thesis*. Padang: Program Studi Ilmu Biomedik Universitas Andalas.

Rumah Sakit Umum Daerah dr. Doris Sylvanus Palangka Raya. (2017). *Profil RSUD dr. Doris Sylvanus Palangka Raya 2017*. Palangka Raya: Rumah Sakit Umum Daerah dr. Doris Sylvanus Palangka Raya.

Tazkiah, M., Wahyuni, C. U., & Martini, S. (2013). Determinan epidemiologi kejadian BBLR pada daerah endemis malaria di Kabupaten Banjar Provinsi Kalimantan Selatan. *Jurnal Berkala Epidemiologi*, *1*(2), 266-276.

Titisari, B. R. (2011). Hubungan Ibu Hamil Sebagai Perokok Pasif dengan Bayi Berat Badan Lahir Rendah di Surakarta. *Skripsi*. Surakarta: Fakultas Kedokteran, Universitas Sebelas Maret.

World Health Organization. (2013). *WHO recommendations for the prevention and management of tobacco use and second-hand smoke exposure in pregnancy*. Geneva: World Health Organization.

Zulardi, A. R. (2014). Hubungan Lingkungan Perokok dengan Ibu Hamil Terpapar Asap Rokok terhadap Kejadian Bayi Berat Lahir Rendah di Surakarta. *Skripsi*. Surakarta: Fakultas Kedoteran, Universitas Surakarta.

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RESEARCH **Open Access**

Antibacterial Activity of Endophytic Fungus Isolates of Mangrove Fruit (*Sonneratia alba*) Against *Staphylococcus aureus* and *Escherichia coli*

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Abstract
Endophytic fungi live and associate in plant tissues and have a mutualistic relationship. Endophytic fungi produce various compounds such as steroids, terpenoids, phenolics, alkaloids which are the same as secondary metabolites from their host plants. The objective of this study is to isolate and identify endophytic fungi from mangrove fruit (*Sonneratia alba*) and to determine the antibacterial activity of endophytic fungi isolates against the growth of *Staphylococcus aureus* and *Escherichia coli*. The type of research is pre-experimental design, one shoot case study. The methods used are isolation, identification and agar diffusion. The pieces of mangrove fruit were disinfected and then cultured on SDA media to grow endophytic fungi isolates. The isolates were cultured repeatedly until pure isolates were obtained. The test of isolate activity against antibacterial was determined by the agar diffusion method with the test material of 2 isolates of endophytic fungi on Nutrient Agar (NA) media. The results showed that the mangrove fruit (*Sonneratia alba*) produced two isolates of endophytic fungi that could inhibit the growth of *Staphylococcus aureus* and *Escherichia coli*. It was concluded that the mangrove fruit culture produced 2 isolates, which are isolate 1 *Aspergillus niger* and isolate 2 *Aspergillus flavus*. Isolate 1 and isolate 2 had the potential as antibacterial against the growth of *Staphylococcus aureus* and *Escherichia coli*. Isolate 2 was more effective than isolate 1 in inhibiting the growth of Staphylococcus aureus. It is recommended to test the pharmacological and microbiological activity of the findings of isolates 1 and 2 in vivo.

Keywords: Mangrove, Antibacterial, Endophytic Fungi.

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1. INTRODUCTION

Microbes are very small living things that can live outside the host body (epiphytic microbes) and live inside the host body (endophytic microbes). Currently, endophytic microbes from plants have been widely studied to determine their potential in treatments such as antibacterial. Endophytic microbes in the form of bacteria, molds and yeasts can be isolated from all plant tissues. The screening results showed that each tissue contained endophytic microbes that differed from one plant to another. The number of isolates obtained from one part of the host plant is frequently very large, but only a few microbes are dominant in one host (Kumala, 2014).

Endophytic fungi are fungi that live internally and associate in plant tissues and have a mutualistic relationship with their host plants as protection against herbivores, insects and pathogens. Endophytic fungi can produce various compounds such as steroids, terpenoids, phenolics, alkaloids that have the potential as antioxidants, anti-cancer, antibacterial, antiviral, and anti-fungal (Rollando, 2019). The most commonly found bio actives are alkaloids (Kumala, 2014). Some alkaloids can only be produced by plants infected with fungi (Hidayat, et al, 2016).

The existence of mangroves in Indonesia is very abundant in species as identified by Suryono, (2015) finding 10 species in Segara Anakan. Suryono, et al., (2020) found 6 species in Jepara, Central Java. Kezia, et al., (2019) found 10 species in Barru, South Sulawesi. Mangrove fruit has the potential as a source of antioxidants which are proven to contain alkaloids, flavonoids, phenolic compounds, tannins and steroids (Paputungan, et al., 2017). *Sonneratia alba* extract has antibacterial activity of Streptococcus mutans, Propionibacterium acnes, and Candida albicans. The extract contains secondary metabolites such as alkaloids, phenols, tannins, saponins and flavonoids (Putri, et al., 2016; Kurniawan, et al., 2017). Endophytic fungi isolated from mangrove leaves have the potential to inhibit the growth of *Staphylococcus aureus* and *Escherichia coli* (Dwilestari, et al., 2015). Endophytic bacteria from mangroves have the potential as antibacterial against *Bacillus sp* and *Eschericia sp*, *Staphylococcus aureus* and *Escherichia coli* (Lutfia, 2017; Rismawati, 2018). The objective of the study is to isolate and identify endophytic fungi from mangrove fruit and to determine the antibacterial activity of endophytic fungi isolates against *Staphylococcus aureus* and *Escherichia coli* growth. This research is useful for developing the potential of mangroves as medicinal ingredients, especially antibacterial. Finding the types of endophytic fungi isolates on mangrove fruit and proving the activity of the isolates as antibacterial is the novelty of this study.

2. RESEARCH METHOD

The type of research used is a pre-experimental design, one shoot case study which was conducted at the Microbiology Laboratory of the University of East Indonesia. The step-by-step procedure was isolation of endophytic fungi, identification of endophytic fungi isolates and in vitro antibacterial activity of endophytic fungi isolates.

Isolation and Purification of Endophytic Fungi were from Mangrove Fruit (*Sonneratia alba*). All glassware used were sterilized in an oven at 180^{o}C for 2 hours. The test material for Mangrove fruit (*Sonneratia alba*) was taken from the village of Bonto Perak, Pangkajene District, Pangkajene Regency and Islands Province of South Sulawesi. Mangrove fruit was washed with running water for 10 minutes. Then, the surface was sterilized by immersing successively into 75% alcohol for 1 minute, 5% sodium hypochlorite (NaOCl) for 5 minutes, and 75% alcohol for 30 seconds. Furthermore, the mangrove fruit was dried in a sterile petri dish which was given sterile

filter paper. Mangrove fruit was cut transversely and longitudinally with a size of ± 1 cm above a sterile glass object. Then, the pieces of Mangrove Fruit were inoculated on SDA medium (Sabouraud Dextrose Agar with 0.005% chloram phenicol added) in a petri dish. Incubated at 25°C for 5-7 days. The results of the isolation of endophytic fungi growing on SDA medium were purified by re-inoculation of single colonies on SDA media and incubated for 3 days at 25°C. The incubation results discovered several types of pure mold based on observations of the shape and color of the colonies on SDA medium. Each colony with a different shape or color was re-cultured repeatedly to obtain a pure colony isolate of endophytic fungi.

The results of endophytic fungi isolates were further identified based on macroscopic and microscopic basis. Macroscopic observations included colony shape and color and microscopic observations (shape and size of hyphae, conidia, spores with a microscope). Fungi were identified by matching microscopic specifications with the literature.

Testing the Antibacterial Activity of Mangrove Endophytic Fungi Against *Staphylococcus aureus* and *Escherichia coli*. The test bacteria *Staphylococcus aureus* and *Escherichia coli* were rejuvenated 1x24 hours and then suspended until a turbidity level was obtained which was equivalent to the Mc Farland standard of 0.5. Mangrove fruit endophytic fungi (*Sonneratia alba*) which had grown on SDA medium were suspended with sterile distilled water. Blank paper discs were immersed in a suspension of endophytic fungi for 30 minutes and then drained. Sterile Nutrient Agar (NA) medium was poured aseptically into sterile petri dishes and allowed to solidify. *Staphylococcus aureus* and *Escherichia coli* suspensions were inoculated on the surface of the NA medium, respectively, using a sterile swab evenly. Paper discs were placed on NA medium that had been inoculated with the test bacteria at approximately the same distance from each other, incubated at 37°C for 1×24 hours. The zone of inhibition formed was measured. The test was administered with 4 times replication. The research has also received a recommendation from the ethics committee of the Health Polytechnic of the Ministry of Health Makassar with the ethics number: 422/KEPK-PTKMKS/V/2019.

3. RESULTS AND DISCUSSION

The results of macroscopic and microscopic observations on isolate 1 and isolate 2 can be seen from the following figure:

Figure 1. Characteristics of fungal isolate 1 macroscopically.

Figure 1 shows the macroscopic characteristics of isolate 1, which is the color of the colonies black with white around, the shape of the colonies is round, the distribution is concentrated, the surface of the colonies is rough.

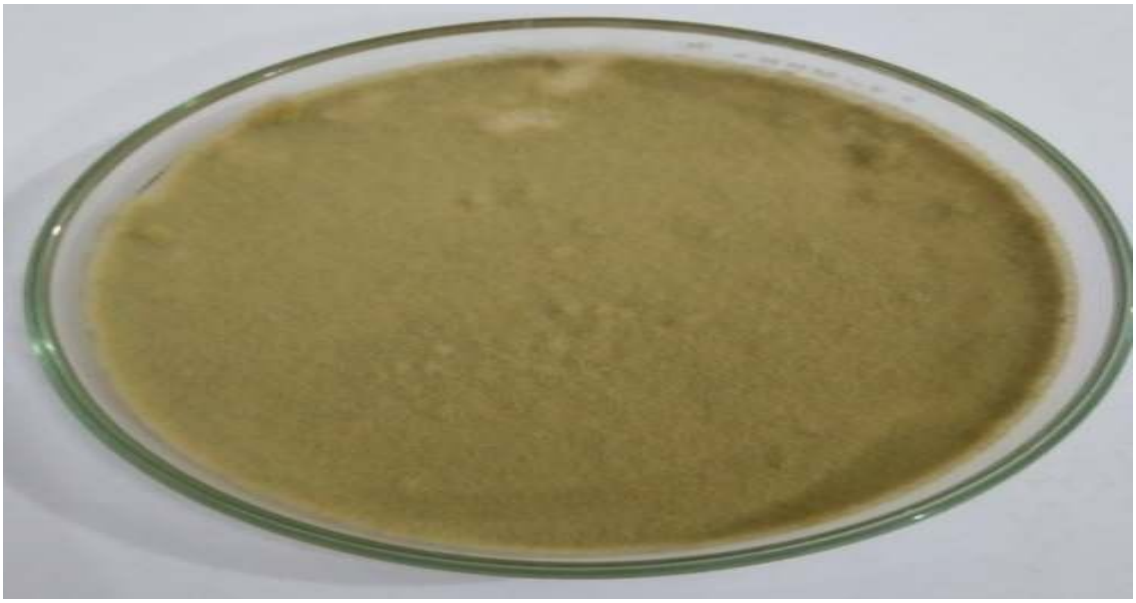

Figure 2. Macroscopic characteristics of fungal isolate 2.

Figure 2 shows the macroscopic characteristics of isolate 2, which is yellowish green colonies, irregular colony shape, spread, smooth colony surface like flour.

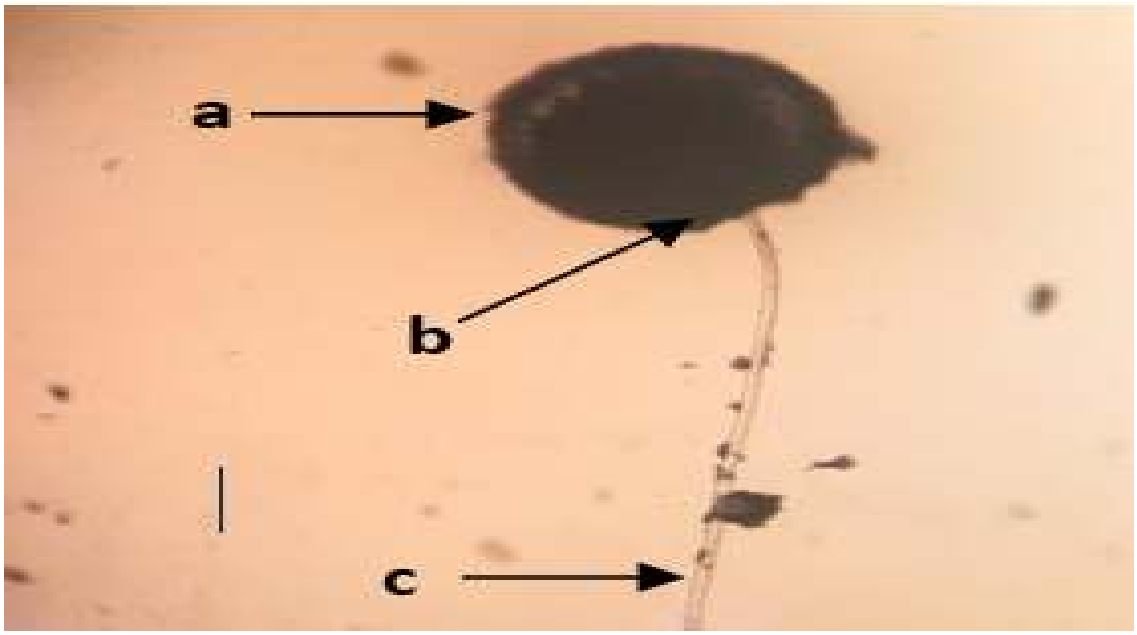

Figure 3. Characteristics of fungal isolate 1 microscopically consisting of: a. Conidia, b. Vesicles and c. Conidiophores.

Figure 3 shows the microscopic characteristics of isolate 1, that is large conidia, round to oval in shape, black in color, conidia in many strands. This fungus has long, thin-walled conidiophores. At the end, it enlarges to form a circle.

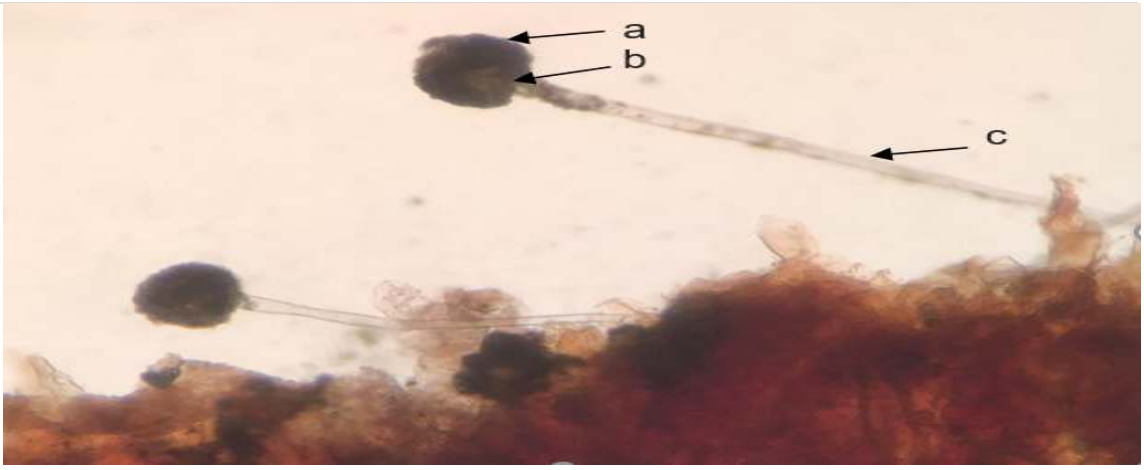

Figure 4. Characteristics of fungal isolate 2 microscopically consisting of: a. Conidia, b. Vesicles and c. conidiophores.

Figure 4 shows the microscopic characteristics of isolate 2, which is conidia in many-shaped series. This fungus has thin-walled conidiophores.

