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The Relationship Between Active Case Finding Of Rheumatic Heart Disease Through Echocardiographic Screening And Nutritional Status In Children Aged 5 – 15 Years Old In Surabaya, Indonesia

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ABSTRACT

Rheumatic heart disease (RHD) is a sequel of acute rheumatic fever (ARF) caused by an autoimmune reaction to group A beta-hemolytic streptococcal (GAS) infection. Although RHD is a preventable disease, it remains a significant health issue, particularly in developing countries like Indonesia, which has the fourth highest prevalence globally with 1.18 million cases each year. Diagnosing ARF and RHD in tropical regions poses challenges, compounded by the limited number of trained screening operators capable of performing and interpreting echocardiograms. The highest incidence of ARF occurs in children aged 5 to 15 years, making this age group a primary target for secondary antibiotic prophylaxis to reduce recurrence and the progression of RHD. This study is expected to serve as an initial step in prophylactic strategies to hinder the development of RHD, improve early therapeutic management, and support Sustainable Development Goals (SDG) indicators in achieving good health and community well-being. This study is a cross-sectional research. The subjects of the study are school-aged children (5-15 years) from schools scattered throughout Surabaya. Data collection includes basic characteristic data and echocardiographic examinations conducted by trained general practitioners using portable transthoracic echocardiography. Screening is categorized into positive and negative screening according to the World Heart Federation guidelines 2023. A total of 403 children aged 5 to 15 years participated in the study, with 71.2% classified as negative and 28.8% as positive for rheumatic heart disease (RHD) based on screening. Younger children in elementary school had a significantly higher prevalence of positive screening results (36.4%) compared to junior high school students (18.6%, $p < 0.001$). Based on the Spearman test results, a p-value of 0.900 was obtained, which is > 0.05, indicating that there is no significant relationship between rheumatic heart disease screening and nutritional status.

Keywords: *Rheumatic Heart Disease, Active Cases Finding, Screening, Echocardiography, School Age, Nutritional Status*

1. INTRODUCTION

Rheumatic heart disease (RHD) is a sequela of acute rheumatic fever (ARF), which is caused by an autoimmune reaction to infection *group A beta hemolytic streptococcal* (GAS). RHD is a disease that can be prevented, but is still a significant health problem, especially in developing countries, with predisposing factors including poor sanitation and hygiene, high household density, and low access to health services, which are commonly found in populations in low and middle-income countries.[1] The peak incidence of initial episodes of ARF occurs in children aged 5 to 15 years, and the highest incidence of recurrence of ARF episodes occurs within 5 years after initial presentation, so school-aged children are the age at highest risk for ARF recurrence and the age group that benefits most from secondary prophylaxis.[2]

Global data shows that there are 15 million cases of Rheumatic heart disease, with 282 thousand new cases and 233 thousand deaths every year. In developing countries, the incidence of rheumatic heart disease is 19 out of 100,000 children [3]. Indonesia is the country with the fourth highest prevalence of rheumatic heart disease globally, with 1.18 million cases every year. In Indonesia, the RHD death rate is estimated at around 4.8 per 100,000 individuals at risk.[7] Research in Bali shows that of the total sample A total of 701 children from 12 schools in Bali found 3 children with a history of rheumatic fever (0.4%), 10

children with a history of recurrent pharyngitis (1.43%), 1 child with a cardiac murmur (0.14%), 3 children met the criteria for definitive RHD (2 cases of mitral regurgitation and 1 case of mitral valve stenosis), and 7 children met the criteria for Borderline RHD, so the prevalence rate for Definite RHD was 4.3 per 1000 children. [14]

The diagnosis of ARF is difficult to make in areas with tropical and subtropical climates. This is due to the differential diagnosis of febrile illness accompanied by widespread joint pain, low self-awareness, and limited laboratory facilities.[5] another important problem is the limited number of screening operators competent in detecting RHD, and performing and interpreting echocardiograms accurately. In Indonesia there are only around 1,200 heart specialists and less than 100 sonographers, with a population of more than 260 million.[4]

