Effect of Peer Education on Knowledge and Attitudes Toward Menstrual Hygiene Management Among Boarding School Students

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ABSTRACT

Background: *More than half of adolescents in low- and middle-income countries feel unprepared for menarche due to a lack of menstrual knowledge, which leads to poor menstrual hygiene practices that increase reproductive health risks. Peer education leverages adolescents' natural dependence on peers for sensitive issues and is especially vital in environments with limited information, such as boarding schools. This study aimed to evaluate the effectiveness of peer education in enhancing Menstrual Hygiene Management (MHM) knowledge and attitudes among female students in a boarding school and to explore their experiences with this intervention.*

Method: *An explanatory sequential mixed-methods design was employed. The quantitative phase involved a One Group Pre-test Post-test design with 31 purposively selected students to assess changes in knowledge and attitude following the peer education intervention. Five trained peer educators conducted 120-minute sessions using standardized modules. Quantitative data were analyzed using paired t-tests and N-gain scores. The qualitative phase adopted a phenomenological approach with in-depth interviews involving six primary informants (students) and five supporting informants (peer educators) to explore the intervention experiences and the mechanisms behind observed changes. Qualitative data were analyzed thematically with source triangulation to enhance credibility.*

Result*: Mean knowledge scores increased significantly from 30.10 to 72.04 ($p<0.001$, N-gain=0.612, moderate effectiveness), with the largest improvement in pad disposal knowledge (90.3 percentage points). Mean attitude scores rose from 54.41 to 80.72 ($p<0.001$, N-gain=0.586, moderate effectiveness). Students gained evidence-based knowledge, corrected menstrual myths, and expressed readiness to adopt proper hygiene practices. However, deeply rooted cultural beliefs remained resistant after a single session. The findings confirmed that knowledge improvements do not automatically lead to uniform behavioral change. Boarding schools should implement multiple-session peer education programs with spaced repetition, invest in peer educator training, establish student-led health clubs, and incorporate a formal MHM curriculum before menarche.*

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INTRODUCTION

More than half of adolescents in low- and middle-income countries (LMICs) feel unprepared for menarche due to limited menstrual knowledge. In Laos, 97% of adolescents demonstrate insufficient understanding of menstruation, while studies from Ethiopia and Pakistan show similar issues at 68.3% and 77.7%, respectively.(1,2) A similar situation exists in Indonesia, where the Indonesian Demographic and Health Survey (IDHS) indicates that over 50% of adolescents lack adequate menstrual knowledge. These patterns are heavily influenced by cultural norms that portray menstruation as taboo, shameful, or impure, discouraging open discussion. As a result, many rely on informal sources such as mothers, sisters, or peers, whose guidance often reflects outdated beliefs rather than evidence-based information.(3) Even when adolescents receive some information, misconceptions remain. Research among junior high school students found that, although most recognized menstruation as a physiological process, nearly 90% could not correctly identify the source

of menstrual blood, exposing significant gaps in reproductive health literacy.(4)

Knowledge significantly influences adolescents' attitudes and hygiene practices during menstruation.(5) Adolescents with good knowledge tend to adopt safer practices, while those with limited knowledge often engage in inadequate menstrual hygiene behaviors.(1) In Indonesia, approximately 63.9% of adolescent girls have poor menstrual hygiene habits.(6) Previous studies show that 56.6% of adolescents change their pads after more than four hours, 79% never change pads at school, and 59.8% do not wash their hands before and after changing pads.(7) Poor menstrual hygiene increases the risk of reproductive tract infections (RTIs), which affect 50-60% of women at least once in their lives, including bacterial vaginosis (8-75%) and vulvovaginal candidiasis (20-75%). Although these conditions are not always life-threatening, they can lead to serious complications such as ectopic pregnancy, sepsis, cervical cancer, infertility, and congenital infections in newborns.(8–10) Because these risks can be prevented, effective educational interventions are urgently needed.

The Menstrual Hygiene Management (MHM) program was introduced to improve adolescents' knowledge and practices related to menstrual health. The program promotes key behaviors such as using clean menstrual products, changing pads every 3-4 hours, washing hands before and after pad changes, carefully wrapping used pads before disposal, thoroughly cleaning the genital area, and washing reusable pads when enough water is available. Its implementation includes providing access to evidence-based information and MHM-friendly sanitation facilities. However, in practice, schools often focus more on improving sanitation facilities than delivering information. Additionally, formal MHM curricula have not been integrated into school programs. Although educational materials like booklets and campaigns are available, the information delivery is often one-sided and lacks interactive engagement, which limits progress in adolescents' understanding.(5) These issues emphasize the need for intervention models that move beyond passive information sharing and encourage participatory, peer-driven approaches that match adolescents' developmental needs and social preferences.

These challenges become even more serious in boarding schools, where structural restrictions greatly limit access to accurate information. The study site, a boarding school in West Sumatra, illustrates this situation. Students live under constant supervision with strict rules designed to keep their focus on religious and academic education: mobile phones are banned, parental communication is limited to supervised visits that only happen during designated holidays, and access to external health information sources is minimal. The school does not have formal health education programs, health-related clubs, or reproductive health guidance. Menstrual hygiene is briefly addressed in religious studies focused on ritual purification for worship rather than health practices or hygiene behaviors. This situation causes students not only to lack access to accurate information but also to face cultural discouragement from seeking it. Under these conditions, students rely almost entirely on their peers and family-transmitted knowledge during occasional visits. However, this informal information often spreads misconceptions instead of correcting them because neither peers nor family usually has evidence-based knowledge. This confirms that menstrual hygiene is frequently overlooked in WASH and school health programs, with no structured guidelines or policies to address menstrual management in boarding schools properly.(11)