Table 1. Results of Measurement of the Growth Inhibition Zone of *Staphylococcus aureus* and *Escherichia coli.*

Sample	Treatment	Diameter of Bacterial Growth Inhibition Zone (mm)				Average
		1	2	3	4	
Staphylococcus aureus	Isolate 1	9,5	9,5	10	10	9,75
	Isolate 2	14,5	13,25	12	12,25	13
Escherichia coli	Isolate 1	10	9,75	10,5	10	10,06
	Isolate 2	11,5	11	10,75	10,5	10,93

The distribution of mangrove plants in Indonesia is very large, for intanstance, in Barru Regency, South Sulawesi, 7 species were found (Saru, et al., 2019) and in Rote Ndao, East Nusa Tenggara, 11 species were found (Ngoma, et al., 2020). It provides an opportunity to utilize mangrove species for treatment, for example as an antibacterial. The use of mangroves has been examined in the form of extracts, but isolating endophytic fungi from mangrove fruit is a more efficient way of utilization. The use of endophytic microbes as antibacterial has been performed on other plant species such as katokkon chili (Rolando, 2019), cucumber (Yuanwar and Ainy, 2019), gotu kola (Hidayat, et al., 2018), secang wood (Amirullah, et al., 2019); areca nut (Nuryanti and Astuti, 2019), and beluntas leaves (Setiawan and Musdalipah, 2018).

The results of the study found two pure isolates of endophytic fungi from mangrove fruit (*Sonneratia alba*). The colony was identified as Aspergillus niger which is in accordance with Hidayat's, et al., (2018) statement that black colonies are a marker of the presence of Aspergillus niger. On microscopic observation of isolate 1, conidia were found to be large, round to oval in shape, black in color, conidia in series to be numerous. This fungus has long, thin-walled conidiophores. At the end, it enlarges to form a circle. Based on these characteristics, the isolate was suspected to be the fungus Aspergillus niger. It is in accordance with the statement of Gandjar (2000) that the characteristic of Aspergillus niger is that the conidia heads are black, round in shape, and tend to split into columns in old colonies. The stipe of conidiophores is smooth-walled, hyaline in color, but may also be brownish. The vesicles are spherical to

semicircular, and 50–100m in diameter. Conidia are spherical to semi-spherical measuring 3.5-5.0 m, brown in color and have irregular ornamentation in the form of protrusions and spines. The findings of *Aspergillus sp* isolates from mangrove plant cultures were also identified (Mukhlis, et al., 2018).

Observations on isolate 2 were macroscopically in the form of yellowish green colonies, irregular colony shape, spread, smooth colony surface like flour. Microscopic observations in the form of many conidia in series. This fungus has thin-walled conidiophores. These characteristics are thought to be the same as those of the flavus fungus. It is based on Amaliyah's (2017) statement that colonies of Aspergillus flavus generally grow rapidly and reach a diameter of 6-7 cm in 10-14 days. This mold has a yellow initial color which will turn greenish yellow or brown with an inverted golden color or colorless while the old colonies have a dark green color. Gandjar (2000), explained that the typical conidia head is round, then splits into several columns, and is yellowish green to yellowish dark green. Conidiophores are hyaline, leathery, and can reach a length of 1.0 mm (some are up to 2.5 mm). Vesicles are round to semi-spherical, conidia are round to semi-spherical (Sumampouw, 2019). Khalimah and Ainy (2019), have also isolated 3 isolates from mangroves and have even identified secondary metabolites from *Aspergillus sp* isolates as flavonoids, tannins and saponins.

The results of endophytic fungi isolates from mangrove fruit were obtained after antibacterial testing was performed against *Staphylococcus aureus* and *Escherichia coli*. The results showed that there were inhibition zones of isolates 1 and 2 of endophytic fungi of mangrove fruit against the growth of *Staphylococcus aureus* and *Escherichia coli*. In isolate 1, endophytic fungi of mangrove fruit which was examined on *Staphylococcus aureus* test bacteria had an average inhibition zone diameter of 9.75 mm and for Escherichia coli had an average inhibition zone diameter of 10.06 mm. For isolates 2 endophytic fungi of mangrove fruit tested on *Staphylococcus aureus* had an average inhibition zone of 13 mm and for *Escherichia coli* had an average inhibition zone of 10.03. These data indicate that endophytic fungi that grow on mangrove fruit (*Sonneratia alba*) can inhibit the growth of *Staphylococcus aureus* and *Escherichia coli*. The endophytic fungi activity of mangrove fruit is in line with the activity of mangrove plant extracts as antibacterial against several bacteria, including *Staphylococcus aureus* and *Escherichia coli* (Dwilestari, et al., 2015). This antibacterial potential is caused by the content of secondary metabolites present in plants such as steroids, terpenoids, phenolics, and alkaloids (Rollando, 2019; Kumala, 2014; Hidayat, et al., 2016). Endophytic fungi isolated from other coastal plants such as mangrove roots (Rhizophora apiculate) also produced 2 isolates of black fungus and white fungus that have potential as antibacterial *Staphylococcus aureus* and *Escherichia coli* (Kartika, et al., 2014). Posangi and Bara (2014) found 2 isolates identified as *Aspergillus sp.* and *Acremonium sp* which functions as an antibacterial for *Staphylococcus aureus* and *Escherichia coli*. Mukhlis, et al., (2018) found 3 types of isolates, which are *Fusarium sp, Penicillium sp* and *Aspergillus sp* which have the potential to inhibit the growth of *Staphylococcus aureus* and *Escherichia coli*.

Isolate 1 was identified as Aspergillus niger (colored black) and isolate 2 was identified as Aspergillus niger (colored white/beige). The results of the measurement of the diameter of the inhibition zone of isolates 1 and 2 of endophytic fungi against the growth of *Staphylococcus aureus* and *Escherichia coli* were analyzed by SPSS. The normality test shows a sig value of 0.024 which means that there is data that is not normally distributed. The homogeneity test shows a sig value of 0.045 <0.05, which means the data is not homogeneous. Hence, the next analysis was performed by the Kruskal Wallis non-parametric test and continued with Mann Whitney. Kruskal Wallis

test showed a sig value of 0.005 <0.05, which means that there was a difference in the effect of isolate 1 and isolate 2 in inhibiting the growth of *Staphylococcus aureus* and *Escherichia coli*. Further analysis with Mann Whitney showed differences in the effectiveness of endophytic fungi isolates as antibacterial as follows: The effectiveness of isolate 1 against *Staphylococcus aureus* and *Escherichia coli* was not significantly different, the effectiveness of isolate 1 and isolate 2 was not significantly different against *Escherichia coli* and isolate 2 was more effective than isolate 1 in inhibit the growth of Staphylococcus aureus. The effectiveness of isolate 2 which was identified as Aspergillus flavus was better than isolate 1 which was identified as Aspergillus niger in line with research (Kasi, et al., 2015) which concluded that white mycelium endophytic fungi had a better antibacterial effect than black mycelium endophytic fungi and positive controls.

The findings of endophytic fungi isolates in this study have the potential for further testing of pharmacological activities. The discovery of endophytic fungi isolates can further develop the use of *Sonseratia alba* without having to harvest this mangrove species every time.

4. CONCLUSION

Mangrove fruit (*Sonneratia alba*) produced two isolates of endophytic fungi, which were Isolate 1 suspected of Aspergillus niger and Isolate 2 suspected of Aspergillus flavus. Isolate 1 and isolate 2 of endophytic fungi from Mangrove Fruit (*Sonneratia alba*) have the potential as antibacterial against the growth of *Staphylococcus aureus* and *Escherichia coli*. Isolate 2 was more effective than isolate 1 in inhibiting the growth of Staphylococcus aureus. It is recommended to continue this research to test the pharmacological and microbiological activities of isolates 1 and 2 in vivo.

REFERENCES

Amaliyah, N. (2017). *Penyehatan Makanan Dan Minuman-A*. Jakarta: Deepublish.

Amirullah, A., Sartini, S., & Nainu, F. (2019). Fungi Endofit dari Tanaman Secang (Caesalpinia sappan L) Sebagai Penghasil Senyawa Antioksidan. *Jurnal Farmasi Galenika (Galenika Journal of Pharmacy)__(e-Journal)*, *5*(1), 26-32. doi: https://doi.org/10.22487/j24428744.2019.v5.i1.12013

Dwilestari, Awaloei, H., Posangi, J., & Bara, R. (2015). Uji Efek Antibakteri Jamur Endifit Pada Daun Mangrove *Sonneratia alba* Terhadap Bakteri Uji Staphylococcus Aureus Dan Escherichia Coli. e*Biomedik*, *3*(1), 394-398.

Gandjar, I., & Rifai, M. A. (2000). *Pengenalan kapang tropik umum*. Jakarta: Yayasan Obor Indonesia.

Hidayat, N., Wignyanto, Sumarsih, S., & Putri, A. I. (2016). *Mikologi Industri*. Malang: Universitas Brawijaya Press.

Hidayat, N., Meitiniarti, I., Yuliana N. (2018). *Mikroorganisme dan Pemanfaatannya*. Malang: Universitas Brawijaya Press.

Hidayat, M., Mufidah, M., & Rante, H. (2018). Isolasi Dan Karakterisasi Molekuler Mikroba Endofit Tanaman Pegagan (Centella asiatica L.) Sebagai Penghasil Antimikroba. *Majalah Farmasi Dan Farmakologi*, *22*(2), 56-60. doi: https://doi.org/10.20956/mff.v22i2.5702

Kartika, R., Bodhi, W., Kepel, B., & Bara, R. (2014). Uji daya hambat jamur endofit akar bakau *Rhizophora apiculata* terhadap bakteri *Staphylococcus aureus* dan *Escherichiae coli*. e*Biomedik*, *2*(1).

Kasi, Y. A., Posangi, J., Wowor, P. M., & Bara, R. (2015). Uji efek antibakteri jamur endofit daun mangrove Avicennia marina terhadap bakteri Uji Staphylococcus aureus dan Shigella dysenteriae. *eBiomedik*, *3*(1), 112-117.

Kezia, E., Nurkin, B., Bachtiar, B., Millang, S., Restu, M., & Larekeng, S. H. (2019). Potential of mangrove stands carbon deposits in the North Part Pannikang Islands, Barru Regency, South Sulawesi Province. *IOP Conference Series: Earth and Environmental Science, 343(1), p.012060.* doi: https://doi.org/10.1088/1755-1315/343/1/012060

Khalimah, D., & Ainy, E. Q. (2019). Isolasi fungi endofit daun mangrove *Avicennia marina* dan uji aktivitasnya sebagai antifungi terhadap *Candida albicans* ATCC. *Symposium of Biology Education (Symbion)*. *2* , 298-305. doi: https://doi.org/10.26555/symbion.3551

Kumala, S. (2014). *Mikroba Endofit Pemanfaatan Mikroba Endofit dalam Bidang Farmasi.* Jakarta: PT. ISFI Penerbitan.

Kurniawan, D., Muliawan, A., & Kuspradini, H. (2017). Efektivitas Ekstrak Buah Sonneratia Alba Terhadap Aktivitas Bakteri. *Jurnal Harpodon Borneo*, *10*(1), 1–12.

Lutfia, A. (2017). Skrining dan Karakterisasi Bakteri Endofitik dari *Sonneratia alba* (Sonneratiaceae) Sebagai Penghasil Antibiotika. *Skripsi*. Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Andalas.

Mukhlis, D. K., Rozirwan, R., & Hendri, M. (2018). Isolasi dan aktivitas antibakteri jamur endofit pada mangrove *Rhizophora apiculata* dari kawasan mangrove Tanjung Api-Api Kabupaten Banyuasin Sumatera Selatan. *Maspari Journal*, 10(2), 151-160.

Ngoma, R. B., Hendrik, A. C., & Ballo, A. (2020). Keanekaragaman Mangrove dan Pemanfaatannya di Desa Daiama, Kecamatan Landu Leko, Kabupaten Rote Ndao, Propinsi Nusa Tenggara Timur. *SIMBIOSA*, *9*(2), 118-128. doi: https://doi.org/10.33373/sim-bio.v9i2.2498

Nuryanti, S., & Astuti, R. (2019). Potensi Fungi Endofit Biji Pinang Sebagai Antibakteri Terhadap Escherichia coli dan Salmonella thypi. *Green Medical Journal*, *1*(1), 87-96. doi: https://doi.org/10.33096/gmj.v1i1.23

Paputungan, Z., Wonggo, D., & Kaseger, B. E. (2017). Uji Fitokimia Dan Aktivitas Antioksidan Buah Mangrove Sonneratia alba Di Desa Nunuk Kecamatan Pinolosian Kabupaten Bolaang Mongondow Selatan Sulawesi Utara. *Media Teknologi Hasil Perikanan*, *5*(3), 96-102. doi: https://doi.org/10.35800/mthp.5.3.2017.16866

Posangi, J., & Bara, R. A. (2014). Analisis aktivitas dari jamur endofit yang terdapat dalam tumbuhan bakau Avicennia marina di Tasik Ria Minahasa. *Jurnal Pesisir dan Laut Tropis*, *2*(1), 30-38. doi: https://doi.org/10.35800/jplt.2.1.2014.7345

Putri, R. R., Hasanah, R., & Kusimaningrum, I. (2016). Uji aktivitas antibakteri dan Uji fitokimia ekstrak daun mangrove Sonneratia alba. *J. Aquawarman*, *2*(1), 43-50.

Rismawati. (2018). Identifikasi Bakteri Endofit Daun Mangrove Api-Api Putih Avicennia marina) dan Potensinya Menghasilkan Senyawa Anti Mikroba. *Skripsi.* Fakultas Sains dan Teknologi, UIN Alauddin. Makassar.

Rollando. (2019). *Senyawa Antibakteri Dari Fungi Endofit*. Malang: CV Seribu Bintang.

Saru, A., Idrus, R., & Ilham, M. (2019). The Mangrove Ecosystem Potential For Educational Tour Development Around Pond Education Of Hasanuddin University (UNHAS) In Mallusetasi District, Barru Regency. *Jurnal Ilmu Kelautan Spermonde*, *5*(2), 70-76. doi: https://doi.org/10.20956/jiks.v5i2.8934

Setiawan, M. A., & Musdalipah, M. (2018). Uji Daya Hambat Antibakteri Fungi Endofit Daun Beluntas (Pluchea indica (L.) Less.) Terhadap Bakteri Streptococcus mutans. *Jurnal Mandala Pharmacon Indonesia*, *4*(1), 53-60. doi: https://doi.org/10.35311/jmpi.v4i1.24

Sumampouw, O. J. (2019). *Mikrobiologi Kesehatan*. Yogyakarta: Deepublish.

Suryono, C. A. (2015). Ekologi Mangrove Di Segara Anakan Ditinjau dari Aspek: Kelimpahan dan Distribusi. *Jurnal Kelautan Tropis*, *18*(1), 20-27. doi: https://doi.org/10.14710/jkt.v18i1.510

Suryono, S., Taufiq-SPJ, N., Pratikto, I., & Ario, R. (2020). Sebaran Mangrove di Desa Bumiharjo Kecamatan Keling Kabupaten Jepara. Buletin Oseanografi Marina, 9(2), 117-124. doi: https://doi.org/10.14710/buloma.v9i2.29067

Yuanwar, B. D., & Ainy, E. Q. (2019). Isolasi fungi endofit kulit mentimun (*Cucumis sativus* L.) dan evaluasi aktivitas penghambatannya terhadap pertumbuhan *Candida albicans* ATCC 10231. *Symposium of Biology Education (Symbion)*. *2, 306-315*. doi: https://doi.org/10.26555/symbion.3552

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RESEARCH **Open Access**

Simultaneous Factors Affecting Toddler Nutritional Status

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Abstract
The province with the highest percentage of malnutrition among children aged 0-59 months in 2018 was East Nusa Tenggara. The number of toddlers experiencing malnutrition in the Feapoi Health Center area, Rote Ndao district, fluctuated from 2013 to 2017 ranging from 3-12 cases. In 2020, data on 31 toddlers were malnourished and 7 were malnourished based on body weight divided by age (W/W). Efforts made by the Rote Ndao government to reduce stunting and malnutrition are education, routinely providing Supplementary Feeding (PMT), but the incidence of malnutrition and stunting is still high. The study was conducted to analyze the simultaneous factors that affect the nutritional status of toddlers in the Feapoi Health Center area, Rote Ndao Regency. This type of research is quantitative, the design is case control. The research sample consisted of 38 well-nourished toddlers and 38 undernourished toddlers. The research instrument was a questionnaire and a Healthy Towards Card. Univariate data analysis was descriptive, bivariate analysis used Chi Square with a significant level of 5% (α = 0.05), multivariate with multiple logistic regression. The results showed that the factors that simultaneously affected the nutritional status of toddlers in the Feapoi health center, Rote Ndao district were a history of low birth weight (p = 0.014, OR 0.109, 95% CI: 0.18-0.638), and toddlers with exclusive breastfeeding (p = 0.000, OR 0.063, 95% CI 0.18-0.215). It is recommended for further research on health promotion efforts for pregnant women to reduce the risk of low birth weight (LBW) and increase exclusive breastfeeding.

