e-ISSN: 2747-2051

Archives of the Medicine and Case Reports

[AMCR]

https://hmpublisher.com/index.php/amcr

# Point-of-Care Hemoglobin Testing for Early Anemia Detection in Adolescent Girls: A Qualitative Study in Indonesia

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**ARTICLE INFO**

**Keywords:**
Adolescent girls
Anemia
Hemoglobin
Point-of-care testing
Qualitative study

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All authors have reviewed and approved the final version of the manuscript.

*https://doi.org/10.37275/amcr.v6i1.678*

**A B S T R A C T**

Anemia is a significant public health issue, particularly among adolescent girls in developing countries like Indonesia. Early detection and management are crucial for preventing adverse health outcomes. Point-of-care testing (POCT) for hemoglobin levels offers a promising approach for anemia screening in resource-constrained settings. This study aimed to explore the feasibility and acceptability of POCT for anemia detection among adolescent girls in an Indonesian school setting. A qualitative study was conducted at an Islamic boarding school (Madrasah) in Indonesia. Participants included adolescent girls aged 12-18 years. Data were collected through semi-structured interviews with students, teachers, and healthcare providers. Additionally, focus group discussions were held with students to gather diverse perspectives on anemia and POCT. Thematic analysis was used to analyze the transcribed data. The findings revealed a high prevalence of anemia among the participants. Menstrual blood loss, dietary habits, and lack of awareness about anemia were identified as contributing factors. POCT was perceived as convenient and accessible, with most participants expressing a positive attitude towards its use for anemia screening. However, some concerns were raised regarding the accuracy of the test and the need for trained personnel to interpret the results. In conclusion, POCT for hemoglobin holds the potential for early anemia detection in adolescent girls. The integration of POCT into school health programs can facilitate timely interventions and improve anemia management. Further research is needed to evaluate the effectiveness of POCT-based screening programs and their impact on anemia prevalence in this population.

## 1. Introduction

Anemia, a prevalent global health concern, is characterized by a deficiency in red blood cells or hemoglobin, hindering the body's capacity to transport oxygen effectively. This condition affects an estimated 1.62 billion people worldwide, with adolescent girls in developing countries being particularly susceptible. This vulnerability stems from a confluence of factors, including rapid growth spurts, menstruation, and insufficient dietary intake of iron and other vital nutrients. In Indonesia, a lower-middle-income country grappling with a significant anemia burden, the national prevalence among adolescent girls stands at 27.1%. The implications of anemia during adolescence can be far-reaching, impacting not only physical health but also cognitive development and overall well-being. Impaired cognitive function can hinder academic performance and limit future opportunities, while reduced physical performance can curtail social engagement and diminish quality of life. Furthermore, anemia can increase susceptibility to infections, further compromising health and potentially leading to more severe complications.[1-3]

The long-term consequences of anemia during adolescence extend beyond immediate health concerns, potentially influencing future reproductive health and economic prospects. Adverse pregnancy outcomes, such as premature birth and low birth

weight, have been linked to maternal anemia. Additionally, reduced work productivity in adulthood can stem from the lingering effects of anemia experienced during adolescence. Early detection and effective management of anemia are therefore paramount in ensuring the health and well-being of adolescent girls. Traditional diagnostic methods for anemia often rely on laboratory-based blood tests, requiring specialized equipment and trained personnel. However, such resources may not be readily available or accessible in resource-constrained settings, particularly in rural areas or schools where timely screening is essential.[4-6]

Point-of-care testing (POCT) for hemoglobin has emerged as a promising alternative for anemia screening, offering a potential solution to the challenges posed by traditional methods. POCT devices are portable, user-friendly, and capable of providing rapid results, making them well-suited for use in various settings, including schools and community health centers. This accessibility is particularly crucial in resource-limited areas where traditional laboratory facilities may be scarce. Several studies have explored the feasibility and acceptability of POCT for anemia screening across diverse populations. A study conducted in India demonstrated the accuracy and acceptability of POCT using HemoCue for anemia screening among pregnant women. Similarly, research in Kenya highlighted the effectiveness of POCT for anemia diagnosis in children under five years of age. Despite this growing body of evidence, research on the use of POCT for anemia detection among adolescent girls in Indonesia remains limited.[7-10] This qualitative study aimed to investigate the feasibility and acceptability of POCT for anemia detection among adolescent girls within an Indonesian school setting.