Peer education leverages adolescents' natural reliance on peers for sensitive topics. The IDHS reports that 62% of adolescents prefer discussing reproductive health with peers compared to 47% with teachers and 15% with no one. Research shows significant differences between adolescents who receive peer education and those who get one-way information from teachers. Peer-led sessions create a relaxed, engaging environment, allowing students to ask questions and share personal experiences, while teacher-led sessions often lead to discomfort, hierarchical distance, and limited interaction. In boarding schools, where students spend almost all their time with peers and have limited access to information, peer educators serve as trusted insiders who can address questions and concerns students might hesitate to raise with teachers or parents. Peer education also enhances interpersonal relationships, encourages sharing different perspectives, and provides relatable sources of information that increase adolescents' confidence and reinforce existing knowledge. For peer educators, this role deepens their understanding while building confidence and leadership skills.(12,13) These mechanisms align with the social changes during adolescence, when peer influence largely shapes thoughts, emotions, and behaviors.(14)

Despite this potential, research on menstrual hygiene interventions among junior high school students, especially in the Asia-Pacific region, remains limited. Most studies conclude that school-based programs can improve adolescents' knowledge about menstrual health and hygiene. However, several key limitations define this body of research. Previous studies have relied mainly on quantitative measures, typically assessing knowledge through Pre-test and Post-test without exploring how students experience, interpret, or internalize educational interventions. There has been limited in-depth evaluation of how interventions influence attitudes and behavior beyond simple knowledge gains. Evidence on peer education in

boarding schools is particularly scarce, despite the growing need for peer-based information in these restrictive environments.(5,11,15) These gaps highlight the need for research designs that not only measure outcomes but also explore the mechanisms and contextual factors affecting intervention success. Addressing these gaps is vital for developing evidence-based policies. In Indonesia, increasing awareness of reproductive health, including menstrual health and hygiene, is part of the policy strategies outlined in the National Action Plan for Improving the Welfare of School-Age Children and Adolescents. National policies and programs supporting menstrual health services and adolescent health information are among five evidence-based interventions aimed at improving the health and well-being of adolescents.(16)

To address these gaps, this study examines the effectiveness of peer education within a boarding school setting as an alternative source of MHM information. Unlike previous studies that rely only on quantitative measures, this research employs an explanatory sequential mixed-methods design, including in-depth qualitative interviews to explore how students experience and internalize peer education. This approach provides a comprehensive understanding of both the outcomes and the contextual relevance of peer education in improving menstrual hygiene knowledge and attitudes among adolescents in boarding schools. Therefore, this study aims to: (1) evaluate the effectiveness of peer education in improving menstrual hygiene knowledge and attitudes among female students in a boarding school, and (2) explore students' experiences and perspectives regarding peer education as an intervention method.

METHOD

Study design

This study used an explanatory sequential mixed-methods design, involving quantitative data collection and analysis followed by qualitative exploration to clarify and contextualize the results.(17) The quantitative phase employed a One Group Pre-test Post-test design to evaluate the effectiveness of peer education on students' menstrual health management (MHM) knowledge and attitudes. This design was selected because all students lived in shared dormitories with continuous interaction, making the creation of a control group impossible due to inevitable information diffusion, and there was no nearby comparable boarding school for an external control. Although this design has limitations, several factors help mitigate these concerns. The short 30-day interval reduces the likelihood of maturation, as adolescent knowledge typically does not change significantly without intervention. The structured boarding environment, with restricted external communication (no mobile phones, limited parental contact, no internet access), greatly minimizes history effects from competing sources of information. The qualitative phase assessed whether the observed improvements could be attributed to the intervention by directly asking participants what influenced their changes.

The qualitative phase employed a phenomenological approach to explore students' experiences during peer education sessions and gather deeper insights that add context and enhance the quantitative results. In-depth interviews with students and peer educators enabled source triangulation, which improved credibility. Qualitative themes were carefully compared with quantitative trends to strengthen interpretive validity.

Participants and sampling

Student participants

Thirty-one female students participated through purposive sampling, representing a complete enumeration of all eligible students within the bounded boarding school population. Participants were students who had experienced menarche and agreed to take part in the study, while those absent during data collection or who withdrew were excluded. However, all 31 students completed the Pre-test, intervention, and Post-test without dropping out.

Peer educators

Five peer educators served as intervention facilitators. The dormitory supervisor, who was familiar with students' interpersonal dynamics, identified candidates who demonstrated leadership, effective communication, comfort discussing sensitive topics, accuracy in sharing information, the ability to correct misconceptions, and the capacity to foster supportive learning environments, using a peer educator checklist.(18)

Selected candidates participated in an intensive one-day training that covered: content knowledge (menstrual physiology, evidence-based hygiene practices, and myth correction); facilitation skills (active listening, probing questions, managing group dynamics, and creating safe spaces); and practical application through role-play and scenario-based exercises. Training materials included a standardized module and UNICEF's *"Apa Itu Menstruasi?"*. After the training, candidates took a Post-test to evaluate their content knowledge and facilitation skills. Those who scored 80% or higher (Bloom's mastery threshold) qualified to lead interventions.(18) All five candidates met this standard, and each was assigned 6-7 students to maintain an optimal peer education group size.

Qualitative informants

The included primary informants, six students who completed all intervention stages, and supporting informants, five peer educators. The primary informants were purposively chosen to ensure at least one student from

each discussion group and to reflectively share their experiences. Data saturation was achieved after six interviews, consistent with phenomenological research guidelines.(17) Supporting informants provided additional insights into group dynamics and facilitation, allowing for source triangulation to improve credibility.

Instruments

The knowledge questionnaire (15 multiple-choice items) and attitude questionnaire (15 Likert-scale statements) were aligned with UNICEF Guidance for Monitoring Menstrual Health and Hygiene.(19) Validity and reliability testing confirmed their appropriateness: knowledge questionnaire ($r>0.514$, $p<0.05$, Cronbach's Alpha = 0.831) and attitude questionnaire ($r>0.514$, $p<0.05$, Cronbach's Alpha = 0.861).

Intervention procedure

Quantitative phase

Pre-test: Participants completed a 40-minute Pre-test to evaluate baseline MHM knowledge and attitudes, including respondent characteristics, 15 knowledge questions, and 15 attitude statements, all conducted in a supervised classroom to maintain standardized conditions.

