



A VOICE IN THE CHOICE: ADOLESCENT GIRLS’ PARTICIPATION IN MENSTRUAL MATERIAL DECISIONS AND ITS ASSOCIATION WITH REDUCED UNMET NEEDS — EVIDENCE FROM THE AMEHC STUDY

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Academic Session: 2025-2026

A thesis submitted to the BRAC James P Grant School of Public Health in partial fulfilment of the requirements for the degree of
Master of Public Health

BRAC James P Grant School of Public Health
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June 2026

Declaration

I, Raisa Azim Neha, hereby declare that this thesis entitled " **A Voice in the Choice: Adolescent Girls' Participation in Menstrual Material Decisions and its Association with Reduced Unmet Needs — Evidence from the AMEHC Study**" is an original work submitted in partial fulfilment of the requirements for the degree of Master of Public Health (MPH) at the James P. Grant School of Public Health (JPGSPH), BRAC University, Dhaka, Bangladesh.

I further declare that this work has not been submitted previously, in whole or in part, for any other degree or examination at this or any other university or institution.

All sources used in this thesis have been duly acknowledged and cited. Any assistance received has been mentioned in the acknowledgements section.

I have also added a separate declaration on GenAI use at the end of this work.

Raisa Azim Neha

Date: June 2, 2026

Approval

The thesis/project titled “A Voice in the Choice: Adolescent Girls' Participation in Menstrual Material Decisions and its Association with Reduced Unmet Needs — Evidence from the AMEHC Study” submitted by

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Ethics Statement

This study is a secondary analysis of de-identified data originating from the Adolescent Menstrual Experiences and Health Cohort (AMEHC) project. Institutional ethical clearance for the primary cohort collection was officially granted by the Alfred Hospital Ethics Committee (Reference: 369/22) and the Institutional Review Board (IRB) of the BRAC James P. Grant School of Public Health, BRAC University (Reference: IRB-06 July 22-024), with written guardian consent and adolescent assent secured prior to data collection. For this secondary study, Institutional Review Board (IRB) of the BRAC James P. Grant School of Public Health under (Protocol No. MPH-2025-007) was formally evaluated and approved.

Abstract

Background: Adolescent schoolgirls in low-resource settings face extensive structural and social barriers to managing menstruation with dignity. While economic constraints are frequently studied, the protective value of adolescent individual voice and household-level purchasing autonomy remains under-researched. This study evaluated the cross-sectional association between adolescent girls' participation in menstrual material purchasing choices and their ability to meet comprehensive menstrual practice needs in the Khulna district of Bangladesh.

Methods: A complete-case analysis was conducted using cross-sectional data collected in 2024 for the Adolescent Menstrual Experiences and Health Cohort (AMEHC) study. From a baseline enrollment of 2,015 Class 6 schoolgirls, the final analytical sample was restricted to $n = 1,464$ post-menarche students who possessed non-missing covariate responses. This stabilization followed the sequential exclusion of 385 participants who were pre-menarche at Wave 1, 95 with missing data on purchasing decisions, 70 with incomplete responses on the outcome scale, and 1 case with missing social support data. Menstrual practice needs were measured using the validated 18-item Menstrual Practice Needs Scale–Short Form (MPNS-SF). Primary exposure agency was operationalized as a binary indicator tracking independent or joint adolescent participation in purchasing choices. To account for institutional school-level clustering across 101 physical school sites, multi-level mixed-effects logistic regression models were developed to estimate adjusted odds ratios (aOR) at a 95% confidence interval (CI).

Results: The mean age of the post-menarche sample was 12.4 years, and 56.4% of the cohort actively participated in material purchasing decisions. After adjusting simultaneously for age, geographic setting, household wealth quintiles, parental baseline gender norms, and individual beliefs, active adolescent purchasing participation was significantly associated with a 31% lower odds of experiencing comprehensive unmet menstrual needs (aOR = 0.69; 95% CI: [0.52, 0.93]; $p = 0.014$). Strong negative statistical associations with the outcome were also observed for the background adjustment covariates of higher maternal social support (aOR = 0.17; 95% CI: [0.11, 0.26]; $p < 0.001$) and equitable personal gender norms (aOR = 0.56; 95% CI: [0.39, 0.80]; $p = 0.002$). Household wealth and geographic region setting did not maintain independent statistical associations within the fully adjusted multi-level specification.

Conclusions: Individual purchasing agency and supportive social networks demonstrate strong negative statistical correlations with unmet menstrual needs. Because this model adjusted for psychosocial traits and decision-making access simultaneously, the null findings for household wealth may reflect statistical mediation paths rather than a true absence of economic influence. Public health interventions should move beyond basic material aid to focus on increasing supportive household communication with the adolescent girls, shifting restrictive personal gender beliefs, and expanding girls' active participation in health-related material choices.