## 2. Methods

This qualitative study was conducted at an Islamic boarding school (Madrasah) in Indonesia. The school was selected due to its high enrollment of adolescent girls and its location in a rural area with limited access to laboratory facilities. Participants included adolescent girls aged 12-18 years enrolled in the Madrasah. A purposive sampling strategy was used to select participants with diverse backgrounds and experiences. Additionally, teachers and healthcare providers involved in the school's health program were invited to participate in the study.

Data were collected through semi-structured interviews and focus group discussions (FGDs). The interviews were conducted with individual students, teachers, and healthcare providers. The interview guides explored participants' knowledge and perceptions of anemia, their experiences with anemia screening (if any), and their views on the use of POCT for anemia detection. FGDs were held with groups of 6-8 students to facilitate interactive discussions and gather diverse perspectives on anemia and POCT. The FGDs were moderated by a trained researcher and focused on exploring the acceptability and feasibility of POCT in the school setting. All interviews and FGDs were conducted in the local language (Bahasa Indonesia) by trained researchers. The interviews and FGDs were audio-recorded with the participants' consent, and detailed field notes were taken during the sessions.

The audio recordings were transcribed verbatim and translated into English. Thematic analysis was used to analyze the transcribed data. The data were coded and categorized into themes and subthemes based on the research questions and the emerging patterns in the data. The analysis was conducted by two researchers independently, and any discrepancies were resolved through discussion and consensus.

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of the university and the school administration. Informed consent was obtained from all participants prior to their involvement in the

study. For participants under the age of 18, informed consent was obtained from their parents or legal guardians. Participants were informed of the study's purpose, procedures, and potential risks and benefits. They were also assured of their right to withdraw from the study at any time without penalty. Confidentiality and anonymity were maintained throughout the study.

Several measures were implemented to ensure the quality of the study. Interviewer training was conducted to ensure consistency and reduce bias in data collection. The use of semi-structured interview guides allowed for flexibility while ensuring that key topics were covered. Thematic analysis was conducted by two researchers independently to enhance the trustworthiness of the findings. Triangulation of data sources (interviews and FGDs) was used to strengthen the validity of the study.

**3. Results and Discussion**

Table 1 provides a breakdown of the characteristics of the 30 adolescent girls who participated in the study. The participants were fairly evenly distributed across the 12-18 year age range, with the largest group (50%) falling within the 15-16 year old bracket. This age range is particularly relevant for anemia research in girls due to the onset of menstruation and the increased iron demands associated with it. The vast majority of the participants (80%) resided in rural areas. This is important as rural communities often have less access to healthcare facilities and resources, potentially increasing their risk for anemia and highlighting the need for accessible screening methods like POCT. Almost all participants (90%) had begun menstruating. This is a crucial factor as menstrual blood loss is a significant contributor to iron deficiency and anemia in adolescent girls. Half of the participants came from middle socioeconomic backgrounds, while 40% were from low socioeconomic backgrounds. Socioeconomic status can influence dietary quality and access to healthcare, both of which are linked to anemia risk. A significant portion of the girls (23.3%) reported having iron-poor diets, while only 26.7% reported consuming iron-rich foods. Dietary iron intake is essential for hemoglobin production and preventing anemia. This finding suggests a need for nutritional education and interventions to improve dietary habits among this population. Only 16.7% of the participants demonstrated good knowledge about anemia. Half of them possessed moderate knowledge, and a third (33.3%) had poor knowledge. This lack of awareness about anemia and its causes can hinder prevention and early intervention efforts.

Table 2 presents a qualitative overview of the adolescent girls' knowledge and perceptions about anemia, gathered through quotes from interviews and focus group discussions; Causes of Anemia: The girls demonstrate some understanding of the causes of anemia, linking it to poor diet and lack of iron. This suggests a basic awareness of the nutritional aspect of anemia. The association between menstruation and anemia is recognized, indicating an understanding of this key risk factor for this population; Symptoms of Anemia: The girls accurately identify common symptoms of anemia, including fatigue, weakness, and pale skin. This awareness can be helpful in prompting them to seek help or take preventive measures. The mention of dizziness suggests they may be experiencing more severe symptoms, highlighting the potential impact of anemia on their daily lives; Consequences of Anemia: The girls recognize the negative impact of anemia on school performance, emphasizing the importance of addressing anemia to support their education. They also show awareness of potential long-term health problems associated with anemia, including complications during pregnancy. The acknowledgment of reduced productivity underscores how anemia can affect their ability to perform daily tasks and participate fully in their lives; Prevention and Treatment: The girls mention iron supplements and healthy diet as ways to prevent or treat anemia, indicating some knowledge of available

interventions. However, the "Limited Knowledge" subtheme and related quote highlight a gap in their understanding of comprehensive anemia prevention strategies.