Intervention: Each peer educator guided 6-7 students through the standardized module and UNICEF's "Apa Itu Menstruasi?". The sessions lasted 120 minutes and followed a structured agenda: opening and rapport-building (10 minutes); Session 1 on MHM and health, covering menstrual physiology and myths (50 minutes); a break (10 minutes); and Session 2 on MHM and hygiene, addressing pad changing frequency, handwashing protocols, proper disposal, and genital hygiene (50 minutes). The module outlined time allocations, discussion prompts, and myth-correction examples to ensure consistent content across groups. No adults were present during sessions to maintain peer-to-peer authenticity, as adult presence could create hierarchical dynamics and hinder open discussion of sensitive topics. Process insights were gathered retrospectively through qualitative interviews, avoiding Hawthorne effects and allowing a comprehensive understanding of intervention dynamics. Intervention completion was consistent across groups once all content was delivered and no further discussion occurred, ensuring comparable exposure.

Post-test: Conducted 30 days after the intervention using the same instruments and conditions (40 minutes, supervised classroom). The 30-day interval allowed for information internalization and attitude stabilization while reducing knowledge decay or external exposure. All 31 participants completed the Post-test.

Qualitative phase

Six students who completed all intervention stages were selected as primary informants for in-depth interviews. Individual interviews using semi-structured guides examined three themes: knowledge changes (initial understanding, newly learned concepts, myth correction); attitude changes (perceptions and willingness to practice hygiene); and peer education experiences. The interview guides were created based on patterns in quantitative data, allowing targeted exploration of observed trends. Peer educators were also interviewed as supporting informants to provide insights on group dynamics and facilitation challenges. Interviews lasted about 30 minutes, were audio-recorded with consent, and used probing techniques to ensure thorough exploration.

Data analysis

Descriptive statistics (frequencies, means, standard deviations, minimum-maximum values) summarized respondent characteristics and Pre-test Post-test scores. Paired t-tests compared mean scores before and after the intervention (significance at $p < 0.05$). Normalized gain (N-gain) scores measured improvement magnitude relative to the maximum possible increase, accounting for ceiling effects: N-gain scores were categorized as low (<0.3), moderate (0.3-0.7), or high (>0.7). Interview transcripts were analyzed thematically. Credibility was enhanced through source triangulation, which involved comparing student and peer educator perspectives. The primary researcher and a second coder independently reviewed transcripts, compared coding decisions, and discussed discrepancies until reaching consensus to reduce subjective bias. Integration of quantitative and qualitative findings occurred during interpretation using a connecting-and-explaining approach. Quantitative results identified patterns of changes in knowledge and attitudes; qualitative themes described how participants interpreted, experienced, and internalized peer education. This combined approach provided a comprehensive understanding of the mechanisms behind the observed improvements.

Ethical considerations

Ethical approval was obtained from Universitas Andalas Health Research Ethics Committee (No. 84/UN.16.2/KEP-FK/2025). Participation was entirely voluntary, and all participants provided written informed consent. Confidentiality and anonymity were maintained throughout the study. Published results only identify participants by alphanumeric codes (e.g., IN1 for informant 1, PS1 for peer educator 1).

RESULT AND DISCUSSION

Table 1. Distribution of respondents' characteristics

Variable	f	%
Current age		
12 years	4	12.9
13 years	12	38.7
14 years	8	25.8
15 years	7	22.6
Age at menarche		
<12 years	20	64.5
12-13 years	8	25.8
>13 years	3	9.7
Experience of receiving information about menstruation		
Yes	31	100.0
No	0	0.0
Timing of receiving information		
Before menarche	15	48.4
After menarche	16	51.6
Sources of menstrual information*		
Mother	27	87.1
Friend	12	38.7
Teacher	8	25.8
Printed Media	1	3.2
Internet / social media	15	48.4
Total	31	100

Note: Respondents could select multiple options

Age and age at menarche

As shown in Table 1, most respondents were 13 years old (38.7%), consistent with typical menarche age ranges (10-16 years, average 12.4 years).(20) Notably, the majority experienced menarche before age 12 (64.5%), with all informants reporting menarche at ages 10-11 while in elementary school. Recent evidence supports a continued decline in the age at menarche. Statistics Indonesia reports that over the past five years, the proportion of adolescents experiencing menarche at or before age 12 has increased, while the proportion experiencing it at 13 years or older has decreased.(21)

The narratives from participants in this study further support this broader trend of earlier menstruation onset among adolescents. Nutritional factors, especially high dietary fiber intake, have been identified as significant influences on menarcheal age.(22) Considering this earlier start, providing adequate psychological preparation and appropriate menstrual information for girls is essential.(23)

Experience and timing of receiving information about menstruation

All respondents had received information about menstruation (100%), but more than half (51.6%) only received it after experiencing menarche. Qualitative data showed that most participants felt surprised and confused during their first period. One participant from Group 2 (IN3, age 13, menarche at 10) was an exception, reporting relative calmness after observing her older sister's experience, which shows how prior family exposure can serve as informal preparation. A participant from Group 5 (IN1, age 14, menarche at 10) said: "*I was shocked. I just woke up, and it had already leaked. I told my mother, 'Mom, what is this?' She said it was menstruation*." Another from Group 3 (IN2, age 13, menarche at 11) recalled: "*I thought it wasn't blood, like urine. I had eaten dragon fruit, so I thought it was because of that. But it wasn't, it was menstrual blood*."

Previous studies show that mothers often delay talking about menstruation because they feel uncomfortable or worry that early information might cause curiosity or misunderstandings.(21) Still, getting information after menarche can lead to anxiety and confusion due to a lack of preparation.(22)

Menstruation and menarche are natural processes, but adolescents' psychological reactions are shaped by what they learn. Vague information can affect their emotions, attitudes, and behaviors during menarche and menstruation, fostering the idea that menstruation is taboo and embarrassing. As a result, adolescents might react negatively when menarche occurs. However, with the right information and enough support beforehand, they can respond to menarche and menstruation in a more positive way.(3,24) UNICEF stresses that understanding the biological and physiological aspects of menstruation boosts self-confidence and promotes healthier hygiene habits.(25)

Source of information about menstruation

Most respondents received menstrual information mostly from their mothers (87.1%), followed by the internet and social media (48.4%) and friends (38.7%). Teachers provided only 25.8%, showing limited formal health education. Qualitative results showed troubling patterns. Most of the information they got involved menstrual myths, like restrictions on cutting nails or washing hair during menstruation and certain foods like cucumbers or cold drinks.