The peak incidence of initial episodes of ARF occurs in children aged 5 to 15 years. The highest incidence of recurrence of ARF episodes occurs within 5 years after the initial presentation, so school-aged children are the highest age risk for ARF recurrence and the age group that can benefit most from secondary prophylaxis.[2]. Surabaya is developing as a Metropolitan City, with a population of around 3,095,026 people in 2019. Population density is around 9,900/km^2. The number of children aged 5-15 years in Surabaya will be around 412,471 in 2023, with 8.55% attending elementary school, 3.37% in junior high school, and 3.64% not/never school [46]. Children's health is also the responsibility of the Community Health Center and is included in essential public health efforts that oversee health promotion, disease prevention, and control services.

RHD can cause severe disability, poor quality of life, premature death, and burden the national economy. Still, most sufferers do not realize that they have RHD or experience ARF symptoms that precede RHD. The initial development of RHD is usually clinically asymptomatic but will manifest clinically in adulthood. Inappropriate ARF/RHD treatment causes significant valve damage and subsequent disability.[6] Severe RHD causes high morbidity and mortality rates, with a *case fatality rate* 2 years of 16.9%.[8] Progression of the disease, morphology of rheumatic heart valves, and younger age are factors that influence poor outcomes.[9] Rheumatic heart disease is associated with very high healthcare costs, lost productive time in school and work, and lost life opportunities due to premature death. Rheumatic heart disease is often diagnosed in the working population of children and young adults, causing major losses in terms of productivity. The need for high health expenditures, such as heart surgery, also influences a decrease in consumption power. Cost loss of approx the 220,000 deaths from rheumatic heart disease in 2010 were estimated at US$ 5.4 billion, with the highest economic burden on countries with large populations, namely South Asia and East Asia. Rheumatic heart disease is a preventable disease. However, the estimated funding related to research and development of rheumatic heart disease is US$ 1.7 million, or only around 0.1% of total global health funding.[10]

The progression of RHD is influenced by repeated GAS infections and episodes of ARF, so the inflammatory response continues.[8] Secondary prophylaxis with regular intramuscular injection of benzathine penicillin can cause regression in sufferers ARF with a regurgitation heart murmur and inhibit the development of stenosis in the heart valves. Other studies also show that early initiation of secondary prophylaxis, given early disease development, can inhibit the progression of RHD.[11] Patients with severe RHD have a poor prognosis when they do not receive adequate secondary prophylaxis strategies.[12] Late clinical manifestations, especially in advanced disease states, are associated with poor clinical outcomes, including congestive heart failure and death.[13]

In a retrospective cohort study regarding risk factors for recurrent attacks of DR/RHD patients at the Pediatric Department of Dr. Hospital. Wahidin Sudirohusodo, for the period January 2005 - December 2009, found that in the DR/RHD–TR group there were 19 (95%) good nutrition, 46 (80.7%) undernutrition, and 3 (100%) malnutrition. While in the DR/RHD-R group, there was 1 (5%) good nutrition, 11 (19.3%) malnutrition, and no malnutrition (0%). The distribution of nutritional status in the DR/RHD-R group was good nutrition 1 (15%), undernutrition 11 (19.3 %,) and malnutrition 0 (0%). Statistical analysis showed there was no significant difference between the two groups based on the distribution of nutritional status, p=0.23. [15]

Researchers hope that nutritional status, one of the environmental factors that plays a role in the occurrence of acute rheumatic fever, which can develop into rheumatic heart disease, can be overcome as early as possible. Researchers hope that this research can be important in early prophylaxis strategies to inhibit the progression of RHD development, improve adequate therapeutic management from an early age, improve target health, and reduce the burden of costs incurred for advanced RHD interventional treatment. This is in accordance with the SDG indicators (*Sustainable Development Growth*) in an effort to achieve a healthy and prosperous life (*Good Health and Well-being*) and economic growth (*Decent Work and Economic Growth*).