Keywords: Nutritional Status, Toddlers, Feapoi Health Center.

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1. INTRODUCTION

The problem of malnutrition occurs in almost all economic strata of people in rural and urban areas. This condition is one of the main obstacles affecting the development of Indonesian human resources. Nutritional status is one of the determinants of the quality of human resources, as well as a determinant of success in national development (Kementerian Kesehatan, R. I., 2019).

Malnutrition is nutritional status based on the body weight index for age (W/W) and this is still a problem in Indonesia, including the province of East Nusa Tenggara. The 2018 Basic Health Research stated that the percentage of malnutrition in children aged 0-23 months in Indonesia was 3.8%, while the percentage of undernourished was 11.4% (Kementerian Kesehatan, R. I., 2018). It is not much different from the results of the Nutrition Status Monitoring (PSG), that is the percentage of malnutrition in toddlers aged 0-23 months is 3.8% and the percentage of malnutrition is 11.4% (Kementerian Kesehatan, R. I., 2020). The province with the highest percentage of malnutrition and malnutrition in children aged 0-23 months in 2018 is East Nusa Tenggara, which is 17.7% (Kementerian Kesehatan, R. I., 2020).

The number of toddlers experiencing malnutrition in the Feapoi Health Center area of Rote Ndao Regency has fluctuated from 2013 to 2017 ranging from 3-12 cases (Dinas Kesehatan Kabupaten Rote Ndao, 2019). In 2020, the number of toddlers at the Feapoi Health Center was 771 people. Toddlers with malnutrition 31 people and 7 toddlers experienced severe malnutrition which was measured based on BB/U.

The problem of malnutrition and poor nutrition occurs due to several factors, which are nutritional intake and infectious diseases. External factors that cause malnutrition are environmental sanitation, access and utilization of health services, consumption of blood-added tablets, poverty rates, incomplete immunizations, diarrheal diseases, and acute respiratory infections. In addition, unstable political conditions and a slow-growing economy have also contributed to the increase in the problem of malnutrition (Boli, et al., 2018).

Various efforts have been performed by various parties, both government and private to overcome nutritional problems. The Ministry of Health has increased the target for Supplementary Feeding (PMT) for underweight toddlers and pregnant women with Chronic Energy Deficiency (KEK), providing Blood Supplementary Tablets (TTD) for all pregnant women, and young women. Provision of PMT for underweight toddlers, nutrition education efforts to increase exclusive breastfeeding, infant and child feeding (PMBA), and promotion of balanced nutrition guidelines (Kementerian Kesehatan, R. I., 2019).

Efforts to implement balanced nutrition are conducted by means of education and assistance to families on how to prevent and deal with nutritional problems in their family members. Families also need to provide nutritional supplements as recommended by health workers. Nutritional supplements are in accordance with the Regulation of the Minister of Health Number 51 of 2016 concerning Nutritional Supplementation Product Standards, including vitamin A capsules, Blood-Adding Tablets (TTD), supplementary food for pregnant women, toddlers, and school-aged children, complementary foods for breast milk, and multi-vitamin powder and minerals (Kementerian Kesehatan, R. I., 2019). Another effort is the Minister of Health Regulation Number 23 of 2014 concerning Nutrition Improvement Efforts. The activities conducted were weighing regularly, giving exclusive breastfeeding to babies

from birth to 6 months of age, varied food menus, and consuming iodized salt according to the specified dose.

The Regional Government of East Nusa Tenggara Province (NTT) has made a nutrition policy that is listed in the Regional Medium Term Development Plan (RPJMD) document with a target focus on reducing cases of toddlers malnutrition to 7.64% and malnutrition to 0.76% in 2018 as the basis for nutritional development in East Nusa Tenggara Province. There is a Governor's Regulation Number 46 of 2016 concerning Regional Action Plans for the Acceleration of Fulfillment of Food and Nutrition for the Province of East Nusa Tenggara in 2016-2020. The nutrition policy is expected to be able to overcome nutritional problems in East Nusa Tenggara Province. Data shows an increase in nutritional problems, especially underweight and stunting, in 2016 by 28.2% and 38.7%, respectively, to 28.3% and 40.3% in 2017 (Boli, et al., 2018).

Efforts made by the Rote Ndao government to reduce stunting and malnutrition are conducting outreach activities in the community, and the provision of Supplementary Food for undernourished toddlers on a regular basis. The government is committed to prioritizing health services for toddlers. However, the incidence of undernourished toddlers and stunting is still there. It needs to be studied more deeply about the factors that most influence the incidence of malnutrition in Rote Ndao, especially in the Feapoi Health Center area. The objective of this study is to analyze the simultaneous factors that affect the nutritional status of toddlers in the Feapoi Health Center area, Rote Ndao Regency.

2. RESEARCH METHOD

The type of research used was quantitative with a case control design. The research was conducted at the Feapoi Health Center, Rote Ndao Regency in January – February 2021. The research population was all mothers of toddlers with malnutrition in the working area of the Feapoi Health Center, Rote Ndao Regency. The sampling technique was non-probability sampling with the determination of the total population sample. The number of malnourished toddlers was 38, consisting of 31 undernourished and 7 malnourished. As the control, 38 toddlers with good nutrition were selected. The control sample was determined by the researchers with the criteria of mothers and toddlers living in the working area of the Feapoi Health Center, participating in integrated service post activities and having a Healthy Towards Card (KMS).

The instrument employed was a questionnaire, which contains the characteristics of the respondents, knowledge and actions. Knowledge was measured using a questionnaire with 18 questions. The category of knowledge is good if the score is 10-18 and less good with a value of <10. The measuring instrument consists of 18 questions. The action category is good with a score of 54-72 and less good if the score is 1-53. The nutritional status of toddlers is measured by using the KMS that the toddler already has. The research questionnaire was adopted from Munthofiah in 2019. From the results of testing for each variable, it was found that knowledge has good internal consistency with each statement item having a total item correlation above 0.20 and Cronbach's Alpha value >0.60, that is 0.777 while the behavioral element in this study has good internal consistency with each statement item having a total item correlation above 0.20 and Cronbach's Alpha value of 0.795 (Munthofiah, 2019).

Data collection procedures include obtaining research permits and ethical permits. Ethics certificate was issued by the Kupang Ministry of Health Polytechnic ethics commission. Researchers identified mothers whose babies were underweight through maternal health unit cadres and health workers. After the research sample was obtained

based on the inclusion criteria, the informed consent was given to parents of toddlers. If the respondent is willing, a questionnaire is distributed to be filled out by the parents of the toddler. Interviews were conducted if the respondents did not understand the questions in the questionnaire. Assessment of the nutritional status of toddlers using data was taken from KMS.

Univariate analysis was employed to describe each independent and dependent variable. Bivariate analysis was performed to examine the relationship between two variables (independent and dependent) at a significant level of 5% (α=0.05). The type of test was determined based on the data scale and the normality of the data. The results of the study obtained that the distribution of abnormal data so that the tests used were Chi-Square. Multivariable analysis used multivariate test with multiple logistic regression to determine the factors that influence the nutritional status of toddlers simultaneously.

3. RESULTS AND DISCUSSION

Table 1. The relationship between maternal characteristics and the nutritional status of toddlers in the working area of the Feapoi Health Center in 2021.

CHARACTERISTICS	Malnutrition (Case)		Good Nutrition (Control)		*p*
	n=38	%	n=38	%	
Age					
17-25 years old	5	13,2	2	9,2	0,272
26-35 years old	14	36,8	22	47,4	
36-45 years old	15	39.5	13	36,8	
≥ 46 years old	4	10,5	1	6,6	
Education					
Graduated Elementary	11	28,9	14	36,8	
School	11	28,9	6	15,8	0,456
Graduated Junior High	13	34,3	12	31,6	
School	3	7,9	6	15,8	
High School Graduation					
Bachelor					
Occupation					
Civil servant	1	2,6	1	2,6	0,804
Enterpreneur	4	10,5	4	10,5	
Farmer	3	7,9	6	15,8	
Housewife	30	79	27	71,1	
Number of children					
1-2	20	52,6	25	65,8	0,194
> 3	18	36,8	13	34,2	

Table 1 shows that most of the age group of mothers with malnourished toddlers were in the age group of 36-45 years, amounting to 15 people (39.5%) and the highest number of well-nourished children was at the age of 26-35 years, which were 22 people (47.4%). The education of mothers with malnourished toddlers mostly graduated from high school (SLTA), who were 13 people (34.3%) and the group of toddlers with good nutrition mostly graduated from elementary school (SD), which are 14 people (36.8%). The work of mothers of toddlers who are malnourished and well-nourished are mostly housewives, that were 30 people (71.1%). The number of children in mothers of

toddlers with malnutrition and good nutrition is mostly 1-2 people. The results of statistical analysis with the Chi-Square Test showed no relationship between the influence of mother's age, education, occupation and number of children on the nutritional status of toddlers.

Table 2. Relationship between Toddler Characteristics and Toddler Nutritional Status in the working area of Feapoi Health Center in 2021.

Category	Malnutrition (Case)		Good Nutrition (Control)		*p*	OR	95% CI	
	n	%	n	%			Lower	Upper
Age								
1 year old	10	26,3	11	28,9	0,587			
2 years old	10	26,3	6	15,8				
3 years old	9	3,7	13	34,2				
4 years old	9	23,7	7	18,4				
≥5 years old			1	2,7				
LBW history								
Yes	11	28,9	2	5,3	0,06	7,333	1,500	35,857
No	27	71,1	36	94,7				
Exclusive breastfeeding								
Yes	12	31,6	33	86,8	0.000	14,30	4,469	45,753
No	26	68,4	5	13,2				
Infectious Disease								
Yes	22	57,9	16	42,1	0,126	1,891	0,760	4,700
No	16	42,1	22	57,9				
Knowledge								
Low	20	52,6	9	23,7	0,009	3,580	1,341	9,561
Good	18	47,4	29	76,3				
Treatment								
Low	27	71,1	12	31,6	0,001	5,318	1,997	14,163
Good	11	28,9	26	68,4				

Table 2 shows that the most malnourished toddlers were in the 1-and 2-years age group (10%) while the good nutrition was at the age of 3 years (34.2%). The history of LBW in the group of toddlers with less nutrition (28.9%) was higher than that of well-nourished children (5.3%). The group of toddlers who received exclusive breastfeeding was 31.6% and well-nourished toddlers (86.8%) received exclusive breastfeeding. Undernourished toddlers who suffered from infectious diseases were 57.9% and toddlers with good nutritional status were 42.1%. Immunization of both undernourished toddlers and both 100% received complete immunization. The results of statistical analysis used the Chi-Square Test for age and history of infectious diseases have no effect on the nutritional status of toddlers, while the history of LBW has an influence on the nutritional status of toddlers with a value of = 0.06 with an OR of 7.333, and there is an effect of exclusive breastfeeding on the nutritional status of toddlers with a value of = 0.000 with an OR value of 14.300.

Most of the knowledge of mothers with toddlers with malnutrition was poor, who were 20 people (52.6%) and mothers with good nutrition toddlers mostly had good

knowledge, who were 29 people (76.3%). The results of statistical analysis with the Chi-Square Test with p value = 0.009 and OR 3, 580, hence, there is an influence of knowledge on the nutritional status of toddlers. Mothers with malnourished toddlers, mostly did not take action to meet the nutritional needs of their toddlers, which are 27 people (71.1%). Mothers of toddlers with good nutritional status took action to meet the nutritional needs of their toddlers well, who were 26 people (68.4%). The results of statistical analysis with the Chi-Square Test, p value = 0.001 and OR 5, 318, thus, there is an effect of mother's actions on the nutritional status of toddlers.

Table 3. Factors Influencing the Nutritional Status of Toddlers Simultaneously in the Work Area of the Feapoi Health Center in 2021.

Variable	B	Wald	*P value*	OR	95%C.I Exp (B)	
					Lower	Upper
LBW	-2,220	6,038	0,014	0,109	0,18	0,638
Exclusive	-2,767	19,440	0,000	0,063	0,18	0,215
breastfeeding	1,384	12,260	0,000	3,991		
Constant						

Based on the results of the logistic regression test using the Backward Stepwise method, the factors that influence the nutritional status of toddlers with a history of low birth weight (p = 0.014), and getting exclusive breastfeeding (p = 0.000). Toddlers with a history of low birth weight and not getting exclusive breastfeeding are protective of the nutritional status of under-nourished/bad children. the possibility that children who do not have LBW will increase their nutritional status by 9 times (1/0.109). And children who get exclusive breastfeeding will increase their good nutritional status by 16 times (1/1,063).

a. Relationship between mother's age and nutritional status of toddlers

The highest maternal age for undernourished toddlers is in the age group of 36-45 years and the most well-nourished toddlers are at the age of 25-35 years, who were 22 people. Based on the Chi-Square statistical test, there is no effect between age and nutritional status of toddlers. These results are in accordance with Setyaningsih's research 2014 that the majority of mothers are in the age range of 21-40 years or early adulthood. In this phase, the responsibility for caring for toddlers, including parenting in terms of nutrition, is a normal life stage experienced by a woman (Setyaningsih & Agustini, 2014).

The results of this study explain that maternal age does not affect the nutritional status of toddlers. The reason is that mothers with early adulthood play an important role in the upbringing of their children, especially in providing good nutrition for their children. The arrangement of meeting the nutritional needs of each mother is different. It is influenced by other factors.

b. Relationship between education and nutritional status of toddlers

The education of mothers with toddlers' nutritional status is mostly high school graduates and mothers with good nutritional status are mostly elementary school graduates. The results of the analysis show that there is no significant relationship between mother's education and undernutrition under five. This result is supported by Lestari, (2016), which shows that there is no significant relationship between mother's education and toddler malnutrition. It is because mothers do not receive education about nutritional status in formal education. Mothers with low education can get

information related to nutrition through informal education through health workers at maternal health unit, health center or hospitals with information packaging that is easy to absorb and understand without having to go to higher education (Lestari, 2016).

Another research result was conducted by Gusrianti, et al., 2019, who found that education had no effect on the nutritional status of toddlers. This study is not in accordance with research conducted by Ahsan, et al., in 2013, which explained that the level of education is very influential on the level of nutrition in toddlers. Mothers with low levels of education tend to have toddlers with less nutrition and even stunting (Ahsan, et al., 2017).

Research conducted by Talukder found that malnourished toddlers were found in mothers or fathers who had basic education (Talukder, 2017). More than half of malnourished children live with families with large family members and most of their parents have low educational background (Galgamuwa, et al., 2017).

The level of education can determine the nutritional status of toddlers. The higher the level of education affects the mother's mindset in making good and right decisions in determining the growth and development of her toddler. However, the results of the research stated that there was no effect between the level of education and the nutritional status of toddlers. Many factors can determine the nutritional status of toddlers.

c. Relationship between parents' occupation and the nutritional status of toddlers

The work of mothers of toddlers with poor and good nutritional status is mostly as housewives and fathers of toddlers are mostly farmers. The results of statistical analysis with the Chi-Square Test have no effect on the nutritional status of toddlers. The results of the study were supported by Gusrianti who explained that work status had no effect on the nutritional status of toddlers (Gusrianti, et al., 2019). This result is not in accordance with the research conducted by Ahsan, et al., (2017), which explains that mothers who work outside the home significantly have underweight toddlers (Ahsan, et al., 2017).