Participants from Groups 2, 3, 5, and 6 said they received such info: "*They said we can't cut nails when menstruating and can't wash hair.*" (IN2, IN5, IN6). One person explained: "*They said we can't eat cucumber. Cucumber causes excessive vaginal discharge, so it's forbidden. Also, we can't wash our hair.*" (IN1). Similar findings showed mothers were the predominant information source, followed by older sisters. Although menstruation is an uncomfortable topic to discuss, mothers and female siblings play a crucial role in conveying information about physiological changes as well as social, emotional, and cultural issues. However, the credibility of menstruation-related details provided by them requires attention, as they

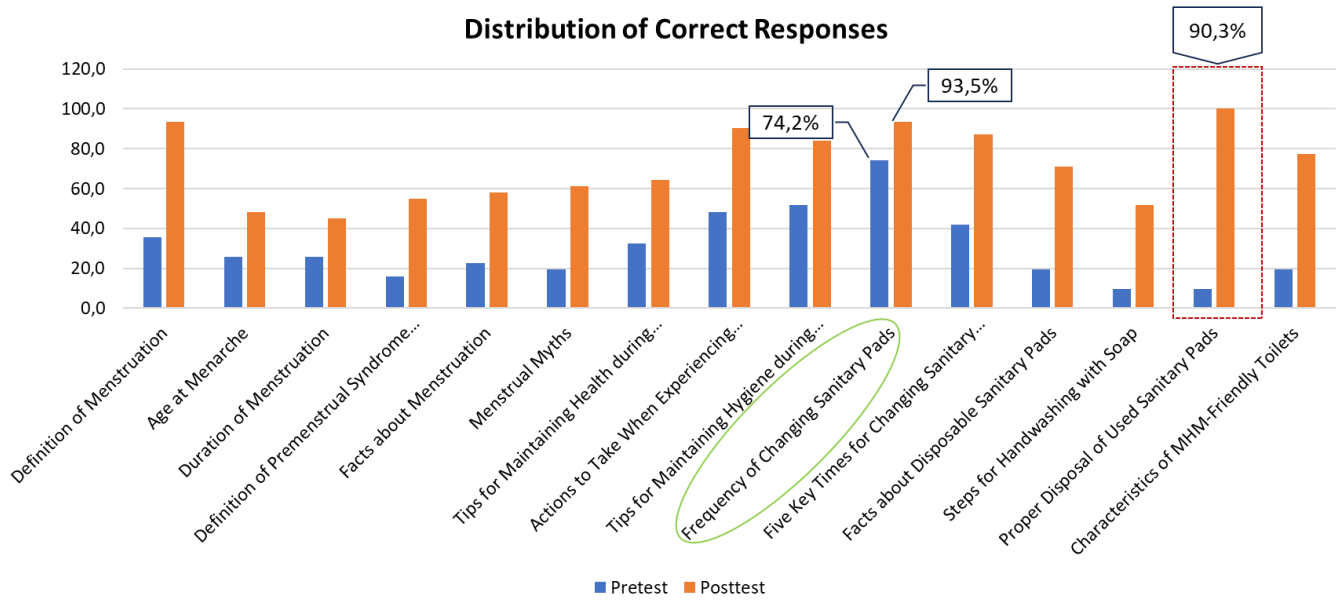

Figure 1. Distribution of correct responses for each knowledge item before and after the peer education intervention

may have misinformation about menstruation that could be passed down to adolescents.(2) Cultural beliefs support the spread of misinformation, myths, and taboos about menstruation. Even if many people do not fully believe these myths, they often avoid challenging them out of fear of consequences. These prohibitions are usually passed down through generations by mothers, friends, family members, and teachers. Therefore, providing adolescent girls with accurate and evidence-based information is essential to effectively help them manage menstrual health.(2,3)

Figure 1 illustrates clear improvements across all knowledge items from Pre-test to Post-test. Three distinct patterns emerge: items with high baseline accuracy showing moderate gains (e.g., pad-changing frequency); items with significant improvements from nearly zero at baseline (e.g., pad disposal methods); and items with minimal gains despite intervention (e.g., menstruation duration, menarche age, menstrual myths). These patterns indicate different levels of difficulty in learning and the uneven impact of peer education across content areas

Question 10 (recommended pad-changing frequency) showed a high baseline accuracy of 74.2%, which increased to 93.5% after intervention, reflecting a moderate 19.3 percentage point improvement. This suggests prior familiarity through personal experience, with peer education offering additional reinforcement. Sanitary pads should be changed every 3-4 hours (excluding sleep), about four times daily. Bacterial growth can reach up to 512 times its original level within three hours, and pads used for more than two hours may contain up to 10^7 bacteria per square centimeter. Such rapid bacterial growth raises the risk of irritation and infection, making regular changing a hygiene necessity rather than just a recommendation.(25,26)

Question 14 (proper pad disposal) showed the greatest improvement (90.3 percentage points), increasing from just 9.7% to 100% correct responses. This significant change occurred because disposal methods were nearly unknown before the intervention. Students did not realize that used pads should be wrapped in paper or plastic before disposal. Qualitative data clarified this gap. Participants from Groups 1, 3, and 5 described previous habits of throwing unwrapped pads directly into the trash or washing reusable pads without understanding hygiene concerns. After the intervention, most students from Groups 2, 3, 4, and 5 reported wrapping used pads properly: "*I wrap it in a plastic bag, then throw it in the trash*" (IN3, IN4, IN5, IN6). This shift in behavior demonstrates that peer education improved not only knowledge but also actual hygiene practices.(12)

Items with modest improvements included Question 3 on menstruation duration (a 19.4 percentage point increase, from 25.8% to 45.2%) and Question 2 on menarche age (a 22.6 percentage point increase, from 25.8% to 48.4%). These smaller gains suggest that basic physiological knowledge may require different teaching methods or more time for effective understanding. Question 6 on menstrual myths (a 41.9 percentage point increase, from 19.4% to 61.3%) showed moderate progress, indicating that deeply ingrained cultural beliefs need more intensive efforts despite significant exposure to accurate information.