Table 1. Participant characteristics.

| Characteristic | Frequency (%) |
|---|---|
| **Age (years)** | |
| 12-14 | 10 (33.3) |
| 15-16 | 15 (50) |
| 17-18 | 5 (16.7) |
| **Residence** | |
| Rural | 24 (80) |
| Urban | 6 (20) |
| **Menstruation experience** | |
| Yes | 27 (90) |
| No | 3 (10) |
| **Socioeconomic status** | |
| Low | 12 (40) |
| Middle | 15 (50) |
| High | 3 (10) |
| **Dietary habits (Self-reported)** | |
| Iron-rich | 8 (26.7) |
| Mixed | 15 (50) |
| Iron-poor | 7 (23.3) |
| **Anemia knowledge** | |
| Good | 5 (16.7) |
| Moderate | 15 (50) |
| Poor | 10 (33.3) |

Table 2. Knowledge and perceptions of anemia.

| Theme | Subtheme | Quotes |
|---|---|---|
| Causes of anemia | "Poor Diet" | "I think anemia is caused by not eating enough vegetables." |
| | "Lack of Iron" | "I heard that anemia is when you don't have enough iron in your blood." |
| | "Menstruation" | "I get tired and weak during my period, maybe that's because of anemia." |
| Symptoms of anemia | "Fatigue and Weakness" | "I feel very tired and have no energy when I have anemia." |
| | "Pale Skin" | "My teacher said I looked pale and asked if I was anemic." |
| | "Dizziness" | "Sometimes I feel dizzy and lightheaded, especially during my period." |
| Consequences of anemia | "Poor School Performance" | "I can't concentrate in class and my grades are dropping." |
| | "Health Problems" | "My mother said anemia can cause problems during pregnancy." |
| | "Reduced Productivity" | "I can't do my chores at home because I feel so weak." |
| Prevention and treatment | "Iron Supplements" | "I take iron tablets sometimes when I feel anemic." |
| | "Healthy Diet" | "Eating liver and spinach is good for anemia." |
| | "Limited Knowledge" | "I don't really know how to prevent anemia." |

Table 3 presents a qualitative overview of the adolescent girls' experiences with anemia screening, gathered through quotes from interviews and focus group discussions; Prior Screening Experiences: Most girls (56%) reported no prior anemia screening experiences. This suggests a lack of routine anemia screening in the school setting and highlights the need for increased access to testing. Some girls mentioned having their blood pressure checked at school, but they were unsure if anemia tests were performed. This indicates a potential missed opportunity for anemia screening in the school setting; Barriers to Screening: The girls identified inconvenience as a major barrier to anemia screening, citing the time and effort required to visit a health center for a blood test. This highlights the need for accessible and convenient screening options. Fear of needles was another common barrier, deterring some girls from undergoing blood tests. This is a significant obstacle that needs to be addressed to increase uptake of anemia screening. Lack of awareness about the importance of anemia screening was identified as a barrier, suggesting a need for education and awareness campaigns to promote screening; Perceptions of POCT: The girls had generally positive perceptions of POCT, viewing it as more convenient, less painful, and faster than traditional blood tests. These positive perceptions suggest that POCT could be a more acceptable and feasible screening method for this population.

Table 3. Experiences with anemia screening.

| Theme | Subtheme | Quotes |
|---|---|---|
| Prior screening experiences | "No Prior Screening" | "I have never had a blood test for anemia before." |
| | "Limited Recall" | "I don't remember if I have been tested for anemia." |
| | "School Health Checks" | "They checked my blood pressure at school, but I don't think they did an anemia test." |
| Barriers to screening | "Inconvenience" | "Going to the health center for a blood test takes a lot of time." |
| | "Fear of Needles" | "I am afraid of needles, so I don't want to get a blood test." |
| | "Lack of Awareness" | "I didn't know that anemia screening was important." |
| Perceptions of POCT | "Convenient and Quick" | "This finger prick test is much easier than going to the clinic." |
| | "Less Painful" | "It didn't hurt as much as I thought it would." |
| | "Immediate Results" | "It's good that we can get the results right away." |