Families with more income are likely to be good or even excessive in meeting their food needs. On the contrary, families with limited income tend to be less likely to meet their food needs, especially to meet nutritional needs. However, this opinion contradicts the results of the research. It happened because families in the Feapoi health center area always received direct assistance from the government in the form of additional food, financial support for underprivileged families. Furthermore, the main commodity for Rote Ndao district is rice production which contributes to increasing income for the community, which of course affects the purchasing power of food needs.

d. The relationship between the number of children and the nutritional status of toddlers

The number of toddlers with poor and good nutritional status is mostly 1-2 people. The results of statistical analysis with the Chi-Square Test did not affect the number of children on the nutritional status of toddlers. This result is supported by Lestari in 2016, with statistical analysis showing that there is no significant relationship between the number of family members and malnutrition in toddlers. It is because there are families of toddlers with the composition of the number of productive family members working more, so that it will increase family income which causes the condition of children's nutritional status to be better (Lestari, 2016).

This study is not in accordance with Ahsan, et al., (2017), who found that birth spacing has a significant relationship with toddler nutrition. The wider the child birth interval, the better the nutritional status of toddlers (Ahsan, et al., 2017). A large number of family members is believed to have sufficient resources to work so as to improve their economic status. It causes the child's health condition and nutritional status to be better.

e. Relationship of LBW History with Toddler Nutritional Status

The results showed that the history of LBW in the group of underweight children was higher than those with good nutritional status who had a history of LBW. Statistical analysis with Chi-Square Test for LBW history has an influence on the nutritional status of toddlers. The results of this study are in accordance with Minkhatulmaula, et al., in 2020, who found that most of the undernourished children had a history of low birth weight so that there was a relationship between low birth weight and the incidence of malnutrition in the Karangpawitan District. It happens because mothers of toddlers have low knowledge of nutrition during pregnancy so they tend to experience anemia in mothers during pregnancy (Minkhatulmaula, et al., 2020).

Research conducted by Rahman in 2016, explained that this study found a very strong positive relationship between LBW and malnutrition among children under the age of five in Bangladesh. Toddlers who have a history of LBW tend to experience underweight during their growth period compared to toddlers with normal birth weight. Birth weight is a determinant of the nutritional status of toddlers. Children with a history of LBW tend to experience infections such as diarrhea and lower respiratory tract infections and an increased risk of complications including sleep apnea, jaundice, anemia, chronic lung disorders, fatigue and loss of appetite (Rahman, et al., 2016).

Children were born with low birth weight in the working area of the Feapoi health center, Rote Ndao district. The condition will have the potential to become a child with less nutrition, even worse. Furthermore, poor nutrition in toddlers has an impact on decreasing the level of intelligence or IQ. Moreover, the resulting impact is an increase in the incidence of illness and even death. Those who are still able to survive due to permanent nutritional deficiency, the quality of life has a very low level and cannot be improved even though at the next age their nutritional needs have been met.

f. Relationship of Exclusive Breastfeeding with Nutritional Status of Toddlers

The results showed that one third of the number of toddlers with poor nutritional status received exclusive breastfeeding, while the majority of well-nourished children received exclusive breastfeeding. The results of statistical analysis using the Chi-Square Test for toddlers who receive exclusive breastfeeding have an influence relationship on the nutritional status of toddlers. In the group of under-nourished toddlers who received exclusive breastfeeding, 31.6% and well-nourished toddlers (86.8%) received exclusive breastfeeding.

This result is in accordance with Lestari, in 2016, who analyzed the relationship between history of breastfeeding and under-nutrition under five years of age. Toddlers with a history of non-exclusive breastfeeding have a 4.34 times greater chance of experiencing malnutrition than toddlers with a history of exclusive breastfeeding (Lestari, 2016).

This finding is in line with Purba, et al., in 2020, which explains that there is a significant relationship between the duration of exclusive breastfeeding and the nutritional status of toddlers, where babies who are exclusively breastfed tend to experience better nutritional status, and vice versa (Purba, et al., 2020).

Toddlers who are exclusively breastfed in the working area of Feapoi in health center are in good nutritional status compared to toddlers who are not exclusively breastfed. Exclusive breastfeeding provides immune substances to toddlers so that the toddler becomes less susceptible to disease. Healthy toddlers do not lose their appetite so that their nutritional status remains good.

g. Relationship of Infectious Diseases with nutritional status of toddlers

In undernourished toddlers, most of them suffered from infectious diseases in the last 6 months compared to toddlers with good nutritional status. The results of this study indicate that both toddlers with poor and good nutritional status have the same risk of getting infectious diseases such as ARI, diarrhea. Based on the Chi-Square test, it was found that there was no effect of infectious disease on the nutritional status of Toddlers in Feapoi Rote Ndao.

The results of this study are supported by research conducted by Rosliana, et al., in 2020, which explains that the percentage of children aged 12 - 24 months at the Teratai maternal health unit in the work area of the Ciasem Health Center, Subang Regency, who are undernourished and not sick have a higher percentage than children who are malnourished and sick. The results of statistical analysis of the relationship between comorbidities and nutritional status stated that there was no relationship between comorbidities and nutritional status (Rosliana, et al., 2020).

This study was also supported by Lestari, in 2016 who found that the results of the analysis of the relationship between a history of infectious diseases and malnutrition in toddlers showed that there was no significant relationship between a history of infectious diseases and under-nutrition toddlers. It is because prevention efforts against cases of malnutrition have been performed well by families of toddlers, for instance by exclusive breastfeeding (Lestari, 2016).

This study is not in accordance with Ristanti's research in 2020, which found that there was a relationship between infectious diseases and nutritional status in toddlers in the work area of the Paal V Health Center Jambi City in 2020. The results showed that toddlers suffering from infectious diseases had a higher risk of 6.6 times having toddlers with less nutritional status when compared to respondents who have toddlers who do not suffer from infectious diseases (Ristanti, et al., 2020).

The relationship between malnutrition and infectious diseases depends on the magnitude of the impact caused by a number of infections on the nutritional status itself. Some examples of how infections can contribute to malnutrition such as digestive infections can cause diarrhea, HIV/AIDS, tuberculosis, and some other chronic infectious diseases can cause anemia and intestinal parasites can cause anemia.

h. Relationship between Immunization and Nutritional Status of Toddlers

The results of this study showed that all toddlers with poor or good nutritional status all received complete immunization. The results of statistical tests with Chi-Square showed that there was no effect of immunization on the nutritional status of toddlers. The results of the study are not in accordance with Gebre, et al., in 2019, which states that children who have not been fully immunized have a higher risk of being underweight compared to children who are fully immunized. Children who are not immunized can be at risk of many vaccine-preventable diseases such as diarrhea and

respiratory infections, which can lead to depletion of nutrients from the body (Gebre, et al., 2019).

Sand's study 2018 also found vaccination status, which was often found to be significantly associated with acute malnutrition. Vaccination status and frequent infections were found to be significantly associated with severe acute malnutrition in Mithi city center hospital, Tharparkar district, Sindh province (Sand, et al., 2018).

Complete immunization has a significant relationship with malnutrition because immunization provides immune substances to toddlers so that these toddlers become less susceptible to disease. Healthy toddlers will not lose their appetite so that nutritional status remains good. However, in this study, there was no effect on the nutritional status of toddlers it is because all toddlers, both malnourished and well nourished, have received complete immunization. Malnutrition status in most toddlers is caused by other risk factors.

i. The Relationship of Knowledge to the Nutritional Status of Toddlers

The results of the study showed that the knowledge of mothers with malnourished toddlers was mostly sufficient and mothers of toddlers with good nutrition had good knowledge about nutrition. The results of statistical analysis with the Chi-Square Test showed the effect of knowledge on the nutritional status of toddlers. These results are in accordance with the research of Lestari in 2016, which found that mothers who had less knowledge about nutrition had children with poor nutritional status, and there was a significant relationship between mother's knowledge and nutritional status and values. Lack of knowledge about the nutrients needed by toddlers causes mothers to give non-nutritious food to their children.

Based on the results of Ristanti's, et al., in 2020 research, it shows that there is a relationship between knowledge and nutritional status of toddlers in the work area of Paal V Health Center Jambi City in 2020. Knowledge is a risk factor for the nutritional status of toddlers. This relationship occurs because mothers who have extensive knowledge of toddler nutrition understand the techniques to meet the nutritional needs of their children. Furthermore, mothers are able to provide nutritious food, so that toddlers will have a good nutritional status. Conversely, if the mother does not understand how to understand the nutritional needs of her child, the child's nutritional status will be less good (Ristanti, et al., 2020)

Knowledge is the result of learning to hear, see and do. Mothers who have gained knowledge about nutrition for toddlers are more aware of feeding arrangements for their children, thus, they can apply what they know. This knowledge can be obtained from health center staff, sharing experiences with others, electronic and mass media. Conversely, if the mother's knowledge about toddler nutrition is not enough, it will affect the menu settings for toddlers according to their needs.

When mothers know that nutritious food has a good impact on the growth and development of their children, it is likely that mothers will provide food that meets the needs of their children, both in quantity and quality. The better the mother's knowledge of toddlers' nutrition will be the basis for supporting the good nutritional status of her toddlers.

j. The Relationship of Mother's Actions to the Nutritional Status of Toddlers

The results of the study showed that most of the mothers with toddlers who were malnourished did not take action to provide balanced nutritional intake to their children. On the other hand, mothers who had toddlers with good nutritional status always

regularly provided food with balanced nutrition to their children. The results of statistical analysis with The Chi-Square test were obtained that there was an effect of mother's actions on the nutritional status of toddlers affecting the nutritional status of toddlers such as from toddler factors such as a history of LBW.

The results of this study were supported by Tariq, et al., in 2018 who explained that toddlers were malnourished due to a lack of nutritional food intake including supplements such as vitamin A by parents to their children. It occurs due to lack of education, knowledge, and socioeconomic factors (Tariq, et al., 2018).

This research is in accordance with research conducted by Fadilah, et al., in 2017 in Yosowilangun Lor Village, Lumajang Regency, which shows that there is a relationship between maternal behavior regarding balanced nutrition and the nutritional status of children that most mothers have less behavior about balanced nutrition. Mother's behavior about balanced nutrition is getting less, hence, the child's nutritional status is getting lower (Fadila, et al., 2017)

One of the factors that affect the nutritional status of children is the mother's behavior in choosing and providing food. The low mother's behavior can be caused by a lack of mother's level of knowledge about balanced nutrition and lack of ability to apply it in daily life.

k. The dominant factor influencing the nutritional status of toddlers simultaneously at the Feapoi Health Center, Rote Ndao Regency

Based on the results of the logistic regression test using the Backward Stepwise method, the factors that influence the nutritional status weretoddlers with a history of low birth weight and do not receive exclusive breastfeeding. The results of the Yirga, et al., study 2019 found that the dominant factors affecting the nutritional status of toddlers in Euthopia were the child's weight at birth, the mother's body mass index, and marital status (Yirga et al., 2019). Reinbott and Jordan 2016, explained that the problem of malnutrition in Cambodia is due to the type of food given to toddlers that does not meet nutritional standards, only watery porridge is given. It occurs due to lack of knowledge possessed by caregivers or parents. To improve the nutritional status of toddlers, the Cambodian government provides education to mothers about the fulfillment of toddler nutrition (Reinbott & Jordan, 2016).

Tette, et al., 2015, found that malnutrition in children who were in Princess Marie Louise Children's Hospital was due to inadequate antenatal care family income. To be able to overcome this problem, optimal antenatal care assistance is needed, especially meeting the nutritional needs of pregnant women so that they do not give birth to babies with low body weight (Tette et al., 2015). Lestari, 2016, describes that the most dominant factor in the occurrence of malnutrition in toddlers is inadequate food intake (Lestari, 2016).

There are many factors that cause malnutrition/poor nutrition. Low birth weight will have the opportunity to experience nervous system disorders, which will result in slow growth and development when compared to normal weight. Breast milk has a very complete nutritional content. If given exclusively, it will increase the body's resistance so that it can reduce the risk of illness.

4. CONCLUSION

Most mothers with malnourished toddlers are in adulthood, have high school education (SLTA), do not work, and the number of children in a family of 1-2 people, have less knowledge and actions in meeting the nutritional needs of their toddlers. Toddlers who do not get exclusive breastfeeding and low birth weight tend to have poor

nutritional status. These two conditions are simultaneous factors that cause malnutrition in toddlers in the Feapoi working area, Rote Ndao district. It is recommended for further research on health promotion efforts for pregnant women to reduce the risk of low birth weight (LBW) and increase exclusive breastfeeding.

REFERENCES

Ahsan, K. Z., Arifeen, S. E., Al-Mamun, M. A., Khan, S. H., & Chakraborty, N. (2017). Effects of individual, household and community characteristics on child nutritional status in the slums of urban Bangladesh. *Archives of Public Health*, *75*(1), 1-13. doi: https://doi.org/10.1186/s13690-017-0176-x

Boli, E. B., Baliwati, Y. F., & Sukandar, D. (2018). Komitmen Politik dan Peluang Pengembangan Kebijakan Gizi Pemerintah Daerah Provinsi Nusa Tenggara Timur. *Media Kesehatan Masyarakat Indonesia Universitas Hasanuddin*, *14*(4), 351-359. doi: http://dx.doi.org/10.30597/mkmi.v14i4.5104

Dinas Kesehatan Kabupaten Rote Ndao. (2019). *Rencana Strategi Dinas Kesehatan Kabupaten Rote Ndao 2019-2024*. Rote Ndao: Dinas Kesehatan Kabupaten Rote Ndao.

Fadila, R. N., Amareta, D. I., & Febriyatna, A. (2017). Hubungan Pengetahuan Dan Perilaku Ibu Tentang Gizi Seimbang Dengan Status Gizi Anak Tk Di DesaYosowilangun Lor Kabupaten Lumajang. *Jurnal Kesehatan*, *5*(1), 14-20. doi: https://doi.org/10.25047/j-kes.v5i1.26

Galgamuwa, L. S., Iddawela, D., Dharmaratne, S. D., & Galgamuwa, G. L. S. (2017). Nutritional status and correlated socio-economic factors among preschool and school children in plantation communities, Sri Lanka. *BMC Public Health*, 17 (377). doi: https://doi.org/10.1186/s12889-017-4311-y

Gebre, A., Surender Reddy, P., Mulugeta, A., Sedik, Y., & Kahssay, M. (2019). Prevalence of Malnutrition and Associated Factors among Under-Five Children in Pastoral Communities of Afar Regional State, Northeast Ethiopia: A Community-Based Cross-Sectional Study. *Journal of Nutrition and Metabolism*, 2019 (9187609). doi: https://doi.org/10.1155/2019/9187609

Gusrianti, G., Azkha, N., & Bachtiar, H. (2019). Analisis Faktor yang Berhubungan dengan Status Gizi Balita di Kelurahan Limau Manis Selatan Wilayah Kerja Puskesmas Pauh Kota Padang. *Jurnal Kesehatan Andalas*, 8(4), 109-114. doi: https://doi.org/10.25077/jka.v8i4.1126

Kementerian Kesehatan, R. I. (2018). *Laporan Riskesdas 2018*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan, R. I. (2019). *Gizi Seimbang, Prestasi Gemilang*. Jakarta: Warta Kesmas.

Kementerian Kesehatan RI. (2019). *Kemenkes Tingkatkan Status Gizi Masyarakat*. Jakarta: Biro Komunikasi dan Pelayanan Masyarakat, Kementerian Kesehatan Republik Indonesia.

Kementerian Kesehatan, R. I. (2020). *Profil Kesehatan Indonesia Tahun 2019*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Lestari, N. D. (2016). Analisis determinan gizi kurang pada balita di Kulon Progo, Yogyakarta. *IJNP (Indonesian Journal of Nursing Practices)*, *1*(1), 15-21.

Minkhatulmaula, M., Pibriyanti, K., & Fathimah, F. (2020). Faktor Risiko Kejadian Gizi Kurang pada Balita di Etnis Sunda. *Sport and Nutrition Journal*, *2*(2), 41-48.

Munthofiah, D. (2019). Hubungan Konsumsi Fast Food, Kebiasaan Dan Kualitas Sarapan Pagi Dengan Status Gizi Siswa Sd Muhammadiyah Program Khusus

Surakarta. *Skripsi*. Institute Teknologi Sains dan Kesehatan, PKU Muhammadiyah Surakarta.

