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RHEUMATIC HEART DISEASE SCREENING USING HANDHELD ECHOCARDIOGRAPHY: A STUDY AMON`G JUNIOR HIGH SCHOOL STUDENTS IN INDONESIA

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ABSTRACT

Considering the high burden of morbidity and mortality associated with Rheumatic Heart Disease (RHD) in Indonesia, there is increasing interest in assessing cost-effective screening modalities, particularly the application of handheld echocardiography. Our study aimed to determine the prevalence of Rheumatic Heart Disease (RHD) in Batu Bara, North Sumatra, Indonesia. Our descriptive observational study was carried out in the Batu Bara region of North Sumatra in May 2025. The study population comprised junior high school students aged 10 to 15 years from a selected school in Batu Bara. Data collection included sociodemographic variables, parental characteristics, environmental and household factors, anthropometric measurements, physical examination findings, auscultation results, and echocardiographic evaluations. All data were analyzed using descriptive statistical methods. A total of 190 children were assessed in this study, with a median age of 13 years, and females comprised 54.7% of the participants. Echocardiographic screening detected Rheumatic Heart Disease (RHD) in three participants, corresponding to a prevalence of 1.6%. Within our study population, the prevalence of RHD was 1.6%. Expansion of echocardiographic screening programs is warranted to comprehensively establish RHD prevalence, accurately evaluate disease burden, and facilitate earlier detection to mitigate adverse clinical outcomes.

*Keywords**:** Rheumatic Heart Disease, Valvular Heart Disease, Echocardiography, Screening.*

INTRODUCTION

Rheumatic heart Disease (RHD) remains a major global public health concern. Recent data indicate a rising global incidence and prevalence of RHD, affecting an estimated 40.5 million individuals worldwide, despite a gradual decline in mortality, which currently accounts for approximately 305,000 deaths annually. The disease burden is disproportionately concentrated in low-income countries (Ghamari *et al*., 2022). While an overall decrease in RHD incidence and mortality was observed between 1990 and 2019 in high-income regions such as Europe, North America, Canada, and Australia, over half of these countries have experienced a recent resurgence in RHD incidence (Ojha *et al*., 2024). In Asia, age-standardized incidence and prevalence rates of RHD demonstrate substantial heterogeneity across countries. Notably, the South Asia super-region reports the highest age-standardized rates of disability-adjusted life years (DALYs) and RHD-related mortality, globally (Ghamari *et al*., 2022).

Despite the substantial burden posed by RHD, systematically collected, contemporary data on its clinical characteristics, management, complications, and long-term outcomes remain limited. This data gap is especially pronounced in low- and middle-income countries, including Indonesia, where surveillance and reporting systems are often inadequate. Consequently, there is a critical need for comprehensive and up-to-date epidemiological data to inform evidence-based, context-specific strategies aimed at reducing the impact of RHD (Soesanto, 2022). Indonesia is recognized as a major contributor to the global burden of RHD. According to a global analysis of RHD burden, over 73% of cases were attributed to five countries: India, China, Pakistan, Indonesia, and the Republic of Congo, with the majority located in Asia. However, these estimates were primarily based on algorithmic modelling and extrapolations from data spanning 1990 to 2015 (Watkins *et al*, 2017). More recent studies from Indonesia have reported variable RHD prevalence and case numbers across several hospitals. Nonetheless, these investigations have been limited in scope, with small sample sizes and data derived from a limited number of geographic regions within the country. Fortunately, Indonesia has recently initiated Ina-RHD, a national multicenter study designed to provide critical insights into the current epidemiology and clinical profile of RHD in the country. While this represents the first nationwide dataset on RHD, it is not without limitations. There remains a pressing need for more granular, province-level data, particularly from rural and underserved regions, to obtain a more comprehensive understanding of the disease burden and inform targeted public health interventions (Soesanto *et al*, 2025).

Recent research has increasingly focused on evaluating the feasibility of handheld or portable echocardiography (HAND) as a cost-effective and accurate modality for RHD screening, particularly in large low and middle income countries (LMICs) such as Indonesia. North Sumatra, the fourth most populous province in Indonesia, was selected as a representative region reflecting the nation's demographic diversity. This study aimed to estimate the prevalence of RHD in North Sumatra and to improve understanding of its prognostic factors and associated risk burden. The findings may support the development and implementation of an affordable, community-based screening strategy. If effective, this approach could be scaled to other provinces and serve as a foundation for further research into the long-term benefits of early detection and intervention (Ardini *et al*, 2024).

METHODS

Study Design

This descriptive observational study was conducted at a junior high school in Batu Bara, North Sumatra, Indonesia, in May 2025. To fulfil the study objectives, a defined study population was established, and comprehensive data were collected, including sociodemographic characteristics, parental and household information, environmental context, anthropometric measurements, physical examination findings, cardiac auscultation results, and echocardiographic assessments. The study protocol strictly followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines and adhered to the ethical principles outlined in the Declaration of Helsinki (Cuschieri, 2019; Goodyear *et al*, 2007). Written informed

consent was obtained from all participants, who were thoroughly informed about the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any stage without penalty. No financial or material incentives were provided to participants or their families.

