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**Research Article**

# Early Detection Screening for Congenital Heart Disease (CHD) in the Junior High School Student Population in the Coastal Area of Batu Bara Regency, North Sumatra

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**ABSTRACT**

**Background:** Congenital Heart Disease (CHD) is a leading contributor to pediatric morbidity globally. In remote coastal regions like Indonesia, the absence of routine screening often results in delayed diagnosis, leading to irreversible cardiovascular complications. **Objective:** This study aimed to implement a proactive CHD screening program for junior high school students in an underserved area as a vital preventive healthcare strategy. **Methods:** A descriptive cross-sectional study was conducted at SMP Negeri 1 Tanjung Tiram, Batu Bara Regency, North Sumatra. A total of 190 students (aged 10–15 years) underwent screening involving anamnesis, physical examination, 12-lead electrocardiography (ECG), and portable echocardiography. Data were analyzed to determine the prevalence of undetected CHD. **Results:** The screening identified one positive case of Atrial Septal Defect (ASD) in a previously asymptomatic student, yielding a prevalence of 0.5%. Statistical analysis showed that this finding is consistent with global epidemiological trends ($p = 1.000$). Despite 97.4% of participants being asymptomatic, the use of portable diagnostic tools proved essential for identifying structural anomalies. **Conclusion:** School-based screening utilizing portable echocardiography is a feasible strategy for early CHD detection in remote areas. Such initiatives are essential for bridging the diagnostic gap and reducing the incidence of late-onset complications.

**Keywords:** atrial septal defect, congenital heart disease, school-aged children, screening

## 1. Introduction

As the most prevalent congenital anomaly worldwide, congenital heart disease (CHD) remains a formidable challenge to global pediatric health, with an estimated prevalence of 8 to 10 per 1,000 live births [1], [2]. Recent systematic analyses mapping this burden across 204 countries reveal that CHD accounts for a substantial portion of the global disease burden in the pediatric population [3]. In the Indonesian context, CHD is a primary health concern requiring integrated management from birth through adolescence [4]. Despite rapid advancements in modern cardiac care, CHD unexpectedly remains the leading cause of non-communicable disease-related deaths for individuals under the age of 20 on a global scale [5].

The primary barrier to improving outcomes is delayed diagnosis, particularly in resource-limited regions where CHD often goes undetected until it reaches an advanced stage, necessitating complex and expensive interventions [6]. In Indonesia, this challenge is exacerbated by the lack of a structured national database. Data from referral centers reveal alarmingly high annual mortality rates, emphasizing that early detection is a critical necessity to close the existing treatment gap [7], [8]. Furthermore, late diagnosis of critical CHD is statistically linked to an increased incidence of heart failure and a higher demand for intensive care [9]. Global trends indicate that while mortality is decreasing in some regions, it remains high in developing nations where diagnostic infrastructure is lacking [10].

Screening for CHD in school-age children before they transition into severe symptomatic phases emerges as a vital strategy to prevent long-term cardiovascular complications [11]. Moreover, children with late-diagnosed CHD often face significant developmental challenges during their growing years [12]. . Tanjung Tiram Sub-district in Batu Bara Regency represents a typical vulnerable coastal area currently lacking adequate diagnostic infrastructure and epidemiological CHD data.

Despite the known risks of late-diagnosed CHD, there remains a significant research gap regarding the undetected prevalence of mild, non-cyanotic CHD among adolescents in remote coastal areas of Indonesia. Junior high school students (aged 10–15 years) in Tanjung Tiram, Batu Bara Regency, represent a critical demographic; they are entering a physiological phase where untreated CHD may begin to manifest with severe consequences, yet they reside in a vulnerable coastal region lacking routine specialized cardiovascular screening. The implementation of portable 12-lead Electrocardiography (ECG) and Echocardiography directly within the school environment represents a transformative shift toward decentralized specialist care. By utilizing mobile diagnostic technology, this approach successfully bypasses traditional barriers such as transportation costs and geographical hurdles. This program not only identifies structural heart anomalies but also serves as an essential platform for health promotion among students and educators in underserved areas. Therefore, this community service activity aimed to conduct a systematic and integrated CHD screening for junior high school students in Tanjung Tiram. This initiative successfully identified a case of Atrial Septal Defect (ASD) in a previously asymptomatic student, demonstrating the high feasibility and clinical importance of community-based specialized screening.