Purba, I. E., Purba, A., & Sembiring, R. (2020). Factors associated with nutritional status of children under the age of 5 years in the working area of Sadabuan Public Health Center. *Enfermería Clínica*, *30*, 140-143. doi: https://doi.org/10.1016/j.enfcli.2019.11.040

Rahman, M. S., Howlader, T., Masud, M. S., & Rahman, M. L. (2016). Association of low-birth weight with malnutrition in children under five years in Bangladesh: do mother's education, socio-economic status, and birth interval matter?. *PloS one*, *11*(6), e0157814. doi: https://doi.org/10.1371/journal.pone.0157814

Reinbott, A., & Jordan, I. (2016). Determinants of child malnutrition and infant and young child feeding approaches in Cambodia. *Hidden Hunger*, *115*, 61-67. doi: https://doi.org/10.1159/000444609

Ristanti, E., Harahap, P. S., & Subakir, S. (2020). Faktor Yang Mempengaruhi Status Gizi Pada Balita Di Wilayah Kerja Puskesmas Paal V Kota Jambi. *Journal Of Healthcare Technology and Medicine*, *6*(2), 742-753. doi: https://doi.org/10.33143/jhtm.v6i2.980

Rosliana, L., Widowati, R. & Kurniati, D. (2020). Hubungan Pola Asuh, Penyakit Penyerta, Dan Pengetahuan Ibu Dengan Status Gizi Pada Anak Usia 12-24 Bulan Di Posyandu Teratai Wilayah Kerja Puskesmas Ciasem Kabupaten Subang Tahun 2020. *Syntax Idea,* 2(8), 415-428.

Sand, A., Kumar, R., Shaikh, B. T., Somrongthong, R., Hafeez, A., & Rai, D. (2018). Determinants of severe acute malnutrition among children under five years in a rural remote setting: A hospital based study from district Tharparkar-Sindh, Pakistan. *Pakistan Journal of Medical Sciences*, *34*(2), 260–265. doi: https://doi.org/10.12669/pjms.342.14977

Setyaningsih, S. R., & Agustini, N. (2014). Pengetahuan, Sikap, dan Perilaku Ibu dalam Pemenuhan Gizi Balita: Sebuah Survei. *Jurnal Keperawatan Indonesia*, *17*(3), 88-94. doi: https://doi.org/10.7454/jki.v17i3.451

Talukder, A. (2017). Factors associated with malnutrition among under-five children: illustration using Bangladesh demographic and health survey, 2014 data. *Children*, *4*(10), 88. doi: https://doi.org/10.3390/children4100088

Tariq, J., Sajjad, A., Zakar, R., Zakar, M. Z., & Fischer, F. (2018). Factors associated with undernutrition in children under the age of two years: secondary data analysis based on the Pakistan demographic and health survey 2012–2013. *Nutrients*, *10*(6), 676. doi: https://doi.org/10.3390/nu10060676

Tette, E. M., Sifah, E. K., & Nartey, E. T. (2015). Factors affecting malnutrition in children and the uptake of interventions to prevent the condition. *BMC pediatrics*, *15*(1), 1-11.doi: https://doi.org/10.1186/s12887-015-0496-3

Yirga, A. A., Mwambi, H. G., Ayele, D. G., & Melesse, S. F. (2019). Factors affecting child malnutrition in Ethiopia. *African health sciences*, *19*(2), 1897-1909. doi: https://doi.org/10.4314/ahs.v19i2.13

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RESEARCH **Open Access**

Anti-Cholesterolemic Activity of Mulberry (*Morus australis* Poir) Ethanol Extract in Increasing HDL Levels and Inhibiting Formation of Foam Cells on Rat

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Abstract
Mulberry leaves are one of the medicinal plants empirically used by people to reduce cholesterol levels. Previous study found that mulberry leaves contain flavonoids, act as cholesterol-lowering and tannins function to inhibit the absorption of food, including fat in the GI tract. The objective of this study is to determine the effect of mulberry leaf ethanol extract on increased HDL levels and to determine the inhibition of the formation of foam cells in male Wistar strain rats given the atherogenic diet. Thirty male Wistar rats were divided into six groups, which were normal group, negative control, positive control, and three groups of mulberry leaf extract at a dose of 25, 50, and 100 mg/200g BW rats, respectively. The HDL levels were measured pre- and post- treatment on days 0, 28, 35 and 42. The results showed that the most effective dose augmenting the HDL as well as inhibited the formation of aortic wall foam cell was the ethanol extract at a dose of 100 mg/200 g BW. In conclusion, mulberry leaves ethanolic extract have the potency to be developed as a natural cholesterol-lowering agent.

Keywords: Ethanol Extract of Mulberry Leaves, HDL Level, Foam Cells.

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1. INTRODUCTION

The death incidence due to coronary heart disease (CHD) in Indonesia was almost 2.0 million people aged between 15-55 years old in 2017 (Uli, et al., 2020). Based on the Indonesia national health survey in the past ten years, the number of CHD tends to increase each year and counted as the 3rd leading mortality (Hussain, et al., 2016). Cholesterol is one of the precursors of steroid compounds which exist in the body, synthesized from acetyl-CoA and forms mevalonic acid through complex pathways (Murray, et al., 2008). Sutejo, (2006), suggested that the liver synthesizes most cholesterol and a small portion which absorbed from the diet. The presence of cholesterol in blood vessels in high amounts create deposits or plates which narrow or clog arteries that cause atherosclerosis, whichin turn has an impact on CHD (Xu, et al., 2018).

HDL is anti-atherogenic because it lifts excess cholesterol in the blood vessel tissue to the liver which is released through the bile ducts (Dewi, et al., 2012). Epidemiological evidence and its clinic present a negative relationship between HDL cholesterol and CHD. Dietary interventions can raise HDL cholesterol levels and at the same time, reduce CHD. Thus, efforts needed for prevention, for instance by using hypolipidemia drugs.

Mulberry leaf or *Morus australis* Poir is an herbal plant well-known by the people of Indonesia as a traditional treatment for cough, fever, diabetes, anemia, and hypertension (Hariana, 2008). Its growth is wildly and easily found in Indonesia and usually taken for its fruit. The ethanol extract of the mulberry leaf contains quercetin, where its compound belongs to the flavonoid glycoside group. Flavonoid glycosides are phenol compounds which act as protein coagulators (Lenny, 2006). Ethanol is a solubilizing solution that can dissolve tannins and flavonoids because the content of these compounds is a compound which has cholesterol-lowering properties (Chairungsi, et al., 2006). Tannins are efficacious in the process of compaction of the mucous layer of the digestive tract, thus, it inhibits the absorption of food substances, including fats and cholesterol, by the digestive tract (Smeriglio, et al., 2017).

The results of previous studies by Valacchi et al. (2014), stated that the combination of mulberry leaf and fruit extracts influence high-fat diets to regulate cholesterol transport in rat liver hence. This combination was useful for preventing obesity. Therefore, researchers were interested in conducting research on the activity of mulberry leaf ethanol extract on HDL levels and investigating the inhibition of mulberry leaf extract on the formation of foam cells in the aortic wall of male Wistar rats (*Rattus novergicus*) induced by atherogenic diet.

Previous study found that combination of 500 mg/kg BW extract of mulberry leaves and berries has been effectively proven regulating cholesterol transport (Valacchi, et al., 2014). Meanwhile, this study used a half reference dose (250 mg/kg BW) since it only used the mulberry leaves. It was also known that the mulberry leaves possess similar active compound as mulberry.

2. RESEARCH METHOD

This study was a quasi-experimental with control design. Utilized rats as animal study, this study investigated the protective effect of mulberry leaves extract against CHD events by rising the HDL level. To pursue that objective, this study covers several steps including preparation of mulberry leaves extract, animal study, and observation of body weight, HDL level and formation of foam cells (Lamanema, 2005).

Mulberry leaves extraction. Amount 600 grams of mulberry leaf powder was placed in a dark-colored container or bottle, added with 70% ethanol as much as 4.5 L. The maceration took 5 days long, and filtrate was gathered at the end of the process for further concentrated using rotary evaporator. To obtain a thick extract, the solvent evaporation procedure was maintained at 50^{o}C.

Experimental animal. Thirty-six male Wistar rats were employed to this study with inclusion criteria which were healthy, weighing between 175-250 g, aged 16-18 weeks. The animals were maintained in controlled condition at temperature 22±3^{0}C, humidity 44-56%, and under 12/12 hours of light/dark cycle, also feed normally with water *ad libitum*. The rats were acclimatized a week prior experiment and divided into six group randomly (n=6 rats each group) as follow: normal control (normal feed and water *ad libitum*), negative control (atherogenic diet), positive control, and three doses of ethanolic mulberry leaves extracts (25, 50, and 100 mg/200g BW of rats respectively). For normal control, the rats were only administered with normal feed (Confeed PAR-S) and water *ad libitum*, while others were treated with atherogenic diet which contains Confed PAR-S, flour, quail egg yolk, cholic acid, lard, and water for 28 days to induce hypercholesterolemia. The negative control group was given 0.5% Na CMC, and 0.18 mg simvastatin was administered for positive control. Meanwhile, ethanolic mulberry leaves extract groups were treated at a dose 25, 50, and 100 mg/kg BW of rats, respectively. All the treatment was delivered for 14 days starting after hypercholesterolemia was confirmed. During the study, the rats were weighed before the treatment and every week until it was terminated.

HDL measurement. The HDL level was determined by blood orbital vein puncture on the day 0, 28, 35 and 42.The measurement of day 0 was intended to know the initial level while day-28 was to confirm the hyperlipidemia state after induction. The rat's total cholesterol level that exceeds 54 mg/dL was classified as hypercholesterolemia. For investigating the effect of the treatments, the HDL level was evaluated on day 35 and 42. The HDL level (mg/dl) was determined using CHOD-PAP method as follow: 0.5 ml venous orbital blood was centrifugated (15 min, 3000 rpm), incubated for 20 minutes (20-25^{0}C) and observed using a readable Stardust absorption photometer.

Foam cell of the aortic wall observation

Foam cell of the aortic wall observation. At the end of the study, all animals were euthanized and necropsied for isolating the abdominal aortic cross-section. It then processed of HE staining to observe the presence of the foam cells. HE staining was prepared by cutting the tissue and arranged on tissue cassette for dehydration process. Once it was blocked with paraffin liquid, cut for 3-5 µm size using microtome, and placed on the glass slide for staining using hematoxylin and eosin. The HE stains resulted on blue and red color with a clear balance that made it easier to observe on its cell component.

The data were statistically analyzed using paired-sample T-test ($p<0.05$) to determine the effect of atherogenic diet induction between day 0 and 28. Furthermore, one-way Anova test followed by Tukey post hoc test were utilized to understand the differences of the HDL level on each group of treatment, particularly the effect of various dose of mulberry leaves extract.

3. RESULTS AND DISCUSSION

The ethanolic mulberry leaves extract was a thick green color, distinctive smell and had sticky also smooth appearance. The extraction process yielded 14.67% thick extract from 600 grams of mulberry leaves powder.

In this hyperlipidemia study models, body weight was measured periodically as seen in figure 1.

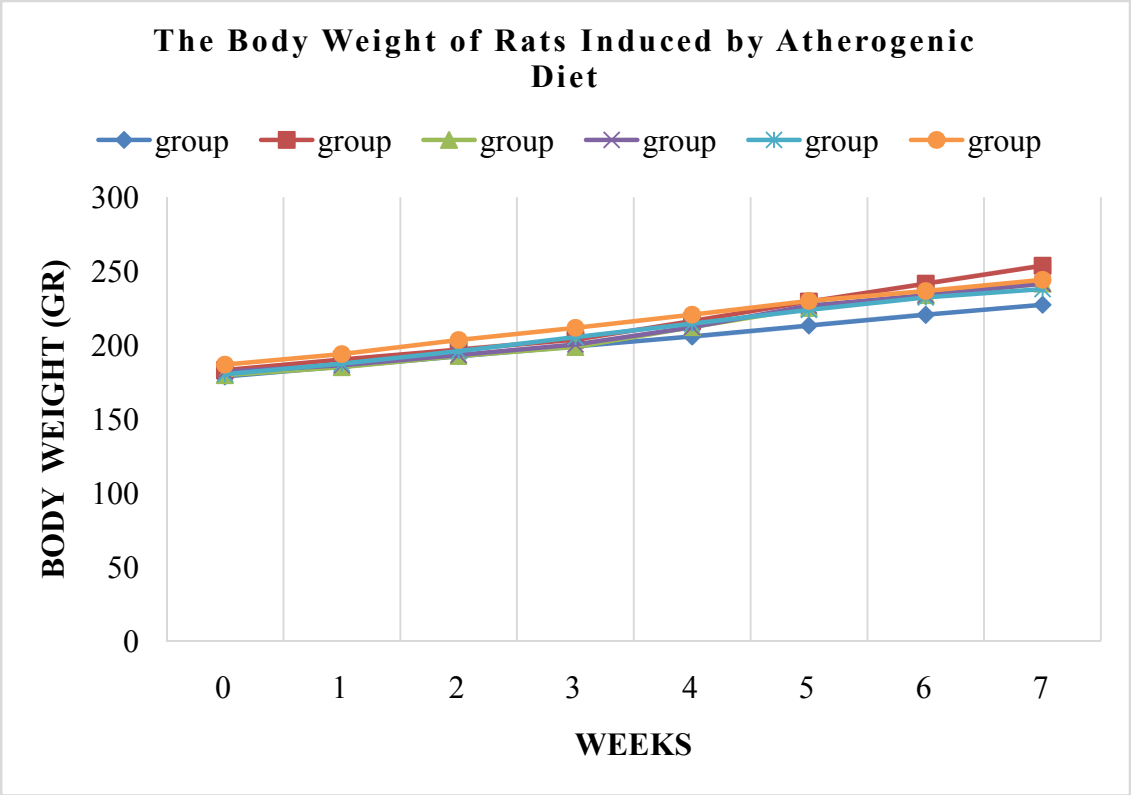

Figure 1. The body weight of animal study (Group I: normal control; II: negative control Na CMC 0.5%; III: positive control simvastatin; IV-VI: mulberry ethanolic extract dose 25, 50, 100 mg/kg BW rats, consecutively)

The weight of the animals during almost 8 weeks of study had no significant differences ($p < 0.05$) for all groups. Although there was a slight increase of the BW, it showed the effect of atherogenic diet that could induce the weight gain. Closely observed, the negative groups showed higher trend of body weight since it induced by the diet continuously without any treatment. Overall, the body weight data revealed that there was an increase of rat's BW but still in normal range. It also proved that the diet was successful on hyperlipidemia model.

To investigate the effect of mulberry extract, the HDL level was determined. It is understood that hypercholesterolemia lowers the HDL level (Jia, et al., 2013). As described in figure 2, the HDL level on day 0 was significant difference compared to day 28 ($p<0.05$) which emphasized the successful induction of atherogenic diet and supported previous statement. The HDL level then increased post treated using mulberry leaves ethanolic extract. The effect was dose dependent, higher dose administered higher level of HDL was described and it was statistically difference for each group ($p<0.05$). The extract at dose 100 mg/200 g BW displayed the strongest effect on augmenting the HDL level that almost similar to the positive control, simvastatin. Therefore, the mulberry leaves ethanolic extract at 100 mg/200 g BW possessed most effective anti-hyper cholesterol effect than other doses.