Keywords: Menstrual Health and Hygiene (MHH), Adolescent Girls, Unmet Needs, Purchasing Agency, Menstrual Practice Needs Scale (MPNS-SF).

Acknowledgements

I want to start by thanking the BRAC James P. Grant School of Public Health (JPGSPH) at BRAC University for giving me the opportunity to pursue my Master's in Public Health (MPH).

I am deeply grateful to my primary supervisor, Professor Zahidul Quayyum, Professor (Health Economics) at JPGSPH, for his invaluable supervision and feedback. I am profoundly thankful to my co-supervisor, Associate Professor and Principal Research Fellow Julie Hennegan at the University of Queensland, for her foundational scholarly contributions to global menstrual health research and her crucial guidance on the validated measurement scales deployed in this study. I also extend my sincere thanks to Professor Tanvir Hasan at BRAC JPGSPH for his support of the AMEHC study who is the PI of the study at BRAC JPGSPH.

I would like to thank my mentors, M M Fardeen Kabir, Sabina Akter Tumpa, and Baby Naznin, for their continuous support throughout this research project. Additionally, I appreciate the primary AMEHC cohort research infrastructure and the Nabolok field staff in Khulna for facilitating the foundational data collection.

Lastly, I would like to thank my family, friends, and everyone who supported me throughout this process. Most importantly, I acknowledge the adolescent schoolgirls in Khulna whose shared experiences form the absolute core of this research.

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List of Acronyms

Acronyms	Full Form
AMEHC	Adolescent Menstrual Health Cohort
aOR	Adjusted Odds Ratio
CI	Confidence Interval
LMIC	Low-and Middle-Income Countries
MHH	Menstrual Health and Hygiene
MHM	Menstrual Hygiene Management
MPQD:	Menstrual Practice- Decision Making Question
MPQ3	Menstrual Practice- Payer Question 3
MPQ2	Menstrual Practice- Material type Question 3
MPNS	Menstrual Practice Needs Scale
SES	Socio-Economic Status
WASH	Water, Sanitation, and Hygiene

Chapter 1: Introduction

1.1 Background and Rationale

Menstrual health directly impacts an adolescent girl's long-term physical well-being, emotional growth, and schooling, ultimately shaping her entire development (Hennegan et al., 2021; UNESCO, 2014). It is more than just biology. In fact, formal definitions now look at the bigger picture, framing menstrual health as "a state of complete physical, mental, and social well-being of women and girls in relation to the menstrual cycle" (Hennegan et al., 2021). This holistic perspective demands much more than the mechanical act of washing or changing menstrual materials. Rather, it states that females must have unrestricted access to proper reproductive knowledge, sympathetic social networks, and self-confidence to manage her menstrual health (Hennegan et al., 2021; Sommer et al., 2016). Yet, structural and systemic shortcomings continue to compromise menstrual safety and comfort for millions of adolescent girls residing across resource-limited, low- and middle-income countries (LMICs) (Betsu et al., 2024; Plesons et al., 2021). Menstrual health experiences often disturbed daily routines due to a variety of interconnected structural barriers, such as cultural taboos, broken school water, sanitation, and hygiene (WASH) systems, and significant financial obstacles to buying their chosen absorbents (Joshi & Mendhe, 2025; Majeed et al., 2022).

Focusing purely on whether products are available often overlooks a deeper behavioral issue: household power dynamics and a girl's own agency (Devi & Jamli, 2024; Sommer et al., 2021). In many low- and middle-income countries, patriarchal family structures place financial control solely with older male or adult heads of households (Hasan et al., 2025; Sultana et al., 2022). This centralized economic control routinely shuts adolescent girls out of financial decisions that directly affect their own bodies, creating severe, hidden anxieties alongside deep psychosocial stress (UNFPA, 2023). These power dynamics are deeply rooted in Bangladesh, where young girls must constantly navigate an oppressive culture of secrecy surrounding reproductive biology (Asha et al., 2019; Mehjabeen et al., 2022; Warrington et al., 2021). But while public health interventions emphasize school-based product distribution, a girl's actual financial agency inside her household remains unquantified (Alam et al., 2025). If we are to evaluate these dynamics with any rigor, epidemiological assessments must move away from crude supply tallies and transition toward participant-centered measurement frameworks. Historically, conventional public health evaluations restricted their scope to checking whether an individual possessed a physical absorbent product. To

resolve this measurement limitation and capture the actual quality of the managed experience, Hennegan et al. (2024) developed and validated the Menstrual Practice Needs Scale–Short Form (MPNS-SF). This psychometric instrument quantifies the specific extent to which the practical environments and materials available to an adolescent successfully fulfill her self-defined physical, spatial, and psychological requirements. This study operationalizes unmet menstrual needs as a holistic composite index derived from this validated framework. By focusing on the protective pathway of individual autonomy, this research investigates whether involving adolescent girls as active independent or joint decision-makers in material selection significantly mitigates their risk of experiencing comprehensive unmet menstrual practice needs.