## 2. Methods

### *2.1 Study Design and Participants*

This study uses a descriptive study design with a cross-sectional approach. This design was chosen because its objective is to systematically describe and measure the prevalence of congenital heart disease (CHD) cases in the junior high school student population in the intervention area during a specific time period. The collected data is observational and analyzed using descriptive statistics. The activity was carried out in one day at Sekolah Menengah Pertama Negeri 1 Tanjung Tiram (State Junior High School 1 Tanjung Tiram), Batu Bara Regency, North Sumatra Province. The target participants were 200 junior high school students. Inclusion criteria included active students aged 10-15 years whose parents or guardians provided written informed consent. Exclusion criteria were students who were absent on the day of the screening or those who refused to participate. Out of the initially targeted 200 students, 10 were excluded due to absence on the screening day, resulting in a final total of 190 participants who successfully completed the screening.

### *2.2 Screening Procedure*

The CHD screening process was implemented in two systematic stages. The initial stage involved comprehensive data collection and clinical assessment, including the completion of demographic profiles, medical history taking (anamnesis) to identify past cardiac-related conditions, and a thorough physical examination. This was followed by a specialized cardiology support examination, which utilized a resting portable 12-lead Electrocardiography (ECG) and portable Echocardiography. The echocardiographic screening was specifically focused on visualizing major cardiac structures to detect structural anomalies, primarily focusing on Atrial Septal Defects (ASD), Ventricular Septal Defects (VSD), and Patent Ductus Arteriosus (PDA). After the screening, all students and teachers were given health education regarding CHD. Participants with positive CHD findings were provided specific education and directed to be immediately referred to a cardiologist at the district hospital for further evaluation and treatment.

### *2.3 Data Analysis*

The data obtained from the screening encompassing demographic profiles, clinical measurements, and cardiac examination results were processed using descriptive statistical analysis. Categorical data, such as gender,

ethnicity, reported symptoms, and the presence of cardiac defects, were presented in the form of frequency distributions and percentages (n, %). For continuous variables, including age, body mass index (BMI), and vital signs (blood pressure, heart rate, and oxygen saturation), the data were expressed as mean values accompanied by standard deviations (mean ± SD).

The analysis was systematically structured to describe: (1) The demographic and clinical characteristics of the adolescent participants to provide a comprehensive baseline of their health status; (2) The frequency of specific congenital heart abnormality findings detected via ECG and Echocardiography; and (3) The overall prevalence of CHD cases successfully identified within the student population. All data were managed using statistical software to ensure accuracy and to provide a clear epidemiological overview of CHD in this remote coastal region.

## 3. Results

The screening program successfully engaged a total of 190 junior high school students in Tanjung Tiram. The demographic and clinical characteristics of the participants are summarized in Table 1. The study population showed a slight majority of male participants (54.7%, n=104) compared to females (45.3%, n=86). The average age of the cohort was 13.21 ± 0.64 years. Ethnically, the population was predominantly Malay (72.1%), followed by Javanese (14.2%) and Batak (7.4%), which accurately represents the local demographics of the Batu Bara coastal area.

Clinically, the participants exhibited stable vital signs, with a mean oxygen saturation of 98.16% and a mean systolic blood pressure of 104.38 mmHg. Notably, 97.4% of the students reported being asymptomatic, while a small fraction reported symptoms such as easy fatigue (1.6%) and shortness of breath (1.1%). Electrocardiogram (ECG) results for all 190 participants showed a normal sinus rhythm (100%).

**Table 1.** Demographic and clinical data of screening results

| Parameter | n= 190 (%) /mean ± Std. Deviation |
|---|---|
| Gender | |
| Male | 104 (54.7%) |
| Female | 86 (45.3%) |
| Age | 13.21 ± 0.64 |
| Ethnicity | |
| Malay | 137 (72.1%) |
| Javanese | 27 (14.2%) |
| Batak | 14 (7.4%) |
| Acehnese | 6 (3.2%) |
| Others | 4 (2.1%) |
| Minang | 2 (1.1%) |
| Body Weight | 38.53 ± 8.24 |
| Body Height | 152.62 ± 11.73 |
| Body Mass Index | 16.38 ± 2.96 |
| Mid-Upper Arm Circumference | 21.23 ± 2.47 |
| Systolic Blood Pressure | 104.38 ± 16.25 |
| Diastolic Blood Pressure | 69.74 ± 12.86 |
| Pulse Rate | 90.96 ± 12.87 |
| Respiratory Rate | 19.85 ± 1.46 |
| Oxygen Saturation | 98.16 ± 1.36 |
| Symptoms | |
| None | 185 (97.4%) |
| Easy fatigue | 3 (1.6%) |
| Shortness of breath | 2 (1.1%) |
| Electrocardiogram | |
| Sinus | 190 (100%) |