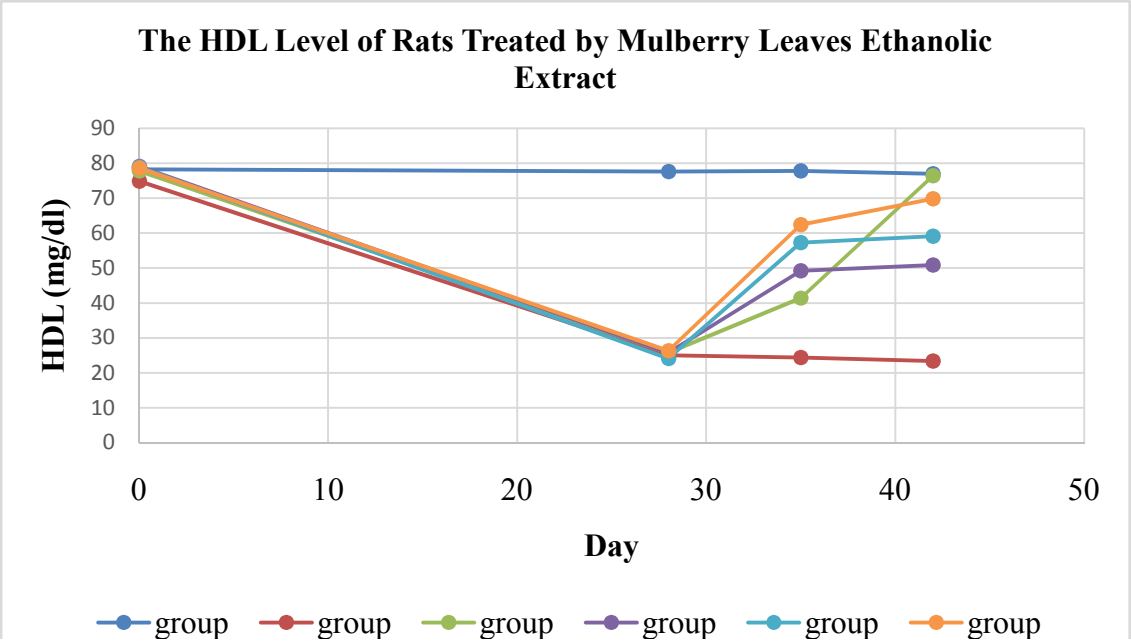

Figure 2. The HDL levels (mg/dL) of animal study (Group I: normal control; II: negative control Na CMC 0.5%; III: positive control simvastatin; IV-VI: mulberry ethanolic extract dose 25, 50, 100 mg/kg BW rats, consecutively)

Mulberry leaves are believed to be an anti-hypercholesterolemia due to its flavonoids content (Syamsuhidayat& Hutapea,1991). Flavonoids as an active component as cholesterol-lowering substances, are semi-polar that may dissolve in semi-polar solvents (Mills & Bone, 2000). An *in vitro* experiment revealed that flavonoids inhibit LDL oxidation and reduce the cytotoxic effects of oxidized LDL even though the mechanism underlying this effect is not yet found.

According to Vallachi, et al., (2014), it is stated that flavonoids reduce triglyceride, LDL, and total cholesterol levels in hyperlipidemic rats. Flavonoid as a family of polyphenols attributed as an anti-cholesterol and anti-inflammatory effects in rats was induced by high-fat diets. Furthermore, polyphenols augment HDL levels and reduce LDL levels. Hence, it induces the plasma lipid level back to normal in this study. Another finding accounted flavonoids are able to increase HDL levels by increasing Apo A1 production (Ruel, et al., 2006), which role is as an enzyme cofactor for LCAT and a ligand to interact with lipoprotein receptors in tissues as well as having protective properties against atherosclerosis (Murray, et al., 2008). Furthermore, flavonoids reduce the blood cholesterol levels by inhibition of cholesterol synthesis and increase LDL receptor expression (Zeka, et al., 2017). Other compound in mulberry leaves is alkaloids which possess ability to reduce the blood cholesterol level (Zhang, et al., 2018), and tannin which is correlated with mucous production in GI tract thus inhibits the absorption of fatty food intake.

Along with HDL level that elevated after treated by mulberry extract in this study, further investigation on foam cell formation in abdominal aortic wall was intended to deeply understand the effect on cellular level. Early signs of atherosclerosis in vascular wall structure were dysfunction or vascular injury, especially endothelial, followed by lymphocyte mobilization, macrophage formation, lipid deposition, the proliferation of smooth muscle through the activity of mitogenic factors and the synthesis of the

extracellular matrix monocytes (Wierda et al., 2010). These monocytes attach to the cytoplasmic endothelium, then infiltrate between endothelial cells and lays in the subendothelial region which then into scavenger cells and later into macrophages. Some of the function of macrophages is to ingest and cleanse fat, especially Lalith oxidized through special receptors called scavenger receptors. Then, Scavenger cells then become foam cells, which is the beginning of fatty streaks (Japardi, 2002). The gathering of macrophages in the sub intima region causes increased endothelial damage. These cells produce and secrete toxic substances and oxidative metabolites such as oxidized LDL and superoxide anions. All those processes initiate the endothelial impaired.

Figure 3 presented the histopathological profile of abdominal aortic wall to observe the presence of foam cell induced by high cholesterol level. As normal control only feed normally without induction, there was no foam cell detected. Meanwhile, in negative control, the foam cell was confirmed presenting on the smear. Similar to the negative control, the histopathological preview on the mulberry leaves extracts at dose 25 and 50 mg/100 g BW found the appearance of foam cells though not much as negative control. On contrary, the extract at 100 mg/200 kg BW successfully inhibited the formation of foam cell closely to the profile on positive control as well as the normal control. This result corresponds to the HDL data that higher level of HDL is equivalent to smaller production of foam cell in abdominal aortic wall as an initial sign of atherosclerosis.

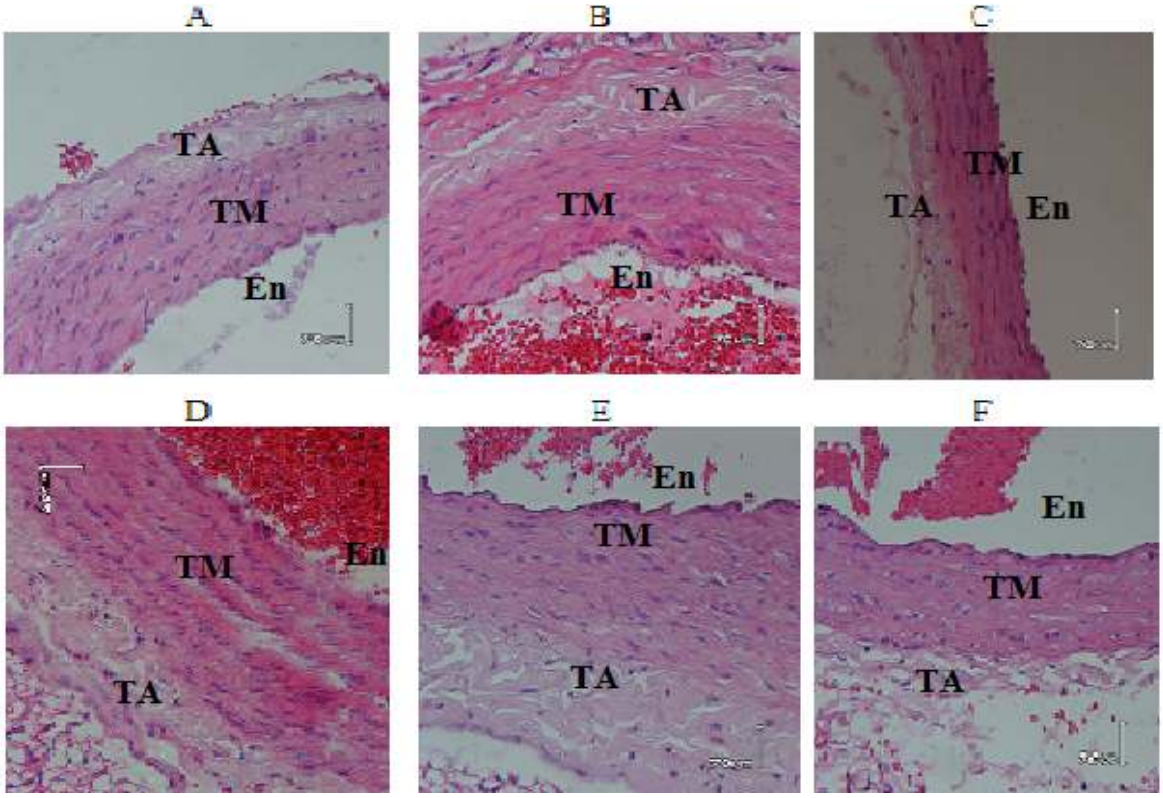

Figure 3. Histopathological profile of abdominal aortic wall (HE staining, 40x) (A: normal control; B: negative control; C: positive control; D-F: mulberry extract dose 25, 50, 100 mg/200 g BW; En: endothelial; LA: adventisia layer; TM: tunica media; TI: tunica intima; SB: foam cells)

A study confirmed that alkaloids, one of mulberry active compound, improved endothelial function by promoting nitric oxide (Sawangjaroen, et al., 2004). Moreover, it reduced atherosclerosis lesion and inflammatory marker like ICAM-1, VCAM-1 and C-RP (Amran, et al., 2011).

4. CONCLUSION

Based on the results, it can be concluded that the administration of mulberry leaf (*Morus australis* Poir.) ethanolic extract increases the HDL levels and inhibits the formation of foam cells in the aortic wall of male white Wistar strain rats induced by atherogenic diet. The most effective dose augmented the HDL as well as constrained the formation of foam cells was 100 mg/200 g BW of rats. Further research studying on its toxicity profile is important to conduct since the anti-hypercholesterolemia treatment routinely requires long duration.

REFERENCES

Amran, A. A., Zakaria, Z., Othman, F., Das, S., Al-Mekhlafi, H. M., & Nordin, N. A. M. (2011). Changes in the vascular cell adhesion molecule-1, intercellular adhesion molecule-1 and c-reactive protein following administration of aqueous extract of piper sarmentosum on experimental rabbits fed with cholesterol diet. *Lipids in health and disease*, *10*(1), 1-8. doi:https://doi.org/10.1186/1476-511X-10-2

Chairungsi, N., Jumpatong, K., Phutdhawong, W., & Buddhasukh, D. (2006). Solvent effects in electrocoagulation of selected plant pigments and tannin. *Molecules*, *11*(5), 309-317. doi: https://doi.org/10.3390/11050309

Dewi, Y. R., Santoso, L. M., & Tibrani, M. M. (2012). Pineapple (Ananascomosus (L.)Merr.)Juice activity test on total cholesterol and blood triglycerides of mice (Musmusculus L.) and their contribution to learning biology in high school. *Skripsi*. FKIP Sriwijaya University

Hariana, A. (2008). *Tanaman Obat dan Khasiatnya*. Jakarta: Cetakan V. Sel. Penebar Swadaya.

Hussain, M. A., Al Mamun, A., Peters, S. A., Woodward, M., & Huxley, R. R. (2016). The Burden of Cardiovascular Disease Attributable to Major Modifiable Risk Factors in Indonesia. *Journal of epidemiology, 26*(10), 515-521. doi: https://doi.org/10.2188/jea.JE20150178

Japardi, I. (2002). *Patomekanisme Stroke InfarkAterotrombotik*. Medan: Fakultas Kedokteran , Universitas Sumatera Utara.

Jia, Y.-J., Liu, J., Guo, Y.-L., Xu, R.-X., Sun, J., & Li, J.-J. (2013). Dyslipidemia in rat fed with high-fat diet is not associated with PCSK9-LDL-receptor pathway but ageing. *Journal of geriatric cardiology : JGC, 10*(4), 361-368. doi:https://doi.org/10.3969/j.issn.1671-5411.2013.04.007

Lamanema, M. E. L. (2005). Perbandingan Profil Lipid Dan Perkembangan Lesi Aterosklerosis Pada Tikus Wistar Yang Diberi Diet Perasan Pare Dengan Diet Perasan Pare dan Statin (The Comparison of Lipid Profile and The Progression of Atherosclerotic Lesion between Momordica Charantia Juice Dietary with and without Statin on Wistar Rats). *Tesis.* Program Pasca Sarjana, Universitas Diponegoro Semarang.

Lenny, S. (2006). Senyawa Flavonoida, Fenilpropanoida dan Alkaloida. *Skripsi*. Medan: Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Sumatera Utara.

Mills, S., & Bone, K. (2000). *Principles and practice of phytotherapy. Modern Herbal Medicine*. UK: Churchill Livingstone.

Murray, RK., D.K Granner, P.A. Mayes, dan V.W. Rodwell. (2008). *Biokimia Harper.* Edisi 25. Jakarta: Penerbit Buku Kedokteran EGC.

Ruel, G., Pomerleau, S., Couture, P., Lemieux, S., Lamarche, B., & Couillard, C. (2006). Favourable impact of low-calorie cranberry juice consumption on plasma HDL-cholesterol concentrations in men. *British Journal of Nutrition*, *96*(2), 357-364. doi:https://doi.org/10.1079/BJN20061814

Sawangjaroen, N., Sawangjaroen, K., & Poonpanang, P. (2004). Effects of Piper longum fruit, Piper sarmentosum root and Quercus infectoria nut gall on caecal amoebiasis in mice. *Journal of Ethnopharmacology*, *91*(2-3), 357-360. doi:https://doi.org/10.1016/j.jep.2004.01.014

Smeriglio, A., Barreca, D., Bellocco, E., & Trombetta, D. (2017). Proanthocyanidins and hydrolysable tannins: occurrence, dietary intake and pharmacological effects. *British journal of pharmacology*, *174*(11), 1244-1262. doi: https://doi.org/10.1111/bph.13630

Sutedjo, A. Y. (2006). Mengenal penyakit melalui hasil pemeriksaan laboratorium. *Yogyakarta: Amara Books*.

Syamsuhidayat, S. S., & Hutapea, J. R. (1991). *Inventaris tanaman obat Indonesia*. Jakarta: Departemen Kesehatan Republik Indonesia.

Uli, R. E., Satyana, R. P., Zomer, E., Magliano, D., Liew, D., & Ademi, Z. (2020). Health and productivity burden of coronary heart disease in the working Indonesian population using life-table modelling. *BMJ open*, *10*(9), e039221. doi:http://dx.doi.org/10.1136/bmjopen-2020-039221

Valacchi, G., Belmonte, G., Miracco, C., Eo, H., & Lim, Y. (2014). Effect of combined mulberry leaf and fruit extract on liver and skin cholesterol transporters in high fat diet-induced obese mice. *Nutrition research and practice*, *8*(1), 20-26. doi:https://doi.org/10.4162/nrp.2014.8.1.20

Wierda, R. J., Geutskens, S. B., Jukema, J. W., Quax, P. H., & van den Elsen, P. J. (2010). Epigenetics in atherosclerosis and inflammation. *Journal of cellular and molecular medicine*, *14*(6a), 1225-1240. doi: https://doi.org/10.1111/j.1582-4934.2010.01022.x

Xu, S., Pelisek, J., & Jin, Z. G. (2018). Atherosclerosis is an epigenetic disease. *Trends in Endocrinology & Metabolism*, *29*(11), 739-742. doi: https://doi.org/10.1016/j.tem.2018.04.007

Zeka, K., Ruparelia, K., Arroo, R. R., Budriesi, R., & Micucci, M. (2017). Flavonoids and their metabolites: prevention in cardiovascular diseases and diabetes. *Diseases*, *5*(3), 19. doi:https://doi.org/10.3390/diseases5030019

Zhang, X., Jin, Y., Wu, Y., Zhang, C., Jin, D., Zheng, Q., & Li, Y. (2018). Anti-hyperglycemic and anti-hyperlipidemia effects of the alkaloid-rich extract from barks of Litsea glutinosa in ob/ob mice. *Scientific reports*, *8*(12646), 1-10. doi:https://doi.org/10.1038/s41598-018-30823-w

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RESEARCH **Open Access**

Saliva pH between Gargling and without Gargling Water after Consuming Sweet and Sticky Foods

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Abstract
Sweet and sticky foods are the main energy source for oral bacteria and are directly involved in lowering the pH. Gargling with boiled water after every meal can speed up the pH of the saliva in the mouth to return to normal. The objective of this study is to determine the difference in salivary pH between gargling and without gargling water after consuming sweet foods in elementary school students. The research method used was quasi-experimental with pretest and posttest with control group design. The instrument in this research was a pH meter. The population in this study were students in grades I – V of public elementary schools in Bantul with a total population of 135. The research sample used total sampling. Analysis of the research data was conducted using the Wilcoxon test, Mann Withney and Anova Test. The results showed that the pH of saliva (direct gargling) of water/0 minutes after consuming sweet and sticky foods was before 7.53 after gargling 7.99 increased by 0.46. The pH of gargling saliva 5 minutes before 7.48 after rinsing 7.63 increased 0.15. pH of saliva gargling 10 minutes, that was before 7.31 after gargling 7.3 decreased by 0.18. pH of saliva (without rinsing) water/0 minutes, which was initial pH 7.68 to 7.55 after consuming sweet and sticky foods, decreased 0 ,13. The pH of saliva without rinsing with water for 5 minutes, the initial pH was 7.70 to 7.06, decreased by 0.64. The most effective gargling time on salivary pH was gargling water immediately 0 minutes after consuming sweet and sticky foods. The time without gargling water affecting the pH of saliva after consuming sweet and sticky foods was 5 minutes.