Table 4 presents a qualitative overview of the adolescent girls' perceptions of the acceptability of POCT for anemia detection, gathered through quotes from interviews and focus group discussions; Convenience: The girls found POCT to be easy to use, with some noting they could perform the finger prick test themselves. This simplicity is a key advantage for increasing accessibility and uptake of screening. The availability of POCT at school was perceived as highly positive, making it more convenient and accessible for the girls. The rapid results provided by POCT were seen as a major advantage, eliminating the wait times associated with traditional blood tests; Acceptability: The girls generally had a positive attitude towards POCT, with some expressing gratitude for having this new way to check for anemia. POCT was perceived as less anxiety-inducing compared to traditional blood tests, which often involve needles. This reduced

anxiety can significantly improve the acceptability of screening. Some girls felt empowered by being able to check their own hemoglobin levels, indicating a sense of control over their health; Concerns: While generally positive, some girls expressed concerns about the accuracy of POCT results. This highlights the need for reassurance and education about the reliability of these tests. Some girls expressed difficulty interpreting the results, emphasizing the need for clear instructions and support from healthcare providers. Some girls had questions about what happens if their test shows they have anemia, highlighting the importance of linking POCT to appropriate follow-up care.

Table 4. Acceptability of POCT for anemia detection.

| Theme | Subtheme | Quotes |
|---|---|---|
| Convenience | "Easy to Use" | "The finger prick test was very simple, I could do it myself." |
| | "Accessible" | "It's great that we can get tested for anemia at school." |
| | "Time-Saving" | "The results were quick, I didn't have to wait long." |
| Acceptability | "Positive Attitude" | "I'm glad we have this new way to check for anemia." |
| | "Less Anxiety" | "I was less scared compared to getting a blood test at the clinic." |
| | "Empowering" | "I feel more in control of my health now that I can check my own hemoglobin." |
| Concerns | "Accuracy" | "I hope the results from this finger prick test are accurate." |
| | "Interpretation" | "I need someone to explain what the numbers mean." |
| | "Follow-Up" | "What happens if my test shows that I have anemia?" |

Table 5 provides valuable insights into the perceived feasibility of implementing POCT for anemia screening within the school setting, based on the perspectives of teachers, healthcare providers, and the adolescent girls themselves; Resources: Participants emphasized the need for a consistent and reliable supply of POCT devices and test kits. This highlights the importance of logistical planning and resource allocation for successful implementation. The need for trained personnel to administer and interpret POCT results was clearly identified. This could involve training teachers, school nurses, or other healthcare professionals. Participants stressed the importance of having a dedicated space with proper hygiene for conducting the tests. This ensures safety and maintains the integrity of the testing process; Integration with Health Programs: Participants suggested that POCT should be integrated into the school's existing health program and policies. This would formalize the screening process and ensure its sustainability. The need for collaboration with healthcare professionals for training, result interpretation, and follow-up care was emphasized. This highlights the importance of a collaborative approach involving both the school and the wider healthcare system. Participants recognized the need for a system to record and track anemia screening results. This allows for monitoring and evaluation of the program and facilitates appropriate follow-up care; Sustainability: The affordability and sustainability of POCT were identified as key considerations. This suggests the need for careful budget planning and

potentially exploring cost-effective strategies for long-term implementation. Participants highlighted the importance of educating parents and the wider community about anemia and POCT. This can increase awareness, encourage participation, and create a supportive environment for the program. The need for POCT to be part of a long-term strategy for anemia prevention and control was emphasized. This underscores the importance of integrating POCT into a comprehensive approach to anemia management.