Mean knowledge scores increased significantly from 30.10 (SD=11.90, range: 13.33-53.33) to 72.04 (SD=11.47, range: 53.33-93.33), reflecting an average gain of 41.94 points. This indicates a large effect size ($d > 0.8$). Paired t-test results ($p < 0.001$) confirmed the statistical significance. The N-gain score of 0.612 categorizes

intervention effectiveness as moderate (0.3-0.7), showing substantial knowledge improvement with potential for further enhancement through additional sessions or reinforcement. These findings are consistent with previous research by Dwivedi et al. (2020), which reported significant differences in students' knowledge before and after peer education ($p < 0.001$).(27) A systematic review identified peer education as effective in improving adolescents' knowledge and personal hygiene practices during menstruation, addressing taboo topics, and fostering comfortable learning environments for sensitive subjects.(28)

Integration: what students learned and how

After participating in peer education, all students reported gaining new, evidence-based knowledge that corrected previous misconceptions. They learned proper hygiene practices, including the importance of handwashing before changing pads and the correct disposal of single-use pads. Students demonstrated increased awareness of menstrual physiological processes and actively engaged in discussions. Peer educators observed high participation, with frequent questions and appreciation for explanations using relatable, everyday language. One peer educator (PS1, age 15, Group 1) noted: "*They listened attentively, nodding along. They asked questions, like what happens during the fertile period after menstruation*." This highlights the effectiveness of peer-led approaches in creating a safe, interactive, and supportive environment for discussing sensitive health topics.(12,27,28)

Qualitative findings provided insight into the significant improvement in pad disposal knowledge observed through quantitative measures. This almost universal knowledge gap prior to the intervention explains the substantial gains seen afterward. When students are introduced to entirely new information that fills a complete knowledge void, their adoption rates tend to be higher compared to correcting partial knowledge or misconceptions. The behavioral outcome, with most students immediately adopting wrapping practices, indicates that peer education improved not only knowledge but also actual hygiene behaviors.(12)

The challenge of correcting myths

The most notable change observed was the correction of menstrual myths. Participants recognized that restrictions such as avoiding nail cutting, hair washing, or eating certain foods during menstruation lack a scientific basis. A participant from Group 4 (IN5, age 14) said: "*I used to think we couldn't wash hair or cut nails during menstruation. Now I know that's not true*." Similarly, another from Group 3 (IN2, age 13) commented: "*Turns out we should wash our hands before changing pads. And about myths versus facts, like not being able to cut nails or wash hair, those aren't true*." Despite these positive outcomes, addressing myths remained challenging. Several participants continued questioning the accuracy of information because their previous beliefs were deeply rooted and reinforced by family stories and personal experiences.

One participant from Group 5 (IN1, age 14) expressed doubt: "*I'm confused about cucumber. I once ate cucumber and had a lot of vaginal discharge afterward*." Peer educators noted that myth-related discussions, such as prohibitions against cutting nails, washing hair, and food or drink restrictions, were the most controversial parts of the sessions. Peer educator PS4 said: "*Many people argued against the myth that you shouldn't drink cold water during menstruation*." Another participant (PS5, age 14) explained: "*We said it's different. Cold drinks affect the digestive system, not menstruation. But they said whenever they drink cold water during menstruation, their bleeding stops. We responded that it's just coincidence and explained why there's no connection*."

The persistence of these beliefs demonstrates that long-standing cultural norms cannot be changed with just one explanation. They require thorough clarification, patient conversations, and repeated exposure to accurate information to shift understanding gradually. This finding highlights a key limitation of interventions: single-session formats may not be sufficient for deeply rooted cultural beliefs that need ongoing engagement and changes in social norms.(29)

Table 2. Difference in knowledge scores before and after peer education

Knowledge of MHM	Mean	SD	Min-Max	N-Gain score	P-value
Before peer education	30.10	11.90	13.33-53.33	0.612	0.000
After peer education	72.04	11.47	53.33-93.33		

Changes in students' attitude of menstrual hygiene management (MHM) before and after peer education

The attitude questionnaire included both positive and negative statements. Overall patterns showed: significant changes in attitudes directly linked to new knowledge (e.g., pad disposal, handwashing); moderate changes toward rejecting misconceptions (e.g., pad-changing necessity); and limited shifts on culturally ingrained attitudes (e.g., activity restrictions, purchasing discomfort). These patterns suggest that knowledge-based interventions effectively change attitudes when addressing information gaps but face greater challenges when confronting deeply rooted cultural norms or personal discomfort.

As Figure 2 demonstrates, positive statements display different patterns of change in Strongly Agree (SA) response proportions from Pre-test to Post-test. Statement 12, "*I must wrap my sanitary pad before disposal*," experienced the greatest improvement (83.9 percentage points), increasing from 0% to 83.9% SA responses. This significant shift directly correlates with a major increase in knowledge about proper pad disposal (Question 14, 90.3 percentage points), showing a strong link between knowledge and attitude, where new information about an almost entirely unknown practice led to firm attitudinal conviction. Other positive statements, like Statement 8, "*I must wash my hands before and after changing sanitary pad,"* also saw a substantial increase in attitude, with SA responses rising 67.7 percentage points (from 9.7% to 77.4%). Handwashing with soap, which should ideally last 40-60 seconds and follow six recommended steps (30), is another practice that benefited from peer education. The large increase in SA responses indicates that this educational effort successfully raised awareness and emphasized this practice among students.