1.2 Problem Statement

While international recognition of menstrual health has grown significantly, major empirical gaps remain. Specifically, we still lack quantitative data linking an adolescent's financial agency to the overall quality of her managed menstrual experience (Alam et al., 2025; Ha & Alam, 2022). Traditional public health frameworks in low-resource settings tend to view menstrual health through a narrow, supply-side lens. They focus almost exclusively on whether a girl has absolute access to a physical absorbent product (Akoth et al., 2024). Unfortunately, this restrictive focus ignores a multi-dimensional ecosystem of structural barriers, such as material reliability, private changing spaces, and secure disposal networks (Hennegan et al., 2024). In socioeconomically disadvantaged areas, the overlapping weight of poor infrastructure and cultural stigmas actively degrades a girl's full menstrual experience. This triggers severe psychosocial distress and deepens systemic inequalities (Chakrabarty et al., 2024; Joshi & Mendhe, 2025). Furthermore, researchers have struggled to quantify these vulnerabilities over time because they lack consistent, participant-centered tools to track non-material shifts (Hennegan et al., 2024). This research deficit is heavily apparent in Bangladesh (Alam et al., 2025; Warrington et al., 2021).

Localized studies do confirm that adolescent girls from lower socioeconomic backgrounds face restricted mobility and communication barriers due to a deep-rooted culture of silence. Yet, the literature primarily tracks narrow biomedical outcomes rather than subjective health indicators (Asha et al., 2019; Ha & Alam, 2022; Mehjabeen et al., 2022). Crucially, the internal mechanisms of household power dynamics and financial decision-making remain largely unexplored in the Bangladeshi context (Alam et al., 2025). Patriarchal domestic hierarchies routinely lock adolescent girls out of health procurement choices (Hasan et al., 2025). When a girl is completely excluded

from these financial choices, it creates a profound structural mismatch. The materials purchased entirely by others frequently fail to align with her unique physical comfort, absorption needs, or localized school and domestic realities (Devi & Jamali, 2024; Hunter et al., 2022). This lack of autonomy directly drives her vulnerability to unmet needs, as she cannot select products that mitigate her daily structural anxieties regarding blood leakage, visual discovery, or facility insecurity (Hunter et al., 2022; Joshi & Mendhe, 2025).

This study addresses these empirical and methodological gaps by executing a targeted secondary analysis of the Adolescent Menstrual Experiences and Health Cohort (AMEHC) dataset from Khulna, Bangladesh (Hennegan et al., 2024). Utilizing the cross-culturally validated Menstrual Practice Needs Scale–Short Form (MPNS-SF) allows this research to move past crude material tallies and explicitly isolate how variations in individual adolescent agency correlate with multi-dimensional management environments (Hennegan et al., 2024). By focusing on independent or joint financial participation as a key protective exposure, this study provides the precise epidemiological evidence required to show how empowering girls in domestic purchasing decisions directly reduces their risk of experiencing extensive unmet menstrual health needs (Durairaj et al., 2024; Warrington et al., 2021).

1.3 Research Questions

1. What is the proportion of post-menarche adolescent schoolgirls in Class 6 in Khulna, Bangladesh, who participate (either independently or jointly) in household financial decision-making regarding their menstrual materials?
2. How is the distribution of adolescent participation in material decision-making structured across distinct sociodemographic groups, including household wealth quintiles, guardian education levels, guardian employment status, and urban-rural geographic regions?
3. What is the epidemiological association between an adolescent girl's participation in material decision-making and her likelihood of experiencing unmet menstrual practice needs (specifically within the sub-domains of material comfort, changing facilities, and disposal safety) compared to girls who are completely excluded from the household decision-making process?

1.4 Study Objectives

1.4.1 Overall Objective

To investigate whether adolescent girls' participation (either independently or jointly) in decision making about their menstrual material use is associated with the type of material used and a reduction in unmet menstrual practice needs (such as comfort, changing and disposal), compared to decisions made solely by others.