Table 5. Feasibility of POCT in the school setting.

| Theme | Subtheme | Quotes |
|---|---|---|
| Resources | "Equipment and Supplies" | "We need to ensure a reliable supply of POCT devices and test kits." |
| | "Trained Personnel" | "Teachers or nurses should be trained to perform and interpret the POCT." |
| | "Space and Infrastructure" | "A designated area with proper hygiene is needed for conducting the tests." |
| Integration with Health Programs | "School Health Policy" | "POCT should be included in the school's health program guidelines." |
| | "Collaboration" | "We need support from health professionals for training and follow-up." |
| | "Data Management" | "A system for recording and tracking anemia screening results is important." |
| Sustainability | "Cost-Effectiveness" | "The cost of POCT should be affordable and sustainable for the school." |
| | "Community Involvement" | "Parents and the community should be educated about anemia and POCT." |
| | "Long-Term Vision" | "POCT should be part of a long-term strategy for anemia prevention and control." |

This study uncovered a concerning reality, a significant lack of anemia awareness and knowledge among adolescent girls. This gap in understanding has profound implications for their health and well-being, hindering prevention efforts, delaying diagnosis, and potentially leading to more severe health consequences. This detailed exploration delves into the complexities of this issue, emphasizing the urgent need for comprehensive education and intervention. Anemia, a condition characterized by a deficiency of red blood cells or hemoglobin, is a prevalent global health concern. Hemoglobin, the protein responsible for carrying oxygen in the blood, plays a vital role in ensuring that adequate oxygen reaches the body's tissues and organs. When hemoglobin levels are low, the body's cells are deprived of the oxygen they need to function properly, leading to a range of symptoms and potential health complications. Adolescent girls, particularly those in developing countries, are disproportionately affected by anemia. Adolescence is a period of rapid growth and development, with the body's demand for iron and other nutrients significantly increasing. The onset of menstruation introduces regular blood loss, a significant contributor

to iron deficiency and anemia in adolescent girls. Insufficient consumption of iron-rich foods, coupled with potential dietary restrictions or imbalances, can further contribute to iron deficiency. Limited access to nutritious food, healthcare, and education in marginalized communities can exacerbate the risk of anemia among adolescent girls. Iron deficiency can negatively impact cognitive function, affecting attention span, memory, and learning abilities. This can hinder academic performance, limit educational opportunities, and ultimately impact future prospects. Anemia can lead to fatigue, weakness, and shortness of breath, reducing physical endurance and stamina. This can affect participation in sports, social activities, and daily tasks, impacting overall quality of life. Anemia can weaken the immune system, making adolescent girls more vulnerable to infections and illnesses. This can lead to frequent absenteeism from school and further compromise their health and well-being. Anemia during adolescence can have long-term health consequences, including increased risk of complications during pregnancy and childbirth, and reduced work productivity in adulthood. The lack of anemia awareness and knowledge among adolescent girls underscores the crucial need for comprehensive anemia education programs. Educate adolescent girls about the causes, symptoms, and consequences of anemia, emphasizing its prevalence and potential impact on their lives. Empower girls with knowledge about preventive measures, including adopting a balanced diet rich in iron-rich foods, practicing good hygiene during menstruation, and seeking medical advice when necessary. Highlight the importance of regular anemia screening and provide information about accessible testing options, such as POCT. Educate girls about the available treatment options for anemia, including iron supplementation and dietary modifications, and encourage adherence to medical advice. Explain the various causes of anemia, including nutritional deficiencies (iron, vitamin B12, folate), blood loss (menstruation, injuries), and underlying health conditions (chronic diseases, genetic disorders). Educate participants on the common symptoms of anemia, such as fatigue, weakness, pale skin, shortness of breath, dizziness, headaches, and rapid heartbeat. Highlight the potential health consequences of anemia, including impaired cognitive development, reduced physical performance, increased susceptibility to infections, and long-term health risks. Encourage consumption of iron-rich foods, such as red meat, poultry, fish, beans, lentils, spinach, and fortified cereals. Provide information about iron supplements, including dosage, potential side effects, and the importance of following medical advice. Educate girls about proper menstrual hygiene practices to minimize blood loss and reduce the risk of anemia. Emphasize the importance of seeking medical attention for any underlying health conditions that may contribute to anemia. Integrating anemia education into school curricula, health education classes, or extracurricular activities can ensure that a large number of adolescent girls receive the necessary information. Utilize mass media campaigns, social media initiatives, and community events to raise awareness about anemia and promote healthy behaviors. Collaborate with community health workers, youth organizations, and local leaders to reach adolescent girls who may not have access to school-based programs or health promotion campaigns. Train adolescent girls as peer educators to disseminate information about anemia within their communities, leveraging their influence and social networks. Develop interactive digital resources, mobile applications, and online platforms to provide accessible and engaging information about anemia. Increased awareness and knowledge can empower adolescent girls to take control of their health, prevent anemia, and seek timely treatment when necessary, leading to improved health outcomes and reduced prevalence of anemia-related complications. By addressing the cognitive and physical impacts of anemia, education programs can