Participants & Inclusion Criteria

The data for this study were obtained during a community service initiative conducted at Sekolah Menengah Pertama (Junior High school) Negeri 1 Tanjung Tiram, located in the Batu Bara Regency, North Sumatra, Indonesia. A total sampling method was employed, encompassing 190 students from grades 7. The inclusion criteria consisted of students aged 10 to 15 years. Exclusion criteria included echocardiographic images of insufficient quality that hindered accurate evaluation.

Data Collection

A structured data collection form was employed to systematically capture a broad spectrum of variables, including sociodemographic characteristics (date of birth, age, sex, ethnicity, and sibling status), parental information (maternal parity, parental education level, monthly household income, and occupation), as well as environmental and housing conditions (number of rooms and number of person per room). Anthropometric measurements, comprising body weight, height, body mass index (BMI), and mid-upper arm circumference, were recorded, in addition to conducting physical examinations, cardiac auscultation, and echocardiographic evaluations. Echocardiographic assessments were performed on-site at the school using two-dimensional (2D) and color Doppler imaging via portable handheld devices, specifically the Lumify Handheld Echocardiography system (Philips, Amsterdam, Netherlands) equipped with phased-array transducers. The examinations were carried out by a team of healthcare professionals, including physicians with expertise in echocardiography acquisition and interpretation. Rheumatic heart disease (RHD) was diagnosed in accordance with the 2023 World Heart Federation (WHF) criteria. The severity of valvular lesions was classified based on the guidelines of the American Society of Echocardiography (ASE), utilizing handheld echocardiographic findings (Baumgartner *et al*, 2009; Pandian *et al*, 2023; Rwebembera *et al*, 2024; (Zoghbi *et al*, 2017). Identified cases of RHD were promptly communicated to the students' parents, who were then referred for further cardiological evaluation and management at the nearest region general hospital.

Statistical Analysis

Categorical variables were presented through frequency (n) and percentage (%). In the context of normally distributed data, numerical variables were described by their mean and standard deviation (SD). Conversely, for numerical variables displaying non-normal distribution, the median was used to signify central tendency, while the interquartile range (IQR) conveyed variability. All datasets underwent rigorous statistical processing and analysis using Statistical Package for the Social Sciences ver. 26 (SPSS, IBM acquired SPSS Inc., Chicago, US).

RESULT AND DISCUSSION

Among the 190 children enrolled in the study, 104 (54.7%) were female and 86 (45.3%) were male. The median age was 13 years old. The median body weight and height were 36.5 kg and 153 cm, respectively. Based on BMI classification, the majority of participants (78.9%) were underweight, while 18.9% had a normal weight and 2.1% were categorized as obese. Detailed demographic data are presented in Table 1.

For the socioeconomic characteristics, most children came from families in which the highest paternal education level was elementary school (35.8%), and the maternal education level was predominantly senior high school (30.5%). A substantial proportion of families (89%) reported a monthly household income of less than 3 million Indonesian rupiahs. Approximately 70% of households had two bedrooms, and 54.7% reported a family history of infrequent upper respiratory tract infections, typically occurring once every three months. These socioeconomic findings are summarized in Table 2.

Table 1. Demographic Characteristics

Baseline characteristics	n (%), median (IQR)
Age, years	13 (1)
Sex	
Male	86 (45.3%)
Female	104 (54.7%)
Body weight (median (IQR)), kg	36.5 (11)
Body height (median (IQR)), cm	153 (8)
BMI	
Underweight	150 (78.9%)
Normal weight	36 (18.9%)
Obese	4 (2.1%)

Note, BMI: Body Mass Index

Table 2. Socioeconomic characteristics

Variable	n (%)
Paternal recent educational status	
Didn't go to school	48 (25.3%)
Elementary	68 (35.8%)
Junior High School	27 (14.2%)
Senior High School	40 (21.1%)
Bachelor	5 (2.6%)
Master degree	2 (1%)
Maternal recent educational status	
Didn't go to school	45 (23.7%)
Elementary	52 (27.4%)
Junior High School	31 (16.3%)
Senior High School	58 (30.5%)
Bachelor	4 (2.1%)
Master degree	0 (0%)
Monthly income	
< 3 million rupiah	169 (89%)
3-10 million rupiah	16 (8.4%)
> 10 million rupiah	5 (2.6%)
Number of bedrooms in the house	
No bedroom	25 (13.2%)
2 bedrooms	133 (70%)
≥ 3 bedrooms	32 (16.8%)
History of flu in the family	
No history	25 (13.2%)
Seldom (1/3 months)	104 (54.7%)
Occasional (1/month)	37 (19.5%)
Frequently (1/week)	24 (12.6%)

Among the study sample, 3 out of 190 students (1.5%) met the diagnostic criteria for RHD, consisting of one case with mild mitral regurgitation, one case with mild mitral regurgitation accompanied by anterior mitral leaflet (AML) prolapse, and one case with mild aortic regurgitation. Additionally, valvular abnormalities not fulfilling the World Heart Federation (WHF) 2023 criteria for RHD were identified during the screening. These included: mild mitral regurgitation in 1 student, trivial mitral regurgitation in 1 student, mild aortic regurgitation in 1 student, trivial aortic regurgitation in 1 student, mild tricuspid regurgitation in 2 students, trivial tricuspid regurgitation in 1 student, mild pulmonary regurgitation in 12 students, and trivial pulmonary regurgitation in 1 student. Another notable finding was mitral valve billowing, observed in 1 student. All participants with positive findings are recommended to undergo confirmatory echocardiography to establish classification, staging, and appropriate management in accordance with the 2023 WHF guidelines. These clinical characteristic findings are summarized in Table 3.