The problem formulation for this research is: Is there a relationship between actively finding cases of rheumatic heart disease through echocardiography screening and the nutritional status of children aged 5 - 15 years in Surabaya?

The aim of this research is to prove the relationship between actively finding cases of rheumatic heart disease through echocardiography screening and nutritional status in children aged 5 - 15 years in the city of Surabaya.

The specific objectives of this research are 1) Determine the proportion of echocardiographic screening findings for cases of rheumatic heart disease in children aged between 5 - 15 years in the city of Surabaya, 2) Determine the results of echocardiographic screening for cases of rheumatic heart disease in children aged between 5 - 15 years in the city of

Surabaya, 3) Determine the nutritional status of children aged between 5 - 15 years in the city of Surabaya. 4) Analyze the relationship between actively finding cases of rheumatic heart disease through echocardiography screening and nutritional status in children aged 5 - 15 years in Surabaya.

The benefits of this research are to obtain epidemiological data on cases of rheumatic heart disease through echocardiography screening in children aged 5 - 15 years in the city of Surabaya, provide a basis for new data and topics for further research on rheumatic heart disease, both from basic and clinical science aspects, improve early secondary prophylaxis strategies to inhibit the progression of RHD development, improve adequate therapeutic management from an early age, improve target health, and reduce the cost burden incurred for advanced RHD interventional treatment.

The hypothesis of this research is that there is a relationship between actively finding cases of rheumatic heart disease through echocardiography screening and nutritional status in children aged 5 - 15 years in Surabaya.

2. RESEARCH METHODS

2.1 Types of research

This research is a type of observational analytical study research, with a research design *Cross Sectional analysis.*

2.2 Place and Time of Research

This research was conducted in the odd semester of the 2023/2024 academic year in four elementary schools (SD) and three junior high schools (SMP) in the city of Surabaya.

2.3 Sample and Research Size

An active RHD case-finding program through echocardiography screening was implemented in Surabaya's school-age children population. The screening program sample selection was based on *simple random sampling* in children without a history of Acute Rheumatic Fever (ARF) or RHD. The selected sample of children was then given a consent form to be filled out by the parents. Children and parents have the right not to participate in the screening program. Children selected according to the program sample criteria undergo a RHD screening examination, including anamnesis, physical examination, and echocardiography examination.

Screening examinations are carried out by non-expert personnel who have undergone training regarding knowledge and skills in echocardiography screening for RHD.

2.4 Inclusion and Exclusion Criteria

This study included school children aged 5 – 15. The exclusion criteria for this study consist of school-aged children with other organic disorders (congenital defects, Down syndrome, intellectual disability), and school-aged children with chronic infections (pulmonary TB, HIV).

2.5 Research Variables

Independent Variables: Height, Weight, Age, Nutritional Status

Dependent Variable: Active cases of rheumatic heart disease

2.6 Research Instruments and Materials

The instruments in this research are interviews, *Google Docs*, and direct examination using a Philips LUMIFY Ultrasound system echocardiography machine with a 1-4 MHz sector transducer. Height and weight are checked using a calibrated SECA measuring instrument.

The materials in this study were school children in Surabaya aged 5 - 15 years, data in the form of age, weight, height, and gel for echocardiography

2.7 How to process and analyze data

The data obtained will be analyzed univariate and bivariate. Univariate analysis was carried out to explore the characteristics of each variable with a descriptive presentation through a frequency distribution table.

Bivariate analysis was carried out to determine the relationship between two variables, namely, between the discovery of active cases of rheumatic heart disease and the nutritional status of children aged 5 - 15 years in Surabaya. *Spearman's* Correlation Test will be carried out to measure the closeness of the relationship between the results of observations from a population that has 2 variants that are not normally distributed. Usually, this type of correlation is used for ordinal scale data.