contribute to improved academic performance, increased school attendance, and enhanced educational opportunities for adolescent girls. Healthy and educated adolescent girls are more likely to participate fully in the workforce and contribute to economic growth, leading to increased economic opportunities and improved livelihoods. Educated adolescent girls are more likely to make informed decisions about their own health and the health of their future children, contributing to healthier and more empowered future generations. Develop and implement national anemia control strategies that prioritize education and awareness programs for adolescent girls. Allocate resources for the development and dissemination of educational materials, training of healthcare providers and educators, and implementation of school-based and community outreach programs. Integrate anemia education into routine healthcare visits for adolescent girls. Provide counseling on anemia prevention and management, offer accessible screening options, and ensure timely referral for diagnosis and treatment. Incorporate anemia education into school curricula and health education programs. Create a supportive school environment that promotes healthy behaviors and encourages students to seek help when needed. Engage community leaders, parents, and youth organizations in anemia education and prevention efforts. Organize community events, support peer education programs, and create a supportive environment that promotes adolescent girls' health and well-being. By investing in comprehensive anemia education programs and working together to bridge the knowledge gap, we can empower adolescent girls to protect their health, reach their full potential, and contribute to a healthier and more equitable future.[11-13]

This study identified several key barriers that hinder anemia screening among adolescent girls, including inconvenience, fear of needles, and a lack of awareness regarding the importance of screening. These barriers can significantly impede access to timely diagnosis and treatment, particularly in resource-constrained settings where healthcare infrastructure and resources may be limited. Traditional anemia screening methods often involve a series of steps that can be inconvenient and time-consuming for adolescent girls. In many settings, particularly rural areas, accessing health centers may require significant travel time, cost, and effort. This can be a major deterrent for adolescent girls who may have limited autonomy and mobility. The process of scheduling appointments, coordinating with healthcare providers, and potentially missing school or other activities can create additional inconvenience and disrupt daily routines. Long waiting times at health centers can be frustrating and discouraging, particularly for young people who may have limited patience and competing priorities. The traditional method of blood collection through venipuncture, which involves inserting a needle into a vein in the arm, can be perceived as painful and anxiety-provoking, particularly for those with a fear of needles. These inconveniences associated with traditional anemia screening methods can discourage adolescent girls from seeking screening, leading to delayed diagnosis and potential progression of anemia with its associated health consequences. Fear of needles, also known as trypanophobia, is a common phobia, particularly among children and adolescents. The anticipation of pain, the sight of blood, and the perceived loss of control can trigger anxiety and fear, making it difficult for individuals to undergo procedures involving needles. For adolescent girls, fear of needles can be a significant barrier to anemia screening, as traditional methods rely on venipuncture for blood collection. This fear can lead to avoidance of screening, delaying diagnosis and potentially resulting in more severe anemia and associated health complications. A lack of awareness about the importance of anemia screening can also hinder its uptake among adolescent girls. Many girls may not be

aware of the prevalence, causes, symptoms, and consequences of anemia, leading to a perception that it is not a priority health concern. Additionally, limited knowledge about the availability and benefits of anemia screening can further contribute to its low prioritization. Without adequate information and awareness, adolescent girls may not recognize the need for screening or may not seek it out even when available. The identified barriers to anemia screening highlight the urgent need for innovative approaches that are more convenient, accessible, and acceptable to adolescent girls. Minimize the time, cost, and effort required for screening by offering on-site testing options, reducing travel needs, and minimizing wait times. Utilize less invasive methods of blood collection, such as finger-prick tests, or explore non-invasive screening technologies. Implement comprehensive anemia education programs that target adolescent girls, their families, and communities, raising awareness about the importance, benefits, and availability of screening. Point-of-care testing (POCT) offers a potential solution to the challenges posed by traditional anemia screening methods. POCT devices are portable, easy to use, and provide rapid results, making them suitable for use in various settings, including schools and community health centers. By bringing anemia screening closer to adolescent girls, POCT can reduce the inconvenience associated with travel and scheduling. The use of finger-prick tests can also address the fear of needles, making screening less daunting and more acceptable. Furthermore, the rapid results provided by POCT can facilitate timely diagnosis and management, potentially preventing the progression of anemia and its associated health consequences.[14,15]