Keywords: Gargling With Water, No Rinse With Water, Saliva pH, Sweet and Sticky Food.

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1. INTRODUCTION

Dental caries can occur, one of which is caused by food/some types of dietary carbohydrates, such as sucrose and glucose fermented by certain bacteria and form acid so that the plaque pH decreases to below 5 within 1-3 minutes. Repeated decrease in pH will result in demineralization of vulnerable tooth surfaces and the caries process begins (Lestari & Putri, 2016). Sweet and sticky foods contain carbohydrates which are the main energy source for oral bacteria and are directly involved in lowering pH (Jannah, et al., 2016). Gargling is one of the preventive measures for dental caries, which is the easiest and cheapest to do, so that the habit of gargling using plain water after eating sweet and sticky foods is an alternative in maintaining the pH of saliva so that it remains within normal limits so that it does not weaken tooth enamel (Wahyuningsih, & Ramadhani, 2015). In the Special Region of Yogyakarta, the number of sufferers of dental and oral problems, according to the 2018 Basic Health Research, was 47.7% higher than the national average of 45.3% of dental and oral problems (Kementerian Kesehatan, R. I., 2018).

Oktarinda (2011), stated that Saliva is one of the components that contributes to the level of acidity (pH) of the mouth. Saliva helps the process of remineralizing small lesions on the tooth enamel layer (Kusumasari, 2012). Saliva is a thick fluid produced by the salivary glands, parotid glands, sublingual glands and submandibular glands, which are located under the tongue near the cheek muscles and near the palate. Saliva contains 99.5% water (Haryani, et al., 2016).

The results of preliminary study interviews with 10 elementary school students in Bantul, regarding gargling water after eating sweet and sticky foods, it was found that 70% of students did not rinse their mouths water after consuming sweet and sticky foods, and had many cavities, and had never been tested for salivary pH after consuming sweet and sticky foods. The objective of this study is to discover an effective gargling time in maintaining normal salivary pH after consuming sweet and sticky foods.

2. RESEARCH METHOD

This type of research was quasi-experimental with Pretest and Posttest with Control Group Design (Notoadmodjo, 2012). The research technique used was to test the difference in salivary pH between gargling and without rinsing with water after consuming sweet and sticky foods in elementary school students at minute 0, minute 5 and minute 10 after consuming sweet and sticky foods. This research was conducted in one of the public elementary schools in Bantul, Yogyakarta. The population in this study were students in Grades I – V of State Elementary Schools in Bantul. The sample in this study used a total sampling technique of 135 respondents. The statistical tests used were Wilcoxon, Mann Withney and Anova test (Jannah et al., 2016). The inclusion criteria in this study were aged 6-12 years, had the habit of eating sweet and sticky foods, willing to be respondents, and communicative. The exclusion criteria in this study were students with teeth that had caries. This research has received approval from the ethics commission with the ethics number e-KEPK/POLKESYO/0149/VI/2019.

3. RESULTS AND DISCUSSION

Table 1. Average Saliva pH of Respondents Gargling Water after Consuming Sweet and Sticky Foods.

Variable	pH Saliva			Wilcoxon Test			
	Before	After	Deviation	Z	Asymp. Sig.	A	Information
Group Directly Gargling/0 minutes	7,53	7,99	0,46	-2.856	0,004	0,05	Meaningful
The group of 5 minutes just rinsed with water	7,48	7,63	0, 15	-1,351	0,177	0,05	Not meaningful
The group of 10 minutes just rinsed with water	7,31	7,13	0,18	-1,543	0,123	0,05	Not meaningful

Table 1 shows that the pH value of saliva in the gargling group/0 minutes after consuming sweet and sticky foods increased the most from before consuming sweet and sticky foods, namely from 7.53 to 7.99 with a difference of 0.46. The 10-minute group just rinsed their mouth after consuming sweet and sticky foods. The saliva pH decreased from 7.31 to 7.13 with a difference of 0.18. The Asymp. Sig (p) value of gargling directly/0 minutes was 0.004 < 0.05, thus, Ho was accepted and Ha was rejected, meaning that statistically it showed that there was a significant difference in gargling directly/0 minutes before and after consuming sweet foods and attached to salivary pH. SDN Puluhan students, meaning that there is an effect of gargling water immediately after consuming sweet foods and is attached to the salivary pH of SDN Puluhan students. The Asymp. Sig (p) value of gargling water 5 minutes after consuming sweet and sticky foods is 0.177 > 0.05, thus, Ho is rejected and Ha is accepted, statistically means that there is no significant difference in salivary pH before and after consuming sweet foods attached for 5 minutes then rinsed with water, meaning that there was no effect of gargling water 5 minutes after consuming sweet foods and attached to the pH of the saliva of SDN Puluhan students. The Asymp. Sig (p) pH value of saliva gargling with water 10 minutes after consuming sweet and sticky foods is 0.123 <0.05, thus, Ho is rejected and Ha is accepted, statistically means that there is no significant difference in salivary pH before and after consuming sweet food and stick to it 10 minutes then rinse with water. It means that there is no effect of gargling with water, 10 minutes after consuming sweet food and sticking to the pH of the saliva of SDN Puluhan students. The group without gargling water 5 minutes after consuming sweet and sticky foods experienced the most decrease in pH from 7.70 to 7.06 with a difference of 0.64.

Table 2. Average Saliva pH of Respondents without Gargling Water after Consuming Sweet and Sticky Foods.

Variable	pH Saliva			Wilcoxon Test			
	Before	After	Deviation	Z	Asymp. Sig	A	Information
No Gargling Group/0 minutes	7,68	7,55	0,13	-1,147	0,251	0,05	Not meaningful
Group 5 minutes without gargling water.	7,70	7,06	0,64	-5,030	0,000	0,05	Meaningful
Group 10 minutes without gargling water	7,40	6,96	0,44	-4,312	0,000	0,05	Meaningful

Table 2 shows that the group without gargling water 5 minutes after consuming sweet and sticky foods experienced the most decrease in pH from 7.70 to 7.06 with a difference of 0.64. The Asymp. Sig (p) value without gargling directly/0 minutes was 0.251> 0.05, thus, Ho was rejected and Ha was accepted, meaning that statistically there was no significant difference before and after consuming sweet and sticky foods without gargling directly/0 minutes, on the salivary pH of elementary school students, meaning that there is no effect without gargling water directly/0 minutes after consuming sweet foods and sticking to the salivary pH of elementary school students. The Asymp. Sig (p) value without gargling water 5 minutes after consuming sweet and sticky foods is 0.000 < 0.05, thus, Ho is accepted and Ha is rejected. It statistically means that there is a significant difference in salivary pH before and after consuming sweet foods and attached 5 minutes later without gargling with water, meaning that there was no effect without rinsing with water 5 minutes after consuming sweet foods and attached to the salivary pH of SDN Puluhan students. The Asymp. Sig (p) pH value of saliva without rinsing with water 10 minutes after consuming sweet foods and sticking is 0.000 <0.05, thus, Ho is accepted and Ha is rejected. Statistically, it means that there is a significant difference before and after consuming sweet foods and attached 10 minutes later without rinsing with water, to the salivary pH of SDN Tens students. It means that there is an effect without rinsing with water, 10 minutes after consuming sweet foods and sticking to the pH of the saliva of SDN Puluhan students.

Table 3. Results of the Group Analysis of Gargling and without Gargling Water using the Mann Whitney Test

Time	Asymp.Sig	A	Information
0 minute	0,000	0,05	Not meaningful
5 minute	0,000	0,05	Meaningful
10 minute	0,429	0,05	Not meaningful

Table 3 provides information between the average salivary pH of the 0-minute and 5-minute gargling group with the respondent's saliva pH without rinsing with water 0 minutes and 5 minutes after consuming sweet and sticky foods. The result is that the Asymp.Sig value of 0.000 is smaller than 0. 05, thus, Ho is accepted and Ha is rejected.

Statistically, it shows that there is a significant difference between the pH value of the saliva of students who gargle 0 minutes and 5 minutes and the pH of the saliva of students who do not rinse their mouth with water for 0 minutes and 5 minutes. As for the average salivary pH of the 10-minute gargling group with the respondent's saliva pH without rinsing with water 10 minutes after consuming sweet and sticky foods. The results obtained that the Asymp. Sig value of 0.429 is greater than 0.05, thus, Ho is rejected and Ha is accepted. Then, statistically, it shows that there is no significant difference between the saliva pH values of respondents who gargled with no gargling.

To determine the effectiveness of gargling water 0 minutes, 5 minutes and 10 minutes after consuming sweet foods and sticking to the pH of the respondents' saliva, the Anova test was conducted, and the results of the study, there were significant differences (p=0.027), (p=0.000), (p= 0.009).

Table 4. Anova Test Post Hoc Tests Tukey HSD Test Saliva pH Direct gargling 0 minutes, 5 minutes and 10 minutes.

Gargling Time (I)	Gargling Time (J)	Sig
Gargling 0 minute	Gargling 5 minutes	.0,027
	Gargling 10 minutes	0,000
Gargling 5 minutes	Gargling 0 minute	0,027
	Gargling 10 minutes	0,009
Gargling 10 minutes	Gargling 0 minute	0,000
	Gargling 5 minutes	0,009

Table 4 can be seen that between gargling directly/0 minutes and 5 minutes showed a significant difference, sig = 0.027 <0.05), gargling 0 minutes with 10 minutes showed a difference, Sig = 0.000 < 0.05. Gargling 5 minutes with 10 minutes showed a significant difference, sig = 0.009 < 0.05. It means direct gargling time/0 minutes is the most effective in increasing salivary pH.

To determine the effectiveness without gargling water 0 minutes, 5 minutes and 10 minutes after consuming sweet foods and attached to the pH of the respondents' saliva, the Anova test was performed, and the results of the study, there were significant differences (p = 0.000), (p = 0.000), and there was no significant difference between 5 minutes and 10 minutes (p=0.728).

Table 5. Saliva pH ANOVA test without direct gargling/0 minutes, 5 minutes and 10 minutes.

Time Without Gragling (I)	Time Without Gargling (J)	Sig
Without Gargling 0 minute	Without Gargling 5 minutes	.0,000
	Without Gargling 10 minutes	0,000
Without Gargling 5 minutes	Without Gargling 0 minute	0,000
	Without Gargling 10 minutes	0,728
Without Gargling 10 minutes	Without Gargling 0 minute	0,000
	Without Gargling 5 minutes	0,728

Table 5 shows that between no direct gargling/0 minutes and 5 minutes showed a significant difference (sig = 0.000), without rinsing 0 minutes with 10 minutes showed no difference, Sig = 0.000 <0.05. Without rinsing for 5 minutes with 10 nits, there was a significant difference, sig = 0.728 > 0.05. It means that without gargling for 5 minutes the most effect on the decrease in salivary pH.

Gargling can clean the oral cavity from debris, prevent and reduce plaque accumulation and have a direct effect on saliva. One of the simple, inexpensive, efficient and no side effects that can be performed in maintaining oral health is to rinse with water. The results showed that gargling water immediately/0 minutes and 5 minutes after consuming sweet and sticky foods could increase the pH of respondents' saliva. The longer the time to rinse water, which is 10 minutes after eating sweet foods, the lower the salivary pH.

The results of this study are in accordance with the results of research by Jannah, et al., (2016), which revealed that gargling water can remove food debris in the oral cavity, the fluorine contained in it can inhibit the demineralization process and bind to tooth enamel components, reduce the activity of microorganisms and can has a direct effect on salivary pH (Jannah, et al., 2016). Furthermore, in accordance with the results of research Amalia, et al., (2014), that there is an increase in salivary pH after gargling using white tea solution. Another study also stated that there was an increase in salivary pH after gargling with a miswak solution.

Another study that is in line with this research is the research of Wahyuningsih, & Ramadhani, (2015), which states that gargling is one of the preventive measures for the occurrence of dental caries, which is the easiest and cheapest to apply. You should always rinse your mouth with water after every meal. It can speed up the pH of the saliva in the mouth back to normal, thus, it does not have time to weaken tooth enamel. Treatment/intervention time (0 minutes, 5 and 10) minutes for 3 groups without gargling after consuming sweet and sticky foods, the results showed that the three interventions could lower salivary pH, and the most pH-lowering value was without gargling 5 minutes after consuming sweet foods, that is 0.64.

The results of this study are in accordance with research (Jannah, et al., 2016), which states that sweet and sticky foods contain carbohydrates which are the main energy source for oral bacteria that are directly involved in lowering pH. Although the first 5-10 minutes after eating are critical times for pH (around 5.2-5.5), in the author's study 5-10 minutes after consuming sweet foods, there is a decrease in pH, but the pH remains in an alkaline/neutral state. It may be caused by other factors, including the respondent's saliva factor.

Another study that is also in line with the results of this study is a study conducted by Sulendra, et al., (2013), which states that saliva as a host factor plays a role in the protection mechanism that maintains the normal flora of the oral cavity and tooth surface, which are bacterial cleansing, antibacterial activity, buffers, and remineralization. Saliva also has a buffer system that functions to neutralize acidic conditions that arise due to plaque formation or acidic foods and drinks.

Without gargling water for 0 minutes, 5 minutes and 10 minutes after consuming sweet and sticky foods, it can reduce the pH of the respondent's saliva. The results of this study are in accordance with the results of research (Suratri, et al., 2017), which states that sweet and sticky foods containing carbohydrates are the main energy source for oral bacteria and are directly involved in lowering salivary pH. There is a relationship between the pH of Saliva and the habit of drinking sweet milk (sugar), and often drinking and eating sweet and sticky foods in pre-school age children in Banten Province and Yogyakarta Special Region. This is also in accordance with the research

of Suyuti, (2012), which stated that the occurrence of caries in children's teeth was caused by the influence of eating sweet and sticky foods.

The results of the analysis used the Wilcoxon test, the average pH of saliva gargling with water 0 minutes after consuming sweet and sticky foods obtained the Asymp.Sig (p) value of 0.004 <0.05, thus, Ho is accepted and Ha is rejected. It statistically means that there is a difference or there is an effect of gargling water directly/0 minutes after consuming sweet foods and attached to the pH of the respondent's saliva. You should always rinse your mouth with water after every meal, so that the pH of the saliva in the mouth returns to normal.

The results of this study are in accordance with the results of research by A'yun, et al., (2016), that after chewing simple carbohydrate foods, gargling with water, the average pH of saliva after gargling will increase. The pH of saliva after gargling has increased from the pH of saliva after chewing simple carbohydrate foods. It proves that gargling vigorously over the entire surface of the mouth can remove the remnants of food debris in the oral cavity thereby reducing bacterial activity and providing a mechanical effect that can affect salivary pH. The results of this study are also in accordance with previous research which states that you should always rinse your mouth with boiled water after every meal. It can speed up the pH of the saliva in the mouth back to normal, thus, it does not have time to weaken tooth enamel.

Wilcoxon test average pH of saliva gargling with water, 5 minutes after consuming sweet and sticky foods, the Asymp. Sig (p) value is 0.177> 0.05, thus, Ho is rejected and Ha is accepted. Statistically, it means that there is no significant difference or no effect of gargling water 5 minutes after consuming sweet foods and attached to the pH of the respondent's saliva. Although not significant, but numerically/value, there is an increase in salivary pH which is 0.15 from before rinsing 7.48 after gargling water to 7.63.

The results of this study are not in accordance with research by A'yun, et al., (2016), which states that within 1-3 minutes after eating food/some types of food carbohydrates, such as sucrose and glucose which are fermented by certain bacteria will form acid so that the plaque pH decreases to below 5. Repeated decreases in pH will result in demineralization of the vulnerable tooth surface and the caries process begins.

The Asymp. Sig (p) pH value of saliva gargling with water 10 minutes after consuming sweet and sticky foods was 0.123 <0.05, thus, Ho was rejected and Ha was accepted. Statistically it means that there was no significant difference in rinsing with water, 10 minutes. after consuming sweet foods and sticking to the pH of saliva, meaning that there is no effect of gargling water, 10 minutes after consuming sweet foods and sticking to the pH of the respondent's saliva. In this group, there was a decrease in salivary pH of 0.18, from 7.31 (basic) to 7.13 (alkaline). This decrease in salivary pH did not cause a critical pH state, possibly caused by other factors including salivary factors. Meanwhile, the results of this study are in accordance with research (Ismianifatun, et al., 2012), that in the mouth there is saliva (saliva) which has a buffer effect or balance. Fifteen (15) – 20 minutes after eating the salivary pH will return to normal.