The core objective of the screening was to identify structural anomalies through portable echocardiography. The detailed results of the cardiac screening are presented in Table 2. Based on the analysis, the implementing team identified one positive case of congenital heart disease (CHD), specifically an Atrial Septal Defect (ASD),

yielding an overall prevalence of 0.5% within this population.

**Table 2.** Congenital Heart Disease screening results

| Screening Parameter (Echocardiography) | Status | n=190(%) |
|---|---|---|
| Atrial Septal Defect (ASD) | Intact | 189 (99.5%) |
| | Defect | 1 (0.5%) |
| Ventricular Septal Defect (VSD) | Intact | 190 (100%) |
| | Defect | 0 (0%) |
| Patent Ductus Arteriosus (PDA) | Intact | 190 (100%) |
| | Defect | 0 (0%) |

In this study, the screening identified a CHD prevalence of 0.5% (n=1) within the adolescent participant group. Notably, the single confirmed case of ASD was found in a participant who did not report any prominent physical symptoms, such as easy fatigue. This observation reinforces the concept that physical symptoms alone are insufficient predictors for non-cyanotic CHD like ASD in early adolescence, highlighting the essential role of structural imaging via echocardiography in community-based screening efforts [8].

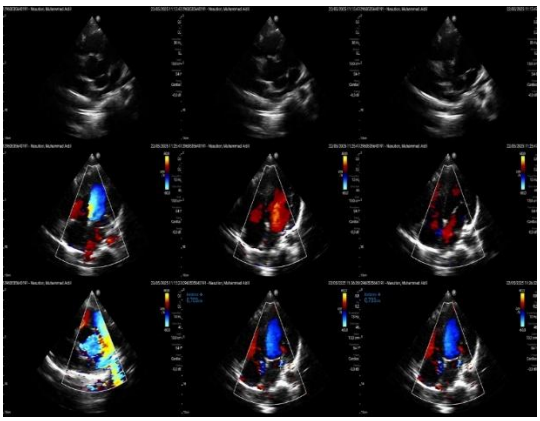

**Figure 1.** Finding of Atrial Septal Defect (ASD) in a screening participant.

The identified case involved a 13-year-old student who had been previously asymptomatic. The visual confirmation of the defect via portable echocardiography is documented in Figure 1. Following the detection, the participant was provided with specialized health education and a formal referral to a cardiologist at the regional hospital for definitive management. This finding confirms the research hypothesis that undiagnosed CHD cases exist within remote school-age populations and can be successfully identified using portable diagnostic technology.

## 4. Discussion

### *4.1 Interpretation of Findings and Comparative Analysis*

The screening successfully reached 190 junior high school students in the Tanjung Tiram Sub-district, with a demographic profile (72.1% Malay) that validly represents the coastal population of Batu Bara Regency. The identification of one case of Atrial Septal Defect (ASD) yields a prevalence of 0.5% in this specific school-age cohort. While this finding highlights the presence of undiagnosed CHD in the community, the 0.5% prevalence must be interpreted with caution as it is based on the detection of a single case and cannot be directly compared to global birth prevalence rates [1].

This finding highlights the "silent" and insidious nature of non-cyanotic CHD. The data shows that 97.4% of participants reported no cardiological symptoms, and all 190 participants exhibited a normal sinus rhythm on their ECG. This indicates that traditional symptom-based screening or basic physical examinations are often insufficient to detect lesions like ASD in school-age children. In this specific case, the student appeared healthy and active, yet the portable echocardiography revealed a structural defect that had gone unnoticed for over a decade. Identifying ASD at the age of 13 represents a critical "window of opportunity" before the onset of irreversible adult physiological changes, such as pulmonary vascular disease or atrial arrhythmias [13]. Without intervention, the risk of long-term mortality remains a threat into early adulthood [14].