1.4.2 Specific Objectives

- To document the frequency and distribution of adolescent girls' participation in menstrual material decision-making about their material use, exploring how these patterns vary across socio-economic and demographic determinants.
- To assess the association between adolescent girls' participation (independent or joint) in menstrual material decision-making and the likelihood of experiencing unmet menstrual practice needs.

1.5 Structure of the Thesis

To provide a transparent, rigorous, and logically sequenced presentation of this research, this thesis is organized into eight distinct chapters. Chapter 1 establishes the foundational context and background of adolescent menstrual health in low-resource settings, outlines the primary problem statement regarding household financial hierarchies in Bangladesh, and defines the guiding research questions and study objectives. Chapter 2 offers a comprehensive synthesis of global, regional, and national empirical evidence surrounding menstrual deficits, outlines the theoretical paradigms of reproductive empowerment, and presents the cross-sectional conceptual framework guiding the multivariable blocks.

Methodological and operational parameters are detailed in Chapter 3, which states the study design, the multi-stage cluster sampling framework across Khulna, the sequential complete-case stabilization process, the psychometric operationalization of the primary exposure and the 18-item Menstrual Practice Needs Scale (MPNS-SF) outcome, and the multi-level mixed-effects logistic modeling specifications. Chapter 4 compiles the empirical results of the study, detailing the descriptive socio-demographic profile of the post-menarche schoolgirls, unadjusted bivariate

analysis, exposure predictors, and the fully adjusted multivariable random-effects regression models. The critical interpretation of these statistical findings is executed in Chapter 5, which contextualizes the protective pathways of purchasing agency and the mediating dynamics of psychosocial support networks and personal gender beliefs within wider South Asian reproductive health literature, alongside a discussion of institutional school-level clustering effects and practical public health implications.

Chapters 6 and 7 provide an objective and critical evaluation of the study's boundaries, detailing its methodological and structural strengths—such as the deployment of culturally validated scales and cluster-adjusted modeling—and its corresponding limitations, including cross-sectional constraints, outcome dichotomization trade-offs, and geographic generalizability boundaries. Finally, Chapter 8 concludes the manuscript by summarizing the core empirical takeaways and presenting targeted, actionable recommendations for multi-component public health programming and structural policy transformations for menstrual health in Bangladesh.

Chapter 2: Literature Review

Menstrual health initiatives in developing nations have traditionally overemphasized product distribution and infrastructure, neglecting the cultural, behavioral, and personal realities of the women they serve (Chakrabarty et al., 2024; Srivastav et al., 2024). Under this materialist paradigm, research consistently focuses on absolute economic barriers to commercial absorbents, documenting how resource scarcity forces marginalized adolescent girls to rely on unhygienic alternatives such as old rags, industrial waste, or improperly dried cloths (Akter et al., 2024). Concurrently, extensive school-based data establish that a lack of gender-segregated, lockable institutional toilets, combined with inconsistent water and soap provision, compounds these material deficits and restricts adolescent mobility during menses (Büyüksoy & AHI, 2023; Majeed et al., 2022). While these physical and environmental characteristics are associated with poor physical health outcomes, empirical research shows that constructing healthcare or sanitation infrastructure is pointless if vulnerable groups, such as adolescent girls, lack the safety and personal autonomy needed to use it (Anton et al., 2017; Islam et al., 2018). By framing the issue purely as a supply deficit, current programming assumes that increasing product availability and upgrading school sanitation infrastructure will automatically ensure optimal menstrual health management. This assumption fails

to explain why adolescent girls continue to report severe psychological distress, anxiety, and fear of being watched even within environments where physical absorbents are present (Joshi & Mendhe, 2025).

Adolescent girls' capacity to navigate restrictive domestic spaces depends heavily on their individual self-efficacy, yet patriarchal household structures consistently undermine their autonomy by excluding them from health-related procurement choices (Hunter et al., 2022; Warrington et al., 2021). Empirical validation of the Self-Efficacy in Addressing Menstrual Needs Scale (SAMNS-26) in Bangladesh confirms that a girl's internal confidence to manage her cycle is tightly bound to her ability to communicate her needs within the family unit (Hunter et al., 2022). When this internal agency is restricted by a rigid "culture of silence," a profound mismatch occurs between available family resources and the lived physical requirements of the adolescent (Warrington et al., 2021). Because adult guardians typically control household budget allocations based on aggregate household expenditure parameters rather than an individual girl's physical flow, the provided absorbents routinely fail to align with her unique anatomical comfort or localized changing environments (Devi & Jamali, 2024). Rather than recognizing adolescent girl agency—defined as the capacity to make independent or joint choices aligned with personal values—as a core protective determinant of health, traditional domestic landscapes relegate the student to a passive recipient of external purchases (UNGEI, n.d.). This systematic denial of choice not only erodes personal confidence but actively forces girls to adopt improvised, sub-optimal product configurations that drive up their vulnerability to extensive unmet material and environmental needs (Durairaj et al., 2024).