2.8 Research Ethics

This research has received ethical approval from the health research ethics committee of RSUD Dr. Soetomo Surabaya (no. 1141/KEPK/X/2024). Patients and families have been given an explanation regarding this research verbally and in writing in the form of an explanation sheet to obtain approval for participation as research subjects (*information for consent*). A statement of approval for patient participation is included in the signing an informed consent sheet by the patient and the

patient's family. Patients or the patient's family are not charged any costs associated with this research. Patient identity data and examination results will be kept confidential from unauthorized parties

3. RESEARCH RESULT

3.1 Basic Characteristics Subject Study

Based on the basic characteristics of sample research, 403 subjects were collected. The average age of the subjects in this study was 11.83 years, and the median age was 12.00 years, ranging from 7 to 15 years. The majority of subjects in this study were women, totaling 225 subjects (55.8%). The average body weight of the subjects in this study was 41.38 kg, and the median body weight was 40 kg, with a weight range from 19 to 115 kg. The average height of the subjects in this study was 145.45 cm, and the median height was 148 cm, with a height range from 90 to 173 cm.

Table 5.1 Basic Characteristics of Research Subjects

Variable	Highest Score (Max)	Lowest Score (Min)	Mean Conv	ertion	Standard Deviation
Age	15	7	11.83	1.954	
Body Weight	115	19	41.38	13.4313	
Height	173	90	145.458	12.7185	

Table 5.2 Percentage Subject By Gender

Gender	Frequency	Percentage (%)
Man	178	44.2
Woman	225	55.8
Total	403	100

Based on the research results, it was found that the majority had educational levels. Those who took part in the research were elementary school (SD) students, as much as 57.3%, and some of the subjects who took part in the research were junior high school students, as much as 42.7%.

Table 5.3 Percentage of Subjects Based on Education Level

Level of education	Frequency	Percentage (%)
Elementary School	231	57.3
Junior High School	172	42.7
Total	403	100

The research results found that the majority of subjects, 54.3% of the total respondents, had normal nutritional status. A small proportion of respondents were in the underweight (17.1%), overweight (15.4%), or obese categories (category I was 8.2%, and categories II-III were 5%). This shows that most of the population has a balanced nutritional status, although a significant proportion has under- or over-nutrition problems.

Table 5.4 Percentage of Subjects Based on Nutritional Status

Nutritional status	Frequency	Percentage (%)
Underweight	69	17.1
Normal	219	54.3

Overweight	62	15.4
Fat/Obese	33	8.2
Very Fat/Obese II-III	20	5.0
Total	403	100

From the results of research using echocardiography, the results of screening for rheumatic heart disease showed the following distribution, namely 287 people (71.2%) showed negative results, while 116 people (28.8%) showed positive results. The cumulative percentage reaches 100%, which indicates that the data covers the entire population examined.

Table 5.5 Percentage of Rheumatic Heart Disease Screening Results

Screening Results	Frequency	Percentage (%)
Negative	287	71.2
Positive	116	28.8
Total	403	100

3.2 Analysis Test of the Relationship between Rheumatic Heart Disease and Nutritional Status

The relationship test results use the Spearman test because it tests ordinal categorical data. Based on the test results, the p-value was 0.900, where a value the >0,05 can conclude that there is a connection significant/meaningful between rheumatic heart disease screening and nutritional status.