Furthermore, the discovery of this case in Tanjung Tiram underscores the impact of geographical disparities on child health. In remote coastal areas with limited specialized healthcare infrastructure, children with "mild" or asymptomatic CHD are frequently missed during infancy and early childhood. This leads to a higher incidence of late-onset CHD, which, as Meng et al. [6] suggest, requires significantly more complex and expensive management once complications arise. Our results confirm that even in a small sample of 190 students, the diagnostic gap is tangible. By bringing advanced diagnostic tools like portable Echocardiography directly to the school setting, we successfully bypassed the "referral barrier" that often prevents rural families from seeking cardiac evaluations in distant city hospitals [8].

This interpretation aligns with the study's objective to demonstrate that active, community-based screening is not only feasible but necessary. It transforms the healthcare approach from a reactive model waiting for a child to fall ill to a proactive model that identifies risks while the patient is still in a manageable, pre-complication phase.

### *4.2 Clinical Importance and Public Health Implications*

The detection of CHD at age 13 is a critical intervention point. As noted by Fachrozi et al. [9], delayed diagnosis of heart defects is a primary driver of preventable morbidity. By identifying this ASD case before the onset of severe complications, the program facilitates a transition from reactive treatment to proactive management.

Furthermore, the successful use of portable Echocardiography and ECG in a school setting demonstrates a feasible model for remote healthcare delivery. This approach overcomes geographical and infrastructural barriers inherent in 3T (frontier, outermost, and disadvantaged) regions. By relocating specialist diagnostic services from tertiary hospitals to the community level, we provide a blueprint for reducing the burden of non-communicable diseases in young populations, a priority highlighted by Wang et al. [5].

### *4.3 Study Limitations*

Despite the successful detection of a CHD case, this study has several limitations that should be acknowledged. Firstly, this study is constrained by a small sample size of 190 students and was conducted in a single-school setting (SMP Negeri 1 Tanjung Tiram). Consequently, the findings cannot be broadly generalized to provide a comprehensive epidemiological prevalence for the entire regency. Secondly, the scope of this research was limited by its cross-sectional design conducted at a single point in time, focusing exclusively on the 10–15 age group. Consequently, it may not capture CHD trends in younger children or those who have already dropped out of school due to health issues. Finally, regarding diagnostic depth, while portable Echocardiography is highly effective for detecting septal defects, more complex or subtle cardiac lesions might require advanced imaging settings and specialized clinical environments that were not available in this community-based setting.

### *4.4 Future Directions and Policy Recommendations*

Based on the findings of this study, several strategic actions are recommended to bridge the diagnostic gap and improve the management of congenital heart disease (CHD) in Indonesia's coastal and remote regions:

1. Policy Integration into School Health Programs: Local governments and health departments are strongly advised to integrate systematic CHD screening into the routine School Health Program (UKS). This should ideally include thorough physical examinations and the use of non-invasive diagnostic tools such as Pulse Oximetry and, where feasible, portable Echocardiography. Prioritizing these programs in 3T (Frontier, Outermost, and Disadvantaged) areas of North Sumatra is essential to address the significant healthcare disparities in these regions.
2. Human Resource Capacity Building: To strengthen the first line of defense, specialized training programs should be developed for doctors and primary healthcare workers at Community Health Centers (Puskesmas). These programs should focus on identifying "CHD red flags" and mastering basic screening techniques. Enhancing the diagnostic intuition of primary care providers ensures that potential heart defects are identified and referred before they become life-threatening complications.
3. Expansion of Research and Longitudinal Tracking: Future research should transition from small-scale cross-sectional studies to larger cohort studies spanning multiple coastal districts in North Sumatra. Such research is necessary to establish a more accurate regional prevalence rate. Furthermore, there is a clear need for longitudinal tracking to monitor the long-term clinical outcomes and treatment adherence of students who are referred to tertiary cardiology services through these community-based programs.