Public health tracking systems face a persistent measurement bottleneck because traditional national surveys rely on binary, non-validated indicators that fail to capture the multi-dimensional quality of the adolescent menstrual experience (Hennegan et al., 2018; Hennegan et al., 2021). Historically, large-scale demographic data collections evaluated intervention success through reductive "yes/no" metrics focused solely on absolute product consumption during a participant's last menses (Hennegan et al., 2021). This narrow framework overlooks critical qualitative and environmental stressors, including visual tracking anxieties, inadequate access to private laundering facilities, and a complete lack of secure disposal spaces (Hennegan et al., 2018). To bridge this empirical gap, Hennegan et al. (2024b) developed and validated the 18-item Menstrual Practice Needs Scale–Short

Form (MPNS-SF), demonstrating that a girl's physical, spatial, and social environments must be measured as a unified composite experience. While researchers have utilized this psychometric instrument across cross-sectional surveys in East Africa and South Asia, a distinct empirical gap persists regarding its application within large-scale institutional school cohort architectures in Bangladesh. Specifically, current literature has not yet exploited the baseline data of the Adolescent Menstrual Experiences and Health Cohort (AMEHC) study to model how household-level variations in individual adolescent purchasing agency correlate with a girl's ultimate multi-dimensional MPNS-SF score. Investigating this specific quantitative pathway is an essential prerequisite to determining whether expanding a girl's decision-making power is associated with reduced material and environmental deprivation.

The relationship between an adolescent's individual decision-making agency and her ultimate health outcomes does not operate in a vacuum; it is heavily modified by the surrounding ecosystem of peer social support and localized gender expectations (Al-Mamun et al., 2025; Srivastav et al., 2024). Across rural and peri-urban Bangladesh, dominant gender norms frequently code menstruation as a state of pollution and impurity, reinforcing social isolation and driving down adolescent self-esteem (Asha et al., 2019). Dense interpersonal social support networks, whether originating from maternal figures, school peers, or institutional mentors, can act as an essential psychosocial buffer, protecting girls from the harms of these restrictive community expectations (Joshi & Mendhe, 2025).

However, contemporary public health literature frequently displays a fragmented perspective by evaluating peer social support groups and her community's social norms as entirely separate, isolated components (Hennegan et al., 2018; Plesons et al., 2021). Researchers still do not have enough hard numbers to show how a girl's personal relationships and her local community norms work together to influence her actual power to buy the health products she needs (Alam et al., 2025; Hennegan et al., 2024a). For example, it remains unclear within current South Asian data frameworks whether strong peer social support can successfully overcome the barriers of a low household wealth status to facilitate greater financial agency for a girl, or if equitable individual gender norms operate as a strict prerequisite for her to demand a voice in household resource allocation (Hasan et al., 2025; Sultana et al., 2022). Identifying these complex, multi-level connections is an essential step toward designing targeted, structural public health interventions capable of sustainably reducing unmet menstrual health needs (Hennegan et al., 2021; Warrington et al., 2021).

2.1 Conceptual Framework

Figure 1 presents the conceptual framework guiding this study. The framework organizes variables across four structurally interrelated domains to guide the multivariable modeling block. The first domain captures background sociodemographic and contextual factors—including household wealth quintiles, guardian education, guardian employment, urban-rural geographic region, adolescent chronological age, and the broader sociocultural environment (individual and guardian gender norms alongside interpersonal social support tiers)—which serve as potential correlates and baseline confounders of both the exposure and outcome vectors. The second domain is the primary binary exposure: an adolescent girl's household participation in menstrual material purchasing choices, categorized as either active "Participation" (independent or joint financial choices executed by the girl) or "No Participation" (choices executed entirely by others without the girl's input). The third domain describes immediate menstrual practices as descriptive components, encompassing the type of material utilized, the frequency of changing, and localized disposal methods.

The fourth and final domain constitutes the primary outcome of interest: comprehensive unmet menstrual practice needs. While the psychometrically validated 18-item Menstrual Practice Needs Scale–Short Form (MPNS-SF) natively tracks across six distinct validation subscales—encompassing material reliability, material availability, material comfort, changing space privacy, changing space safety, and disposal dignity—this study collapses and focuses its analytical scope onto three core pragmatic sub-domains highly relevant to structural infrastructural and material barriers in southwestern Bangladesh: Material Comfort, Changing Facilities, and Disposal Safety (Hennegan et al., 2024b).