The average pH of saliva without rinsing with water (0) minutes after consuming sweet foods decreased by 0.13 from before rinsing with water, from 7.68 (base) to 7.55 (base). The average pH of respondents' saliva without rinsing with water (5) minutes after consuming sweet and sticky foods decreased by 0.64 from before rinsing with water, that was from 7.70 (base) to 7.06 (base). Means that without rinsing water/0 minutes or 5 minutes after consuming sweet and sticky foods can lower the pH of

saliva, although it drops, but in this study, the pH was still in an alkaline state. This may be caused by the respondent's saliva, which tends to be alkaline.

The results of this study are in accordance with research (Sari, 2011), that an alkaline salivary pH can cause high salivary secretion in children, so that it has an impact on high saliva volume as well. One of the functions of saliva is to act as a buffer that helps neutralize the pH of saliva after eating, so that if the volume is high, it will balance the pH of the saliva and reduce the occurrence of demineralization. The average salivary pH of the respondents was alkaline (7.53) after brushing their teeth. It can be due to the effect of toothpaste containing sorbitol and xylitol used by respondents. Sorbitol and xylitol have been shown to increase salivary pH. The results of this study are in accordance with research (Ismianifatun, et al., 2012), that Sorbitol has the advantage of not being easily fermented by bacteria so that it can increase remineralization and reduce dental caries and does not reduce saliva pH so that saliva remains stable at a certain pH. Xylitol is also clinically proven to inhibit plaque teeth by 80%, inhibits tooth enamel demineralization, salivary pH, produces tooth enamel remineralization.

This study is also in accordance with research (Putri, et al., 2010) on 70 smokers. After chewing xylitol gum the salivary pH increased from 5.59 to 7.77. Another study conducted by Ismianifatun, et al., (2012), also stated that sorbitol can suppress the growth of Streptococcus mutans bacteria so that the pH of saliva does not decrease. Toothpaste containing sorbitol and xylitol has the property of stimulating salivary flow so as to increase the rate of salivary saliva contains bicarbonate which can increase the buffering capacity as well as the toothpaste does not reduce salivary pH but increases salivary pH.

The results of this study are in accordance with the opinion of Aldiaman, et al., (2016) in brushing teeth, to be effective, brushing teeth must be considered. One of the good techniques for children is the circular/fone's technique. The results of this study are also in accordance with the study, that the average OHI-S score before brushing teeth with the fone method was 2.3 with bad criteria and after brushing teeth with the fone method it dropped to 0.9 with good criteria. It means that with a good OHIS, the pH of the saliva is neutral or alkaline.

The results of the Wilcoxon test results from three groups showed that there was a decrease in salivary pH, and the most was in the group without gargling 5 minutes after consuming sweet and sticky foods, which was 0.64 followed by no rinsing with water 10 minutes after consuming sweet and sticky foods, at 0, 44. Although there was a decrease in salivary pH, the pH was alkaline (7.55) and neutral (6.96). The results of this study indicate that consuming sweet and sticky foods can reduce salivary pH.

The results of this study are not in accordance with the research of Lestari, (2016), which stated that during the first 5-10 minutes after eating, the pH is critical (around 5.2-5.5). After eating, especially carbohydrate foods, there will be fermentation of food glucose. The result is a compound that is acidic and makes the environment around the teeth acidic. Within a few minutes, the degree of acidity will increase or the pH will decrease. If the pH continues to decrease, it will reach a critical pH value. The pH value under normal conditions is in the range of 5,6,6 with an average of 6,8. The presence of changes in pH after eating will return to normal after 20-30 minutes later.

The results of this study are in accordance with the research of Kartikasari & Nuryanto, (2014), which stated that food/several types of dietary carbohydrates, such as sucrose and glucose which are fermented by certain bacteria will form acid so that the plaque pH decreases. The difference is the results of the research on decreasing the pH are still in an alkaline state Lestari dan Putri, (2016), research reaches below 5 within 1-

3 minutes. Repeated decrease in pH will result in demineralization of vulnerable tooth surfaces and the caries process begins.

According to the research of Worotitjan, et al., (2013), that consuming cariogenic foods frequently and repeatedly will cause plaque pH to be below normal and cause demineralization of enamel and the formation of dental caries. In accordance with the research by Praptiningsih & Ningtyas, (2010), that the food eaten can cause saliva to be acidic or alkaline. Consumption of sugar-containing foods and beverages between meals and at mealtimes is associated with a large increase in caries.

The results of research by Setiawan, (2012), that the pH of saliva 5 minutes after eating has not changed much compared to the initial pH before brushing teeth in the method of brushing teeth before eating. Salivary pH 15 minutes and 30 minutes after eating showed a lower pH change (acidic) compared to the initial pH before brushing teeth on the method of brushing teeth before eating.

School age children, especially elementary school children, are a group that is vulnerable to dental and oral diseases because generally at school age these children still have behaviors or habits that do not support dental health. Dental caries is a disease of the hard tissues of the teeth characterized by demineralization of the hard tissues of the teeth, followed by damage to organic matter that can cause pain to pain (panna). Cariogenic foods are foods that can cause dental caries. The nature of cariogenic foods is that they contain lots of carbohydrates, are sticky and break easily in the mouth.

The relationship between carbohydrate consumption and the occurrence of dental caries is related to the formation of plaque on the tooth surface. Plaque formed from food debris that sticks between the teeth and this plaque will eventually grow bacteria which can convert glucose into acid so that the pH of the oral cavity decreases to 4.5. In such circumstances, the tooth enamel structure will dissolve. Repeated consumption of carbohydrates that are too frequent causes the production of acid by bacteria to become more frequent so that the acidity of the oral cavity becomes more acidic and more enamel is dissolved.

The results of data analysis using the Mann Withney test in this study are in accordance with research (Wahyuningsih & Ramadhani, 2015), which states that gargling is one of the preventive measures for dental caries, which is the easiest and cheapest to conduct. It is better to gargle after finished eating. It can speed up the pH of the saliva in the mouth back to normal, thus, it does not have time to weaken tooth enamel. Saliva has a buffer system that functions to neutralize acidic conditions that arise due to plaque formation or acidic foods and drinks. Saliva forms a mucus layer as a protective mucosa, helps inhibit plaque formation, regulates the pH of the oral cavity, and others.

Meanwhile, without gargling immediately (0) minutes after consuming sweet and sticky foods, it lowered the salivary pH by 0.13. Without gargling water for 5 minutes, the pH lowers by 0.64. This means that without gargling water, 0 minutes and 5 minutes after consuming sweet foods causes a decrease in salivary pH.

The results of this study are in accordance with the research of Praptiningsih & Ningtyas, (2010), which stated that at 5 minutes after consuming sweet carbohydrates it affects the electrolyte properties of saliva so that it can affect the pH value. The result is that the asymp Sig value is 0.429 > 0.05 so Ho is rejected and Ha is accepted, these results indicate that there is no significant difference in effectiveness between the salivary pH value of respondents who rinsed with no gargling, which both lowered the pH of saliva, those who rinsed their mouths decreased. 0.18, without gargling, the pH decrease was 0.44.

The results of this study are in accordance with research by Praptiningsih & Ningtyas, (2010), that changes in the degree of acidity tend to increase 15 minutes after eating and then the acidity value will decrease. It can happen because each intake of consumption can change the state of acidity in the oral cavity,

Between the two brushing times, namely after eating and before going to bed, it is recommended that you always rinse your mouth with water after every meal. It can accelerate the pH of saliva in the mouth to return to normal, so that it does not have time to weaken tooth enamel." The results of this study are in accordance with dental research (Wahyuningsih & Ramadhani, 2015), which states that after chewing simple carbohydrate foods, then gargling with mineral water, then the average pH of saliva after gargling will increase. The average pH of saliva after gargling has increased from the pH of saliva after chewing simple carbohydrate foods. It proves that gargling vigorously over the entire surface of the mouth can remove the remnants of food debris in the oral cavity thereby reducing bacterial activity and providing a mechanical effect that can affect the saliva.

The results of data analysis using the Tukey HSD test in this study are in accordance with research (Setiawati, 2012), which asserted that the decrease in pH can be caused by salivary factors. A decrease in the rate of salivary secretion will cause a decrease in salivary pH. The results of this study are also in accordance with the research of Praptiningsih & Ningtyas, (2010), which stated that cariogenic foods are foods that can cause dental caries. The nature of cariogenic foods is that they contain lots of carbohydrates, are sticky and break easily in the mouth. The relationship between carbohydrate consumption and the occurrence of dental caries is related to the formation of plaque on the tooth surface. Plaque is formed from food debris that sticks between the teeth and this plaque will eventually grow bacteria that can convert glucose into acid so that the pH of the oral cavity decreases to 4.5. In such circumstances, the tooth enamel structure will dissolve. Repeated consumption of carbohydrates that are too frequent causes the production of acid by bacteria to become more frequent so that the acidity of the oral cavity becomes more acidic and more enamel is dissolved.

The results of this study are not in accordance with the research of Oktarianda, (2011), that after eating, especially carbohydrate foods, there will be fermentation of food glucose. The result is an acidic compound and creates an acidic environment around the teeth. Within a few minutes the degree of acidity will increase or the pH will decrease. If it continues, the decrease in the pH value will reach a critical pH value, which is a pH value that can trigger decalcification (loss of calcium salts) in tooth enamel. The presence of changes in pH after eating will return to normal after 20-30 minutes later. During the first 5-10 minutes after a meal is a critical time for pH (approximately 5.2-5.5). In this study, although without gargling, there was a decrease in salivary pH after consuming sweet foods, but the respondent's pH was neutral to alkaline. This might be due to saliva factors and the effect of using toothpaste when brushing teeth before the intervention. Limitations in this study include that researcher has not been able to fully control the gargling behavior of each respondent.

4. CONCLUSION

The most effective gargling time on the salivary pH of elementary school students after consuming sweet and sticky foods is gargling immediately/0 minutes. The time without gargling water that has the most effect on saliva pH in elementary school students after consuming sweet and sticky foods is 5 minutes.

REFERENCES

Aldiaman, H., Adhani, R., & Adenan, A. (2016). Efektivitas Menyikat Gigi Dengan Metode Fone Terhadap Indeks Kebersihan Rongga Mulut. *Dentino: Jurnal Kedokteran Gigi*, *1*(2), 12-16.

Amalia, N., Kaidah, S., Widodo. (2014). Perbandingan Efektifitas Berkumur Larutan The Putih (Camellia sinensisL.) Seduh Konsentrasi 100 % Dengan 50 % Dalam Meningkatkan pH Saliva. *Dentino Jurnal Kedokteran Gigi*, 2 (1), 29-33.

A'yun, Q., Hendrartini, J., & Supartinah, A. (2016). Pengaruh keadaan rongga mulut, perilaku ibu, dan lingkungan terhadap risiko karies pada anak. *Majalah Kedokteran Gigi Indonesia*, *2*(2), 86-94. doi: https://doi.org/10.22146/majkedgiind.11267

Haryani, W., Siregar, I., & Ratnaningtyas, L. A. (2016). Buah mentimun dan tomat meningkatkan derajat keasaman (pH) saliva dalam rongga mulut. *Jurnal Riset Kesehatan*, *5*(1), 21-24.

Ismi'anifatun, D., Kristiyawati, S. P., & Solechan, A. (2012). Perbedaan Ph Saliva Sebelum Dan Sesudah Menggosok Gigi Dengan Pasta Gigi Yang Mengandung Sorbitol Dan Xylitol Pada Pasien Diabetes Mellitus Di Rsud Tugurejo Semarang. *Karya Ilmiah*, 1.

Jannah, M., Hidayati, H., & Afriwardi, A. (2016). Perbedaan pH Saliva Antara Berkumur dan Tanpa Berkumur Air Putih Setelah Mengunyah Makanan Berkarbohidrat Sederhana. *Andalas Dental Journal*, *4*(1), 67-77. doi: https://doi.org/10.25077/adj.v4i1.50

Kartikasari, H. Y., & Nuryanto, N. (2014). Hubungan Kejadian Karies Gigi dengan Konsumsi Makanan Kariogenik dan Status Gizi pada Anak Sekolah Dasar (Studi pada Anak Kelas III dan IV SDN Kadipaten I dan II Bojonegoro). *Journal of nutrition college*, *3*(3), 414-421.doi: https://doi.org/10.14710/jnc.v3i3.6605

Kementerian Kesehatan, R. I. (2018). Laporan hasil riset kesehatan dasar (Riskesdas) Indonesia tahun 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan, Kementerian Kesehatan Republik Indonesia.

Kusumasari, N. (2012). Pengaruh larutan kumur ekstrak siwak (salvadora persica) terhadap pH saliva. *Skripsi*. Program Studi Pendidikan Sarjana Kedokteran, Fakultas Kedokteran Universitas Diponegoro.

Lestari, S., & Putri, T. A. A. (2016). Hubungan antara kebiasaan konsumsi makanan manis dengan karies gigi anak usia sekolah (The relation between habitual consumption of sweet foods with tooth caries of school age children). Jurnal PDGI, 65(2), 55-59. Retrieved from http://jurnal.pdgi.or.id/index.php/jpdgi/article/view/144

Notoatmodjo, S. (2012). Metodologi Penelitian Kesehatan. Jakarta: Rineka Cipta.

Oktarianda, B. (2011). Hubungan waktu, tekhnik menggosok gigi dan jenis makanan yang dikonsumsi dengan kejadian karies gigi pada murid SDN 66 Payakumbuh di wilayah kerja Puskesmas Lampasi Payakumbuh tahun 2011. *Skripsi*. Program Studi Ilmu Kesehatan Masyarakat, Fakultas Kedokteran, Universitas Andalas.

Putri, M. H., Herijulianti, E., & Nurjannah, N. (2010). *Ilmu Pencegahan Penyakit Jaringan Keras dan Jaringan Pendukung Gigi*. Jakarta: EGC.

Praptiningsih, R. S., & Ningtyas, E. A. E. (2010). Pengaruh metode menggosok gigi sebelum makan terhadap kuantitas bakteri dan pH saliva. *Majalah Ilmiah Sultan Agung*, *48*(123), 55-62.

Sari, N. N. G. (2011). Permen Karet Xylitol yang Dikunyah Selama Menit Meningkatkan dan Mempertahankan pH Saliva Perokok Selama 3 Jam. *Tesis*. Program Studi Ilmu Biomedik, Program Pascasarjana Universitas Udayana.

Sulendra, K.T., Fatmawati, D. W. A., & Nugroho A. (2013). Hubungan pH dan Viskositas Saliva terhadap Indeks DMF-T pada Siswa-siswi Sekolah Dasar Baletbaru I dan Baletbaru II Sukowono Jember. *Artikel Ilmiah Penelitian Mahasiswa 2013*. Fakultas Kedokteran Gigi, Universitas Jember.

Suratri, M. A. L, Jovina T. A & Notohartojo, I. T. (2017). Pengaruh (pH) saliva terhadap terjadinya karies gigi pada anak usia prasekolah. *Indonesian Bulletin of Health Research*, *45*(4), 241-248.

Suyuti, M. (2012). Pengaruh makanan serba manis dan lengket terhadap terjadinya karies gigi pada anak usia 9-10 tahun di SD Negeri Monginsidi II Makassar. *Media Kesehatan Gigi,* 2, 14.

Setiawati, F. (2012). Peran Pola Pemberian Air Susu Ibu (ASI) dalam Pencegahan Early Childhood Carries (ECC) di DKI Jakarta. *Disertasi*. Fakultas Kedokteran Gigi, Program Doktor Ilmu Kedokteran Gigi, Universitas Indonesia.

Wahyuningsih, M., & Ramadhani, R. S. (2015). *Bahaya Langsung Menyikat Gigi Setelah Makan*. CNN Indonesia.

Worotitjan, I., Mintjelungan, C. N., & Gunawan, P. (2013). Pengalaman karies gigi serta pola makan dan minum pada anak Sekolah Dasar di desa kiawa kecamatan kawangkoan utara. *e-GiGi*, *1*(1), 59-68. doi: https://doi.org/10.35790/eg.1.1.2013.1931