For negative statements (Figure 3), distinct patterns emerged. Statement 7, "*In my opinion, changing sanitary pads during menstruation is not necessary unless it leaks*.", showed the most significant change, with Strongly Disagree (SD) responses jumping sharply from 12.9% to 64.5% (a 51.6 percentage point increase). This demonstrates a clear rejection of the misconception, reflecting increased awareness that regular pad changing is important regardless of saturation. The high SD percentage indicates a strong conviction, not just passive disagreement.

Statement 3, "*I must limit my physical activities during menstruation*," showed notable improvement, with Disagree responses significantly increasing from 64.5% to 74.2%. However, SD responses remained at 0% both before and after. This pattern suggests students moved toward rejecting activity limitations but had not yet firmly committed (SD level) to dismissing this cultural belief entirely. Statement 5, "I feel uncomfortable when buying sanitary pads at school or stores," similarly showed no change in SD responses (stayed at 0%).

Most students selected Disagree, but the lack of SD movement indicates that discomfort-related attitudes may be deeply rooted in personal feelings and social stigma, which require more than just knowledge-based interventions. Informants mentioned that the school provided sanitary pads at the canteen, but students were hesitant to buy them because the canteen staff were male, causing embarrassment. As alternatives, they brought supplies from home, requested package deliveries, or asked female teachers (ustadzah) with outside access to purchase them.

Although the proportions of Disagree responses generally increased across negative statements, limited SD response increases for some items, particularly Statements 3 and 5, suggest that students had not yet developed a strong conviction to reject these statements fully. While attitudes showed movement toward more positive directions, the shifts had not reached levels of strong internalization or confidence, possibly reflecting the persistent influence of cultural norms in the boarding school environment, where single-session interventions may not be enough to address menstruation-related discomfort, physical activity beliefs, or stigma.

Mean attitude scores increased from 54.41 (SD=6.51, range: 42.22-64.44) to 80.72 (SD=5.72, range: 68.89-91.11), showing an average gain of 26.31 points. This change is statistically significant ($p < 0.001$) with a large effect size. The N-gain score of 0.586 indicates moderate intervention effectiveness (0.3-0.7), similar to the knowledge domain. These results align with previous research by Kumalasari et al. (2025), which found significant differences in female students' attitudes before and after peer education ($p < 0.001$).(31)

Integration: attitude shifts and behavioral readiness

Attitude formation generally occurs in stages: receiving, responding, valuing, and taking responsibility. Attitude does not change instantly but through internalized processes. Peer education facilitates this process through cognitive restructuring, as students engage in open dialogue that allows free expression of opinions without fear or embarrassment. This interactive and personal approach fosters deeper understanding and attitudinal change.(28,31) Participatory learning methods that actively involve students enhance critical thinking and strengthen adolescents' assertive attitudes.(32)

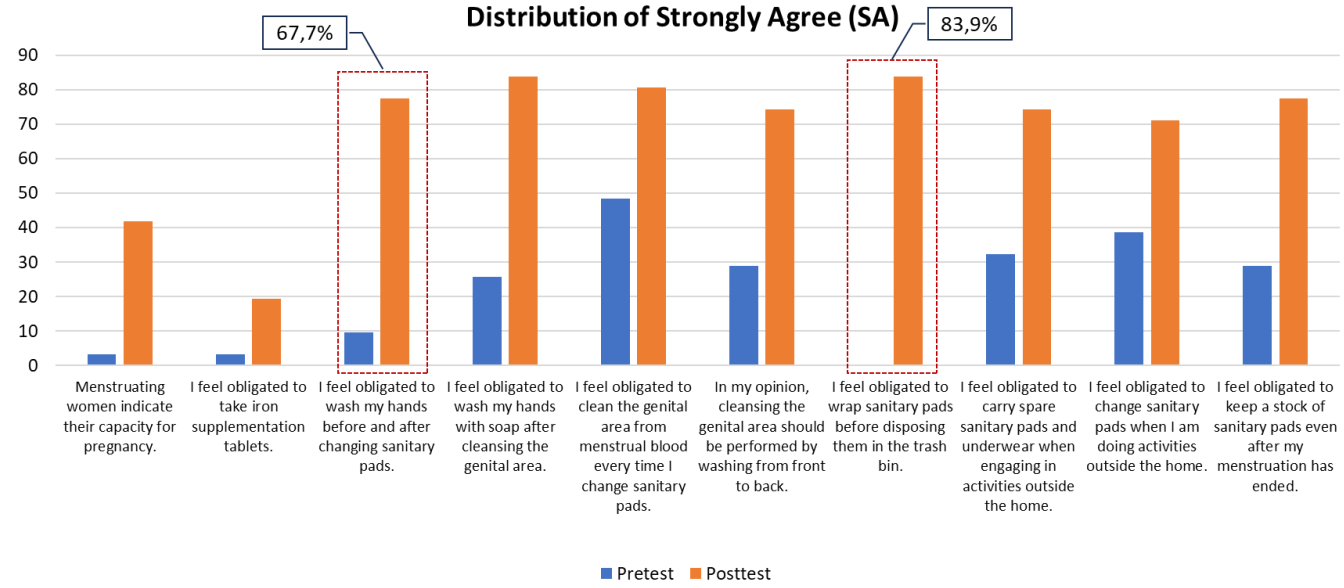

Figure 2. Frequency distribution of strongly agree (SA) responses for positive statement before and after the peer education intervention

Qualitative findings reinforced the quantitative results and offered deeper insight into how attitude change happens. All informants reported shifts in their views on the importance of proper MHM. Several explicitly mentioned becoming more aware of hygienic practices during menstruation and expressed a willingness to adopt healthier behaviors. A participant from Group 3 (IN2, age 13) stated: "*I became more aware of what cleanliness during menstruation means, what's allowed during menstruation, and that we should change pads frequently*." Another from Group 2 (IN3, age 13) noted: "*I used to do it when I was in elementary school, but after learning those were myths, I stopped. Now I don't do it anymore*." This suggests that peer education not only improves understanding but also encourages readiness to apply knowledge in daily life. Peer education serves as an effective bridge between knowledge, attitude, and behavior by motivating individuals to internalize health information and act on it, ultimately boosting health literacy and fostering more positive attitudes toward healthy practices.(31)