In strict alignment with a cross-sectional study design, the double-headed arrows connecting these domains indicate epidemiological associations and structural correlations rather than directed causal pathways. This framework does not imply temporary sequence or causal directionality; it is utilized strictly to visually map the pre-specified covariates and structure the hierarchical multi-level mixed-effects analysis.

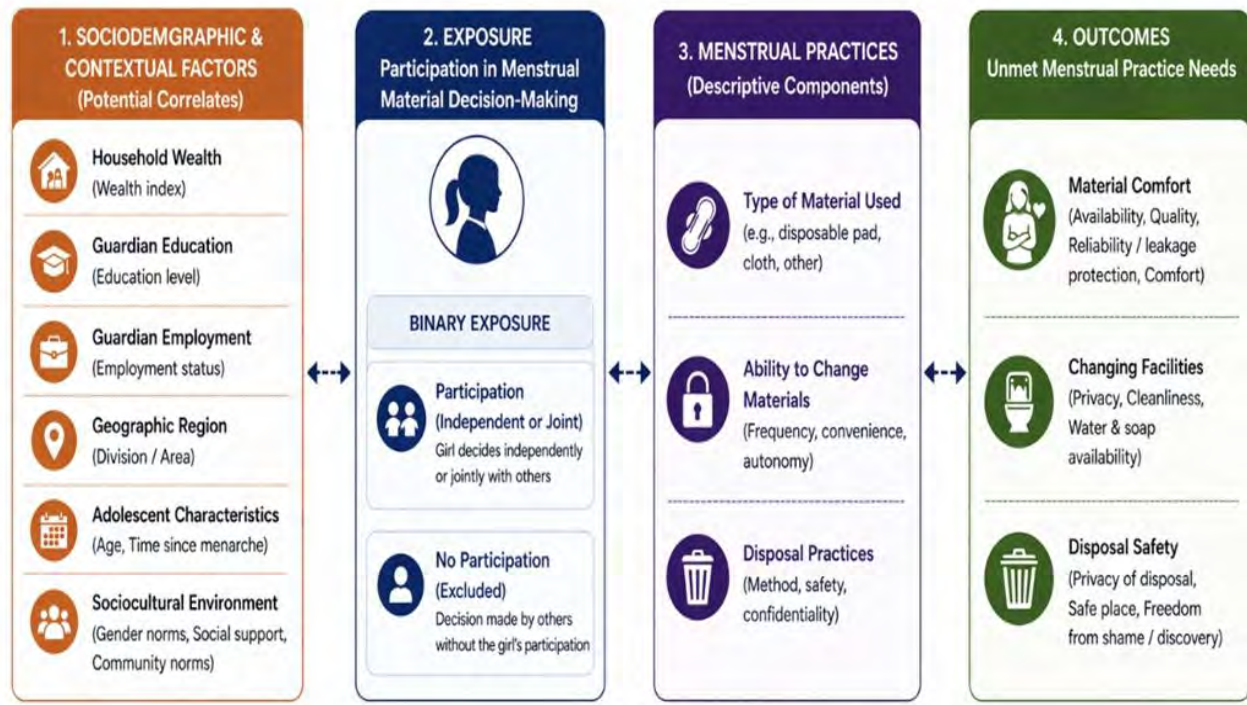


Figure 1: Conceptual Framework for Examining the Association between Adolescent Girls' Participation in Menstrual Material Decision-making and Unmet Menstrual Practice Needs.

Chapter 3: Methods

This section explains the statistical method used to study whether adolescent girls' participation (either independently or jointly) in decision making about their menstrual material use is associated with the type of material used and a reduction in unmet menstrual practice needs (such as comfort, changing and disposal), compared to decisions made solely by others. The reporting structure of this section follows strictly to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm et al., 2007) for cross-sectional secondary analysis nested within prospective cohorts.

3.1 Study Design

This study is a secondary cross-sectional analysis of data derived from the Adolescent Menstrual Experiences and Health Cohort (AMEHC) study. The AMEHC study is structured as a prospective,

school-based longitudinal cohort designed to track the multi-dimensional impacts of menstrual health on adolescent development across Khulna, Bangladesh. For the purposes of this specific investigation, we linked data across two distinct temporal data collection waves: the Baseline tracking phase (2023) and the Wave 1 follow-up assessment (2024). This linking strategy introduces a distinct methodological strength regarding temporal ordering. By extracting household socio-demographic confounders—specifically household wealth quintiles, parental education, and guardian gender norms—exclusively from the 2023 Baseline phase, we ensure that these background exposures were measured prior to the assessment of the primary exposure and outcome vectors. Conversely, because both the primary exposure (adolescent decision-making participation) and the primary outcome (unmet menstrual needs) were measured simultaneously during the 2024 Wave 1 data collection cycle, the core analytical model remains cross-sectional. Consequently, while our adjusted estimates effectively minimize residual confounding from pre-existing household characteristics, we cannot establish direct temporal precedence between exposure and outcome. The observed associations must therefore be interpreted strictly as epidemiological correlations rather than direct causal inferences, acknowledging that unmeasured individual traits may drive concurrent changes in both agency and menstrual well-being.