Table 5.6 Analysis of the Relationship between Rheumatic Heart Disease and Nutritional Status

RHD	n (sample)	Underweight	Normal	Overweight	Obese	Obese II-III	r	p
Positive	116	20	62	18	11	5		
	(17.2%)		(53.4%)	(15.5%)	(9.5%)	(4.3%)	**0.006**	**0.9**
Negative	287	49	157	44	22	15		
	(17.1%)		(54.7%)	(14.3%)	(7.7%)	(5.2%)		

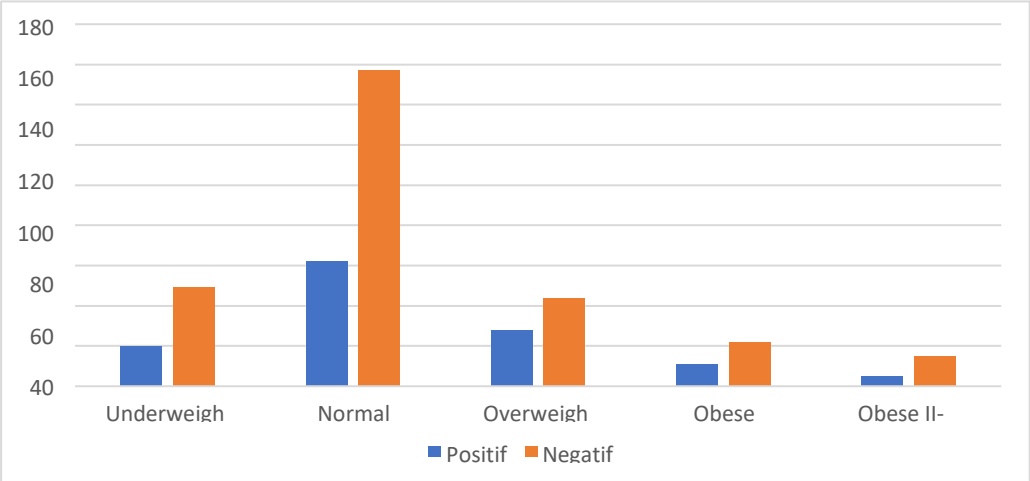

Figure 5.1 Analysis of the Relationship between Rheumatic Heart Disease and Nutritional Status

4. DISCUSSION

4.1 Proportion of Echocardiography Screening Findings of Rheumatic Heart Disease Cases in Children Aged between 5 – 15 Years in Surabaya City

Rheumatic heart disease (RHD) is a significant health problem among children, especially in developing countries. This study showed that of the 403 subjects studied, 28.8% were diagnosed positively with rheumatic heart disease through echocardiography screening. This aligns with research by Utamayasa et al. (2021), who found that the prevalence of RHD in children in Surabaya was also relatively high, with the proportion of cases reaching 30% of the total subjects studied. Another study by Watkins et al. (2018) shows that early detection through echocardiography screening can help identify children at high risk of RHD, so that medical intervention can be carried out earlier.

In this study, the proportion of cases discovered through echocardiography screening shows the importance of this method as an early detection tool. According to Coffey et al. (2018), the use of echocardiography in screening children allows the identification of structural changes in the heart that may not be detected through a regular physical examination. Thus, it is hoped that the high proportion of case findings will encourage public health programs to increase awareness and access to screening for children in Surabaya.

4.2 Results of Echocardiography Screening for Rheumatic Heart Disease Cases in Children Aged 5 – 15 Years in Surabaya City

The results of echocardiography screening in this study showed that of the 403 subjects, 287 people (71.2%) had negative results, while 116 people (28.8%) showed positive results for rheumatic heart disease. These results are consistent with previous research by Sarwono (2015), which found that using echocardiography as a diagnostic tool was able to identify RHD cases with high accuracy. Another study by Halim and Suzan (2018) also noted that positive results on echocardiography often correlate with more severe clinical symptoms and require immediate medical attention.

The importance of these screening results lies in their ability to provide a clear picture of the prevalence of RHD among children in Surabaya. According to research by Blank et al. (2006), positive results on echocardiography screening can be an indicator of high risk for future cardiac complications, requiring more intensive monitoring and management.

4.3 Nutritional Status of Children Aged Between 5 – 15 Years in Surabaya City

Of the total respondents in this study, the majority of children had normal nutritional status (54.3%), while 17.1% were in the underweight category and 15.4% were overweight or obese. This finding aligns with research by Rizky et al. (2020), who reported that nutritional problems in children are often related to unbalanced eating patterns and a lack of nutritional education among parents. Other research by Maryam (2011) shows that poor nutritional status can worsen children's health conditions and increase the risk of chronic diseases such as RHD.