The modest improvements in attitude scores, especially for some items showing ceiling effects or small gains despite significant increases in knowledge, suggest that transforming knowledge into firmly held attitudes requires more than just providing information. It also involves opportunities for practice, social reinforcement, and environmental support. The boarding school environment, while fostering peer influence, may also create structural barriers (e.g., limited privacy, shared facilities) that impede the solidification of attitudes toward certain practices.(11,29)

Behavioral indicators: variable adoption rates

The integration of quantitative and qualitative data clarifies the connection between attitude change and behavior. Regarding pad disposal, the notable increase in knowledge (90.3 percentage points), combined with an equally significant attitude shift (Statement 12: 0% to 83.9% SA, 83.9 percentage points), strongly led to behavioral adoption.

Most students from Groups 2, 3, 4, and 5 reported wrapping the pads properly after the intervention. As one participant (IN6, age 13, Group 3) said: "*I put it in a bag first, then throw it in the trash*." This behavioral change reflects the strengthening of subjective norms and perceived behavioral control, as described in the Theory of Planned Behavior, where peer influence and social modeling in boarding schools created supportive normative environments that facilitated behavior change when both knowledge and attitude shifted significantly.(33)

Regarding handwashing (Statement 8), interview findings showed that most students started washing their hands regularly before and after changing pads, but they have not yet mastered all six proper steps. Participants from Groups 2, 3, 4, and 5 mentioned: "*I wash my hands, but I haven't memorized the steps yet. I just wash normally.*" (IN3, IN4, IN5, IN6). This indicates that although awareness and positive attitudes toward hand hygiene were developed through attitude change, ongoing reinforcement of knowledge and skills is needed for consistent correct technique adherence.(29,34)

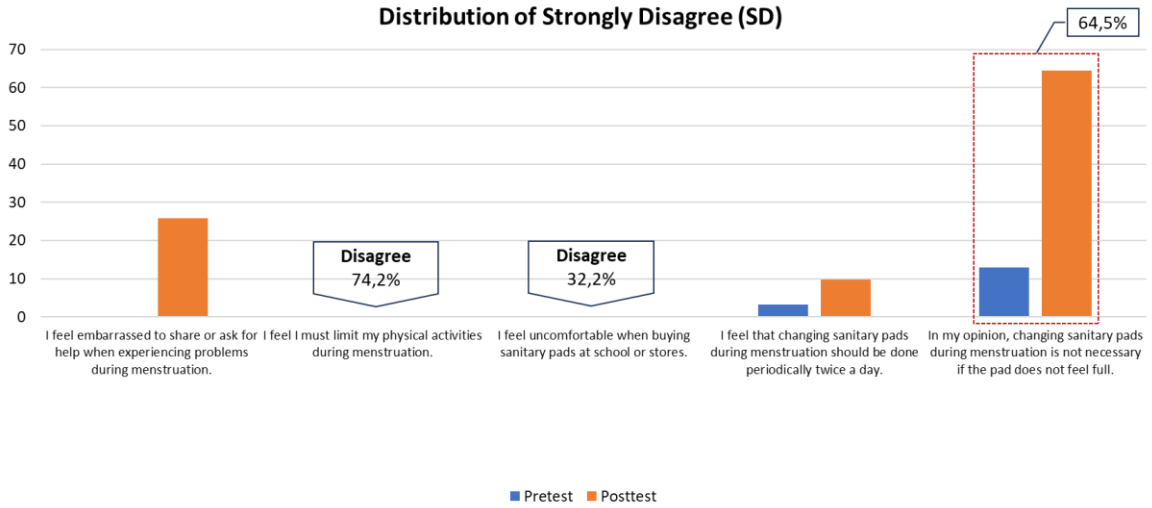

Figure 3. Frequency distribution of strongly disagree (sd) responses to negative statements before and after peer education intervention

Table 3. Difference in attitude scores before and after peer education

Attitude of MHM	Mean	SD	Min-Max	N-Gain score	P-value
Before peer education	54.41	6.51	42.22-64.44	0.586	0.000
After peer education	80.72	5.72	68.89-91.11		

Table 4. Qualitative themes on knowledge and attitude change after peer education

Theme	Category	Representative quotes	Informant code
Knowledge change	Correction of menstrual myths	"*I used to think we couldn't wash hair or cut nails during menstruation. Now I know that's not true*."	IN5 (Group 4, age 14)
	Learning new hygiene practices	"*Turns out we should wash our hands before changing pads. And that disposable pads don't need to be washed*."	IN2 (Group 3, age 13)
	Persistent doubts about myths	"*I'm confused about cucumber. I once ate cucumber and had a lot of vaginal discharge afterward*."	IN1 (Group 5, age 14)
	Active peer engagement	"*They asked a lot of questions, like why we don't have to wash disposable pads*."	PS2, PS4 (Peer Educators)
Attitude change	Increased awareness of MHM importance	"*I became more aware of what cleanliness during menstruation means and that we should change pads frequently*."	IN2 (Group 3, age 13)
	Readiness to change behavior	"*After getting this information, they started practicing it*."	PS1 (Peer Educator, age 15)
	Variation in behavior adoption	"*Four times a day... whenever there's an opportunity, I change*." vs. "*Usually when it's full or when I take a bath*."	IN6 vs. IN1
Behavioral indicators	Proper pad disposal	"*I wrap it in a plastic bag first, then throw it in the trash*."	IN3, IN4, IN5, IN6
	Handwashing practice	"*I wash my hands, but I haven't memorized the steps yet. I just wash normally*."	IN3, IN4, IN5, IN6
	Increased pad-changing frequency	"*Now I change pads five times a day, not waiting until it's full*."	PS5 (Peer Educator, age 14)

Notable variation appeared in pad-changing practices. Among all informants, four reported changing pads multiple times daily (≥4 times) without waiting for saturation: "*Four times a day. In the morning before bathing, during lunch or midday break, in the afternoon, and at night*." (IN6). Two informants still tended to wait until pads were fully saturated. Participants from Groups 5 and 3 stated: "*Usually when it's full or when I take a bath."* (IN1) and "*Sometimes three times, sometimes two. When it's full, then I change*." (IN2).