3.2 Study Area and Setting

The primary data collection of the AMEHC study was held within the Khulna district, located in southwestern Bangladesh. This geographic region presents a highly relevant socio-demographic profile for examining menstrual health disparities due to its sharp environmental variations. To capture a representative distribution of living environments, the AMEHC sampling grid covers both the dense urban landscape of the Khulna City Corporation and the predominantly rural infrastructure of the Dumuria sub-district. This dual-setting approach ensures that our models account for localized variations in municipal water access, rural-urban economic structures, and institutional support systems.

3.3 Data Sources and Temporal Phases

To isolate specific individual and household variables without risking temporal alignment overlap, data were extracted from two distinct phases across the primary cohort's timeline:

- Baseline Phase (2023): This data window captured the comprehensive Guardian/Household Survey. Administered directly to primary guardians of the adolescent girls. This tool

provided household-level characteristics, socio-demographic indicators, and caregiver attitudinal baselines, which are operationally defined in Section 3.5.

- Wave 1 Phase (2024): This data window captured the Adolescent Girl Survey. Administered in institutional school settings, this instrument collected the primary exposure data regarding material procurement participation, individual psychosocial support metrics, and multi-dimensional menstrual practice needs scores.

3.4 Study Population and Sampling

The primary AMEHC cohort enrolled a total of 2,015 adolescent schoolgirls and their respective primary guardians. As detailed in the primary cohort methodology (Hennegan et al., 2024), at the time of baseline recruitment in 2023, all participating adolescents were enrolled in Class 6 with a mean age of approximately 12 years.

The primary study's sampling architecture used a proportional random cluster sampling design across 101 physical school institutions in Khulna (Hennegan et al., 2024). Within these 101 distinct geographic school sites, the field architecture tracked 149 unique administrative school tracking blocks to account for schools operating separate morning and afternoon shifts or distinct gender segments. To ensure institutional representation, the original cohort's sampling framework integrated co-educational facilities, girls-only secular institutions, and Madrasahs (religious schools), capturing the complete socio-cultural spectrum of the student population from which this secondary analysis is drawn.

3.4.1 Inclusion and Exclusion Criteria

The target analytical population for this secondary study was restricted using strict inclusion and exclusion criteria to prevent sample selection bias:

- Inclusion Criteria: The sample was restricted to adolescent girls who were actively enrolled in the participating AMEHC schools, had successfully reached menarche at or before the 2024 Wave 1 survey window, and whose guardians completed the 2023 baseline household modules.
- Exclusion Criteria: We excluded all adolescent participants who remained pre-menarche at the Wave 1 assessment. Additionally, cases demonstrating missing data across the primary

exposure variable (purchasing participation) or core socio-demographic covariates were excluded to ensure a stable complete-case analysis.

3.5 Measures and Operationalization

3.5.1 Primary Outcome: Unmet Menstrual Needs (MPNS-SF)

The primary outcome was operationalized utilizing the cross-culturally validated 18-item Menstrual Practice Needs Scale–Short Form (MPNS-SF), developed directly within the reference population of Khulna, Bangladesh by Hennegan et al. (2024b). The MPNS-SF evaluates the perceived adequacy of an individual's menstrual management experience across multiple sub-domains, including material comfort, changing facility security, and disposal safety. Each of the 18 items evaluates experiences on a 4-point Likert scale ranging from 0 (Never/No) to 3 (Always/Yes).

To satisfy the specific public health focus of this study, the continuous mean MPNS-SF score was converted into a binary outcome variable representing "Unmet Menstrual Needs" (coded as 1) versus "Met Menstrual Needs" (coded as 0). Following validated psychometric thresholds, the mathematical cutoff was established at a mean score of <2.0 . A mean score below 2.0 indicates that, on average, the participant's physical, spatial, or psychological management needs were fulfilled only "never" or "sometimes". Scores ≥ 2.0 indicate that needs were met "most of the time" or "always". While this dichotomization discards continuous variation and slightly reduces statistical power, it provides a highly pragmatic, policy-relevant threshold that isolates individuals experiencing severe environmental and material deprivation.