Nutritional status is an essential factor in a child's development and overall health. According to WHO (2004), good nutritional status supports optimal growth and helps the immune system fight infections. Therefore, attention to children's nutritional status is crucial to preventing degenerative diseases such as RHD.

4.4 Relationship between Actively Finding Cases of Rheumatic Heart Disease through Echocardiography Screening and Nutritional Status

Rheumatic heart disease (RHD) is a complication of infection *group A beta hemolytic streptococcal* which can cause heart valve damage, especially in children in developing countries. Active echocardiography screening using a portable device has increased the detection of subclinical RHD cases compared with regular clinical examination. The study by Beaton et al. (2014) showed that echocardiography screening could detect RHD prevalence up to 10 times higher than traditional clinical methods, especially in pediatric populations in developing countries. This is due to the ability of echocardiography to identify structural and functional heart valve abnormalities that are often asymptomatic at an early stage.

This study aims to analyze the relationship between active detection of RHD cases through echocardiography screening and nutritional status in children aged 5–15 years in Surabaya. Children's nutritional status indicates general health and susceptibility to various infectious diseases, including RHD. Analysis of the relationship between finding cases of rheumatic heart disease through echocardiography screening and nutritional status showed a p-value of 0.900, which means there is no significant relationship between these two variables. These findings align with research by Coffey et al. (2018), who also found that although there is a relationship between nutritional status and the risk of congenital heart disease, this relationship is not always statistically significant. Likewise, a study by Zühlke et al. did not find a significant relationship between nutritional status and the prevalence of RHD in children in South Africa 4. This suggests that other factors such as genetics, environmental exposure, and access to prophylactic antibiotic treatment also play an essential role in developing this disease. In the context of this study, the absence of a significant relationship between finding RHD cases through echocardiography screening and nutritional status could be caused by variations in these factors.

Other studies provide contradictory results. For example, a study by Carapetis et al. suggests that malnutrition may increase the risk of recurrent upper respiratory tract infections *group A beta hemolytic streptococcal*, a significant factor in developing

acute rheumatic fever and RHD. Children with poor nutritional status tend to have a weak immune system, making them more susceptible to bacterial infections.

Another study by Utamayasa et al. (2021) emphasized that although nutritional status plays an important role in children's health in general, other factors, such as genetics and the environment, greatly influence the incidence of rheumatic heart disease. This may be due to the heterogeneity of risk factors that influence development of RHD, such as recurrent infections, access to health services, and socioeconomic environmental conditions. Additionally, nutritional status may not be the only factor influencing susceptibility to RHD, so a direct relationship between the two variables is difficult to prove.

4.5 Possible Explanations for Research Results

Several possibilities can explain why no significant relationship was found between finding RHD cases through echocardiography screening and nutritional status in this study:

1. Multifactoriality Rheumatic Heart Disease

RHD is a multifactorial disease influenced by a combination of genetic, environmental, and socio-economic factors. Nutritional status is just one of many variables that can influence susceptibility to *Streptococcus pyogenes infection* and the development of acute rheumatic fever.

2. Methods for Measuring Nutritional Status

Body Mass Index (BMI) according to age was used to indicate nutritional status in this study. However, BMI may be less sensitive to overall nutritional status, especially in pediatric populations with wide growth variations.

3. Research Population

Children in the city of Surabaya may have unique characteristics regarding diet, access to service health, and parents' educational level influence the results of this research. Studies in other regions or different populations may produce different findings.

4. Subclinical Detection Through Echocardiography

Active echocardiography screening often detects subclinical cases that do not yet show clinical symptoms or systemic impacts, such as severe malnutrition. Therefore, a direct relationship between subclinical case detection and nutritional status may not be apparent in this study.