Although pad-changing frequency was one of the highest correct-response knowledge items in both Pre-test and Post-test, knowledge improvement did not necessarily translate into uniform behavioral change across all participants. This variation indicates that individuals adopt new behaviors at different rates, reinforcing that behavioral change is gradual, requiring time and ongoing adjustment. This aligns with the Transtheoretical Model of behavior change, which suggests individuals progress through readiness stages at different speeds. The two who continued old practices despite gaining knowledge indicate that other factors, such as habit strength, perceived convenience, time constraints, or self-efficacy, influence whether behaviors are adopted beyond just knowledge and attitudes.(33,35) To systematically present the qualitative data supporting the quantitative results discussed above, Table 4 summarizes the key themes, categories, and representative quotes from in-depth interviews with participants and peer educators.

Effectiveness of peer education in enhancing students' knowledge and attitudes toward menstrual hygiene management (MHM)

The peer education intervention showed moderate effectiveness in improving students' knowledge and attitudes about menstrual hygiene management (MHM), with N-gain scores of 0.612 for knowledge and 0.586 for attitudes (both in the 0.3-0.7 moderate range). Mean knowledge scores increased by 41.94 points (from 30.10 to 72.04), and attitude scores rose by 26.31 points (from 54.41 to 80.72), indicating large effect sizes with statistical significance ($p < 0.001$).

These results can be explained by psychological and social mechanisms inherent to adolescent development. During this period, the brain undergoes social reorientation, where individuals become more sensitive to peer feedback and information while gradually shifting social focus from family to peer groups. As adolescents spend most of their time with peers, peer influence becomes a dominant force shaping thoughts, emotions, and behaviors.(14) Self-determination theory similarly emphasizes that relatedness, or personal social relationships within communities like peer groups, influences basic human needs. Since adolescents interact more with peers than with parents or teachers, their behavior is more influenced by peer-delivered information.(7) Peer education strategically leverages these developmental processes by delivering information from socially relevant and credible sources, which facilitates meaningful improvements in knowledge and attitudes.

The boarding school environment further boosted the effectiveness of peer education through its unique features. Shared living spaces promoted ongoing peer interactions during everyday informal activities, increasing opportunities for social learning. As one peer educator (PS1) mentioned, "*After we shared this information, they started practicing it together,"* demonstrating social norming as students aligned their actions with group practices. Because peer educators were close in age and shared the same cultural background, they were seen as credible role models, making hygiene practices seem achievable and standard rather than externally imposed. Sessions held without adult supervision also created psychological safety, reducing embarrassment and allowing open discussion about myths and personal habits.(13,31) Furthermore, structural limitations such as restricted phone access, limited parental communication, and the absence of formal health programs positioned peer educators as trusted and vital sources of information in an otherwise limited information environment.

However, the boarding school context also constrained the intervention's effectiveness through several environmental and social barriers. Limited privacy in shared dormitories and communal bathrooms hindered the application of certain practices, which may explain why attitudes related to purchasing discomfort and activity restrictions showed minimal shifts. In addition, collectively held cultural beliefs sometimes caused peer influence to reinforce existing myths rather than correct them, as reflected in persistent doubts about consuming cold drinks and cucumbers despite accurate information being provided. The moderate rather than high N-gain scores also reflect limitations in the intervention design, as a single 120-minute session offered insufficient opportunity for information consolidation. Consistent with the Ebbinghaus Forgetting Curve, one-time exposures are prone to rapid information loss without repetition. Educational psychology emphasizes the importance of structured reinforcement to support long-term retention. Without booster sessions, students lacked opportunities to revisit key messages, resolve lingering uncertainties, and deepen their understanding, while the rigid boarding school schedule further restricted extended peer discussions. Moreover, single-session interventions are inadequate for contextualizing health messages within cultural norms or fostering sustained behavioral change. These findings align with previous research demonstrating that although peer education can create supportive learning environments for sensitive topics, single-session interventions generally produce limited long-term effects.(29,32,34)

CONCLUSION

Peer education significantly enhanced MHM knowledge and attitudes among female students in a boarding school, with average increases of 41.94 points for knowledge (from 30.10 to 72.04) and 26.31 points for attitudes (from 54.41 to 80.72), both statistically significant

($p<0.001$), and with large effect sizes and N-gain scores of 0.612 and 0.586, indicating moderate effectiveness. The greatest improvement was observed in pad disposal knowledge (90.3 percentage points), which directly led to behavioral changes.

However, the mixed-methods design revealed that while peer education effectively addressed knowledge gaps and introduced new hygiene practices, deeply rooted cultural myths about menstruation remained resistant to correction in a single session. Additionally, knowledge improvements did not automatically lead to uniform behavioral change, due to differences in self-efficacy, environmental support, and habit strength. This study provides empirical evidence that peer education is vital in information-restricted boarding school settings, where students rely solely on peer educators as their primary trusted sources of information.

Despite these promising findings, study limitations include a One Group Pre-test Post-test that restricts causal inference, a single-session format that limits knowledge consolidation for deeply held beliefs, and a small sample size (n=31) from one boarding school that introduces a limitation affecting generalizability. Boarding schools should implement multi-session peer education programs with spaced repetition to enhance retention and dispel myths, invest in peer educator training, establish student-led health clubs for ongoing support, and incorporate a formal MHM curriculum starting before menarche, along with environmental changes like gender-appropriate facility staff. Future research should evaluate multi-session interventions through controlled trials, measure actual behavior changes via direct observation with long-term follow-up (6-12 months), and assess effectiveness across various boarding school settings.

Conflict of Interest

No potential conflicts of interest relevant to this article were reported.

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