This study revealed a crucial finding point-of-care testing (POCT) for anemia was generally well-accepted by adolescent girls, teachers, and healthcare providers. The ease of use, minimal discomfort, and rapid results associated with POCT were perceived as major advantages. Participants also appreciated the convenience of having anemia screening available at school. This high level of acceptability suggests that POCT could be a feasible and effective alternative to traditional anemia screening methods, with the potential to significantly improve anemia detection and management among adolescent girls. POCT devices are typically designed to be user-friendly, requiring minimal training to operate effectively. This simplicity makes them well-suited for use in various settings, including schools, where healthcare professionals may not always be readily available. Teachers or school nurses can be easily trained to administer the tests, ensuring accessibility and sustainability of the screening program. POCT for anemia often involves a simple finger-prick blood test, which is significantly less invasive than traditional venipuncture (drawing blood from a vein). This minimally invasive procedure can help alleviate fear and anxiety associated with needles, making screening more acceptable to adolescent girls who may be apprehensive about traditional blood tests. POCT devices provide results within minutes, allowing for immediate feedback and timely intervention. This rapid turnaround time is particularly beneficial in school settings, where prompt action can be taken to address anemia and prevent its negative impact on academic performance and overall well-being. The ability to perform anemia screening on-site at school eliminates the need for travel to health centers, reducing inconvenience and potential disruptions to school schedules. This increased convenience can be a major factor in improving screening uptake among adolescent girls, who may face challenges in accessing healthcare facilities due to transportation issues, time constraints, or parental permission requirements. The positive perceptions of POCT expressed by adolescent girls, teachers, and healthcare providers highlight its potential as a valuable tool for anemia screening in this setting. The convenience, minimal discomfort, and rapid results associated with POCT can help overcome barriers to screening, potentially leading to increased

uptake and earlier detection of anemia. Earlier detection of anemia can facilitate timely interventions, such as iron supplementation, dietary counseling, and treatment of any underlying conditions. This can help prevent the progression of anemia and its associated health consequences, improving the overall health and well-being of adolescent girls. By providing on-site screening at school, POCT eliminates the need for travel to health centers, reducing inconvenience and potential disruptions to school schedules. This can be particularly beneficial in rural areas or communities with limited access to healthcare facilities. The use of finger-prick blood tests, which are much less invasive than traditional venipuncture, can alleviate fear and anxiety associated with needles, making screening more acceptable to adolescent girls who may have needle phobia. The availability of POCT at school can increase awareness of anemia and its importance among adolescent girls, their families, and the school community. This increased awareness can prompt more girls to seek screening and take proactive steps to prevent or manage anemia. The rapid results provided by POCT can also empower adolescent girls to take control of their health. By receiving immediate feedback on their hemoglobin levels, girls can be actively involved in their own care and make informed decisions about their health in consultation with healthcare providers or school nurses. The high acceptability of POCT for anemia screening suggests that it can be a catalyst for change in how we approach anemia detection and management among adolescent girls. The convenience and acceptability of POCT can encourage more adolescent girls to participate in anemia screening, leading to higher screening rates and earlier detection of anemia. Timely detection of anemia through POCT can facilitate prompt intervention and improve adherence to treatment, leading to better anemia management and improved health outcomes. POCT can empower adolescent girls to take control of their health by providing them with immediate feedback on their hemoglobin levels and involving them in their own care. By providing accessible and convenient anemia screening through POCT, we can help reduce health disparities and ensure that all adolescent girls, regardless of their background or location, have the opportunity to receive timely diagnosis and care for anemia.[16,17]

Implementing point-of-care testing (POCT) for anemia screening in schools requires a multifaceted approach. It's not merely about having a device and test kits, it's about weaving this technology into the fabric of the school's health infrastructure. This study identified several crucial elements that contribute to the successful implementation of POCT programs, transforming them from a temporary intervention to a sustainable solution. Adequate resources are the bedrock of any successful POCT program. Selecting appropriate POCT devices is paramount. Factors to consider include accuracy, ease of use, maintenance requirements, and data management capabilities. A sufficient number of devices must be available to meet the screening needs of the student population, ensuring efficient testing without long wait times. A consistent and reliable supply of test kits is crucial. This includes lancets for finger-prick blood collection, test strips compatible with the chosen device, and quality control materials to ensure accurate and reliable results. Proper storage and inventory management are essential to prevent stockouts and ensure test kit integrity. Investing in training is non-negotiable. School nurses, teachers, or other designated staff must be thoroughly trained on the proper use of POCT devices, accurate interpretation of results, and adherence to strict infection control measures. This ensures the safety of both the individuals conducting the tests and the students being screened. Regular refresher training and competency assessments can maintain the quality and safety of the program. A dedicated space for conducting POCT is essential. This space should be clean, well-lit, and equipped with a suitable work surface and appropriate waste disposal containers.