Table 3. Clinical characteristics

Variable	n (%)
Valve abnormalities	
Normal	166 (87.4%)
MR mild	3 (1.6%)
AML Prolapse	1 (0.5%)
MR trivial	1 (0.5%)
AR mild	2 (1%)
AR trivial	1 (0.5%)
TR mild	2 (1%)
TR trivial	1 (0.5%)
PR mild	12 (6.3%)
PR trivial	1 (0.5%)
Mitral valve billowing	1 (0.5%)
Etiology	
Rheumatic Heart Disease (positive screen)	3 (1.6%)
Others (negative screen)	21 (11%)

Note, MR: Mitral Regurgitation, AML: Anterior Mitral Leaflet, AR: Aortic Regurgitation, TR: Tricuspid Regurgitation, PR: Pulmonal Regurgitatio

The prevalence of RHD in our study was found to be 1.6%. Prevalence rates reported in previous studies have demonstrated variability across different populations and settings. The finding of our study are

comparable to those of a cross-sectional study conducted in Sarawak, Malaysia, which included children aged 5 to 20 years and reported a prevalence of 1.4% (Ajeng *et al*, 2023). A recent study that conducted in Langkat, Tebing Tinggi, and Labuhan Batu region, North Sumatra, Indonesia reported an RHD prevalence of 0.6% (Ardini *et al*, 2024). Additionally, a systematic review and meta-analysis incorporating two studies from Africa, one from South America, and one from Oceania reported a pooled RHD prevalence of 7% (Mutarelli *et al*, 2025).

This study represents screening initiative conducted across rural and coastal areas of North Sumatra, Indonesia. At the time of implementation, Indonesia lacked official data on the prevalence of RHD and Acute Rheumatic Fever (ARF), with existing research on the subject being notably scarce. This limited evidence base can be attributed to logistical challenges such as difficult transportation across remote islands, limited screening infrastructure, and a shortage of healthcare personnel to support wide-scale screening efforts (Soesanto & Suastika, 2020). Screening methodology plays a pivotal role in RHD detection. Echocardiographic screening, while more accurate than clinical examination, presents considerable logistical challenges—particularly in geographically dispersed areas such as Indonesia. Nevertheless, advancements in echocardiographic screening have enabled earlier diagnosis and intervention. Previous studies have demonstrated the cost-effectiveness of echocardiographic screening among Indigenous Australian children, where early detection—by at least two years—has been associated with reduced incidence of heart failure, surgical intervention, mortality, DALYs, and healthcare costs (Roberts *et al*, 2017). Strategic prioritization of screening targets and locations remains essential. Globally, RHD is the most common cardiovascular disease among individuals under 25 years of age, while ARF predominantly affects school-aged children (5–14 years). As a result, echocardiographic screening in high-prevalence regions is recommended to identify candidates for secondary prophylaxis—an approach widely adopted in most existing screening studies, particularly those conducted in school-based settings (Dougherty *et al*, 2017) (Soesanto & Suastika, 2020). In Indonesia, the archipelagic landscape presents substantial challenges, as schools are often widely dispersed, further complicating the logistics of large-scale screening programs.

The results of this study bear significant clinical implications. Precise determination of RHD prevalence facilitated timely interventions that may prevent progression to advanced disease stages, thereby diminishing the need for complex medical treatments and improving patient prognoses. Moreover, the findings suggest a potential reduction in the incidence of ARF and related complications, which could translate into lower morbidity and mortality rates, especially among children and young adult populations. Early detection of RHD cases also allowed for the prompt initiation of secondary prophylaxis, a strategy that is more cost-effective than managing the sequelae associated with advanced disease.

This study has several limitations. Firstly, the relatively small sample size may limit the generalizability of the findings to the wider Indonesian population. Secondly, logistical and accessibility challenges in rural settings likely impacted the reach and execution of the screening program. Thirdly, socioeconomic data—including parental education level, monthly household income, number of bedrooms, and family history of recurrent upper respiratory tract infections—were obtained through patients histories without objective records, posed a challenge in conducting a comprehensive analysis.

CONCLUSION

This study demonstrates that the prevalence of RHD in Batu Bara, North Sumatra, is 1.6% (3 out of 190 students), with involvement of multiple valve types. However, an expanded echocardiographic screening program is warranted to more comprehensively establish RHD prevalence, accurately quantify the disease burden, and enable earlier identification of affected individuals.

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