## 5. Conclusion

This study demonstrates that the early detection screening program for congenital heart disease (CHD) among junior high school students in the coastal region of Batu Bara Regency is a feasible model for preventive and promotional healthcare. The conclusions are summarized as follows:

1. Clinical Prevalence and Detection: The screening of 190 students identified a CHD prevalence of 0.5%, specifically an Atrial Septal Defect (ASD) in a student who was previously asymptomatic. This finding confirms that significant heart defects persist undiagnosed into adolescence in remote areas. It highlights the necessity of active screening, as traditional symptom-based detection often fails to identify non-cyanotic lesions during the "silent" phase of the disease.
2. Strategic and Methodological Impact: The use of portable Echocardiography in a school setting proved to be a vital solution for overcoming the geographical and infrastructural barriers inherent in Indonesia's coastal and remote (3T) regions. This methodology successfully shifted specialized cardiac diagnostics from tertiary hospitals to the community level, effectively bridging the diagnostic gap.
3. Proactive Healthcare Model: By identifying CHD in the school-age population (average age 13 years), this program provides a "window of opportunity" for timely intervention before the development of irreversible complications like pulmonary hypertension. This initiative serves as an efficient, proactive strategy that aligns with national health priorities to reduce pediatric morbidity and mortality related to non-communicable diseases in underserved populations.

## 6. Data Availability Statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## 7. Ethical Statement

This activity was conducted as a formal community service program. While formal clinical trial ethical clearance was not required for this non-invasive observational screening, the protocol and execution of the activity were officially approved and mandated by the Department of Cardiology and Vascular Medicine, Universitas Sumatera Utara under the official assignment letter (Number: 00/POKJA-KPPJB/PERKI/2025). Furthermore, operational permission was granted by the local authority of SMP Negeri 1 Tanjung Tiram. The program strictly adhered to the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all participants prior to the screening.

## 8. Author Contributions

ANN was involved in the conceptualization and design of the research, from its initiation to completion. ANN, and RH were responsible for the methodology and logistical coordination of the screening program. HM, ANN, MR, RRL, and MMA conducted the data collection and physical examinations in the field. ANN and RH performed the data analysis and interpretation of the echocardiographic results. HM and ANN prepared the initial draft of the manuscript and were responsible for the technical writing. ANN was responsible for the final review and finalizing the manuscript for submission. All authors read and approved the final version of the manuscript.

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## 11. Conflict of Interest

Authors declares no conflict of interest.

**References**

[1] Hoffman JI, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39(12):1890-1900.
[2] Van der Linde D, Konings EEM, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJM, et al. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. J Am Coll Cardiol. 2011;58(21):2241-2247.
[3] GBD 2019 Congenital Heart Disease Collaborators. Global burden of congenital heart disease in 204 countries and territories, 1990-2019. Lancet. 2020;396(10260):1632-1649.
[4] Lestari DL. Penyakit jantung bawaan pada anak. Scientific Journal. 2023;2(4):134-142.
[5] Wang R, et al. Time trends in mortality of congenital heart disease in children aged 0-14 years. Front Public Health. 2025;12:1537671.
[6] Meng X, et al. Congenital heart disease: types, pathophysiology, diagnosis, and treatment options. MedComm. 2024;5(7).
[7] Marwali EM, Purnama Y, Roebiono PS. Modalitas deteksi dini penyakit jantung bawaan di pelayanan kesehatan primer. J Indones Med Assoc. 2021;71(2):100-109.
[8] Syam YN, et al. Addressing the gap in congenital heart disease care in Indonesia. Asia Pac J Public Health. 2022;34(8):936-940.
[9] Fachrozi I, et al. Factors associated with clinical outcomes among children with delayed diagnosis of critical congenital heart disease. Narra X. 2025;3(2).
[10] Dolk H, et al. Risk factors for congenital heart disease: the Baby Hearts Study. PLoS One. 2020;15(2).
[11] Rahardjo SS, Putri DF, Lestari W. Community-based screening for congenital heart disease in rural Indonesia. BMC Pediatr. 2021;21(1):1-9.
[12] Rahmawati AN. Hubungan penyakit jantung bawaan dengan perkembangan anak usia 0-5 tahun di RSUP Dr. Cipto Mangunkusumo. J Kedokt Indones. 2011.
[13] Lilly LS. Pathophysiology of heart disease. Philadelphia: Lippincott Williams & Wilkins; 2016.
[14] Aboudou KA, et al. Long-term mortality of children with congenital heart disease. Open J Pediatr. 2024;14(2):259-270.
[15] Jenkins KJ, et al. Noninherited risk factors and congenital cardiovascular malformations: an update. J Am Coll Cardiol. 2007;49(23):2245-2256.