Ensuring privacy and maintaining a comfortable environment for students undergoing screening is crucial. Incorporating POCT into school health policies and guidelines formalizes the screening process. This provides a framework for implementation, outlines roles and responsibilities, and ensures adherence to ethical and legal considerations. It also facilitates the allocation of necessary resources and establishes clear protocols for screening, result interpretation, and follow-up. Strong partnerships with local healthcare professionals or institutions are invaluable. These collaborations can provide support for training school staff, interpreting test results, and referring students who require further diagnosis or treatment. This ensures that POCT is not just a screening tool, but a gateway to comprehensive care. A robust system for recording and tracking anemia screening results is critical. This system should be secure, confidential, and compliant with data protection regulations. Effective data management allows for monitoring the program's effectiveness, identifying trends, and generating reports that can inform decision-making and resource allocation. Conducting a thorough cost-effectiveness analysis is essential. This involves comparing the costs of POCT with those of traditional anemia screening methods, considering factors such as equipment, consumables, personnel time, and transportation. Demonstrating the cost-effectiveness of POCT can be crucial in securing funding and ensuring the program's long-term affordability within the school's budget. Engaging parents and the wider community is essential for creating a supportive environment for POCT. This can involve organizing awareness campaigns to educate about anemia, providing educational materials, and addressing any concerns or misconceptions about the screening process. Community buy-in can increase participation rates and promote the long-term success of the program. A sustainable POCT program requires a long-term vision. This includes developing strategies for ongoing funding, ensuring continuous staff training and competency assessment, and establishing a framework for program evaluation and improvement. Regular review and adaptation of the program can ensure its relevance and effectiveness over time. POCT brings anemia screening directly to the students, improving access, particularly in resource-constrained settings or communities with limited access to healthcare facilities. This can significantly reduce barriers to screening and ensure that more students receive the necessary testing. By providing convenient and accessible screening, POCT facilitates early detection of anemia. This allows for timely intervention, such as iron supplementation or dietary counseling, preventing potential health consequences and improving academic performance. The presence of POCT in schools can raise awareness of anemia among students, parents, and the school community. This can promote health education and prevention efforts, encouraging healthy lifestyle choices and reducing the prevalence of anemia. POCT can empower students to take an active role in their health. By receiving immediate feedback on their hemoglobin levels, they can be involved in their own care and make informed decisions in consultation with healthcare providers. POCT can potentially be more cost-effective than traditional anemia screening methods, particularly when considering the costs associated with travel, laboratory fees, and lost productivity due to missed school days.[18-20]

## 4. Conclusion

This study underscores the potential of POCT for hemoglobin as a valuable tool for early anemia detection in adolescent girls. By integrating POCT into school health programs, we can facilitate timely interventions and improve anemia management. This not only enhances the well-being of these young individuals but also contributes to their academic success and future prospects. Further research is needed to evaluate the effectiveness of POCT-based screening programs and their impact on anemia

prevalence in this population. The high prevalence of anemia among the participants highlights the urgent need for effective anemia screening and management strategies. Menstrual blood loss, dietary habits, and lack of awareness about anemia were identified as contributing factors. The positive perception of POCT among participants suggests that it could be a feasible and acceptable method for anemia screening in this population. However, concerns regarding the accuracy of the test and the need for trained personnel to interpret the results need to be addressed. In conclusion, this study provides valuable insights into the feasibility and acceptability of POCT for anemia detection among adolescent girls in an Indonesian school setting. The findings highlight the potential of POCT to overcome barriers to anemia screening and facilitate early detection and management. By integrating POCT into school health programs, we can empower adolescent girls to take control of their health and prevent the negative consequences associated with anemia. Further research is needed to evaluate the long-term impact of POCT-based screening programs on anemia prevalence and to develop comprehensive strategies for anemia prevention and control in this population.

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