4.6 Clinical Implications and Recommendations

Although the results of this study did not find a significant relationship between finding RHD cases through echocardiography screening and nutritional status, these findings still have important implications in clinical practice. This favorable rate of 28.8% is a quite significant finding and indicates that almost a third of the population examined had indications of rheumatic heart disease. This shows the importance of screening programs for early detection of rheumatic heart disease in the studied population. Early detection of subclinical RHD through echocardiography screening can help prevent long-term complications such as congestive heart failure through prophylactic antibiotic treatment. Therefore, active screening programs still need to be carried out to prevent cardiovascular disease in the pediatric population.

In the face of research results, which show that the positive proportion of rheumatic heart disease cases is 28.8% in Surabaya children aged 5-15 years, the following very important step is coordinating with local health centers and schools. This coordination aims to carry out further confirmation at RSUD Dr. Soetomo, so that appropriate secondary prophylaxis can be immediately determined for diagnosed children. Secondary prophylaxis is a crucial preventive measure to prevent recurrent attacks in patients with a history of rheumatic heart disease. Based on medical guidelines, regular administration of antibiotics can reduce the risk of serious complications that may occur due to reinfection. Therefore, it is important for community health centers and schools to collaborate in identifying children who need special attention and ensuring they receive the necessary care. This coordination also includes educating parents and teachers on the importance of early detection and treatment of rheumatic heart disease. By increasing awareness among the public about the symptoms and risks of this disease, it is hoped that there will be increased compliance with secondary prophylactic treatment. Previous studies have shown that high levels of compliance with secondary prophylaxis are directly related to reduced rates of recurrent attacks in patients with rheumatic heart disease. Furthermore, confirmation at RSUD Dr. Soetomo will provide an opportunity for a thorough evaluation of the health conditions of diagnosed children. Through follow-up examinations, doctors can determine whether further intervention is needed, such as additional treatment or regular monitoring. With a systematic and collaborative approach between community health centers, schools, and hospitals, it is hoped that optimal results can be achieved in handling cases of rheumatic heart disease in children. Thus, this proactive step not only aims to reduce the incidence of rheumatic heart disease but also to improve the quality of life for children in the city of Surabaya through prevention and appropriate treatment.

In addition, a multidisciplinary approach is needed to address other risk factors such as environmental cleanliness, access to prophylactic antibiotic treatment, and public health education regarding the importance of preventing recurrent upper

respiratory tract infections.

As for concerns, there are respondents who are overweight (15.4%) and obese (category I at 8.2% and categories II-III at 5%). This shows that a significant proportion of the population has problems with excess nutrition, which can be a risk factor for coronary heart disease. Therefore, further research is needed for respondents in the nutritional status category of overweight or obesity.

5. CONCLUSION

1. There were 403 subjects, with the average age in this study being 11.83 years, with an age range from 7 to 15 years. The majority of subjects in this study were women, totaling 225 subjects (55.8%). The average body weight of the subjects in this study was 41.38 kg, and the median body weight was 40 kg, with a weight range from 19 to 115 kg. The average height of the subjects in this study was 145.45 cm, and the median height was 148 cm, with a height range from 90 to 173 cm. It was found that 57.3% of the subjects who took part in the research were elementary school students, and 42.7% of the subjects who took part in the research were junior high school students.
2. It was found that 287 people (71.2%) had negative screening results for rheumatic heart disease, while 116 people (28.8%) had positive results.
3. The majority of subjects, 54.3% of the total respondents, had normal nutritional status. A small proportion of respondents were in the underweight (17.1%), overweight (15.4%), or obese categories (category I was 8.2%, and categories II-III were 5%).
4. There was no relationship between actively finding cases of rheumatic heart disease through echocardiography screening and nutritional status in children aged 5 – 15 years in Surabaya City. This shows that nutritional status does not have a direct effect on finding RHD cases through echocardiography screening.

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