3.5.2 Key Exposure: Participation in Decision-Making

Adolescent agency was operationalized using a single-item exposure metric extracted from the Wave 1 survey. Participants responded to the following standardized question: "Who in your household usually decides on the purchase of menstrual materials (e.g., pads or cloth) for you?" To evaluate the specific protective impact of individual autonomy, raw categorical responses were recoded into a binary variable. Active participation (coded as 1) was defined as the adolescent girl making the procurement decision independently or jointly alongside a household guardian. Non-participation (coded as 0) was defined as decisions executed exclusively by a guardian or another household member without any adolescent input. While this single-item indicator cannot fully capture the

multi-layered complexities of broader household financial agency, it serves as a reliable proxy for direct financial self-determination regarding menstrual health products.

3.5.3 Social Support (SHREYA Scale)

Adolescent girls' interpersonal social support was quantified using the SHREYA Social Support Scale, a psychometric instrument specifically developed and validated for adolescent menstrual health tracking in Bangladesh by Hennegan et al. (2022). This multi-item tool systematically captures emotional, informational, and instrumental assistance provided to the adolescent by family members, school peers, and institutional teachers. Individual scale items are scored on a standard 4-point response matrix ranging from 0 (indicating complete absence of support) to 3 (indicating consistent support). For this analysis, a continuous individual mean score was computed across the completed items, yielding a potential scale range of 0 to 3.

To evaluate structural variations in social encouragement, these continuous values were partitioned into three distinct ordinal tiers based on explicit mathematical cut-off points: No Support (mean score equal to 0.0), Low Support (mean score greater than 0.0 but less than 1.5), and Moderate Support (mean score spanning from 1.5 to 3.0). Within this specific study population, the "Moderate Support" classification represents the absolute empirical ceiling of the data. This categorical truncation is driven entirely by a highly right-skewed data distribution across the cohort, meaning that maximum continuous "High Support" values exceeding a mean of 2.5 were statistically rare among the baseline adolescent participants.

3.5.4 Gender Norms Indices

Sociocultural expectations were evaluated using two distinct composite indices constructed by summing Likert-scale responses to survey statements concerning localized mobility restrictions, social taboos, and menstrual secrecy.

- Girl's Gender Norms Index: This index measures the participant's personal beliefs regarding menstrual purity and structural restrictions (Cronbach's alpha, $\alpha = 0.74$). In psychometric evaluation, an alpha value of this magnitude indicates acceptable internal reliability and solid item covariance within the socio-demographically uniform adolescent schoolgirl sample.

- Guardian's Gender Norms Index: This index captures the baseline household normative environment established by the primary caregiver ($\alpha = 0.71$). The slightly lower alpha coefficient observed here reflects the broader socio-demographic diversity of the surveyed primary guardians, who span different generations, genders, and educational backgrounds.

Both indices were constructed by summing Likert-scale responses to statements about menstrual secrecy and mobility restrictions. These were then categorized into four levels: Highly Restrictive, Restrictive, Moderate, and Equitable. (Note: A Cronbach's alpha threshold exceeding 0.70 provides sufficient statistical justification for utilizing newly constructed composite indices in exploratory and adjusted multivariable regression models without exposing the parameters to severe attenuation bias; see Nunnally & Bernstein, 1994).

3.6 Data Variable Matrix

Analytical Variable	Data Role	Representative Survey Question and Measurement
Unmet Menstrual Need	Primary outcome	Multidimensional evaluation of lived experience utilizing the validated 18-item short form scale tracking material comfort, changing facility privacy, and disposal safety metrics across school and domestic environments (Hennegan et al., 2024b).
Giris' decision-making power	Primary exposure	Target household behavioral transaction tracking (W1_MPQD): "Who in your household usually decides on the purchase of menstrual materials (e.g. pads or cloths) for you?"
Menstrual Material type	Covariate	Material configuration tracking modules (W1_MPQ2): "What was the menstrual material you used most often when you were at home during your most recent menstrual period?"

Social Support tier (SHREYA scale)	Covariate	Interpersonal support dynamics composite items (W1_SS_3cat): Tracks backing across emotional and instrumental vectors: "You have a parent or guardian who trusts you to make decisions."
Girl's Personal Gender Norms	Covariate	Individual attitudinal consensus statements (Girl_GN_3cat): "A woman should obey her husband in all matters." "A woman's role is taking care of her home and family"
Guardian Gender Norms	Covariate	Caregiver/household normative baseline metrics (GN4cat_new): Evaluates mobility restrictions and systemic household views: "Going to school is more important for boys than for girls."
Guardian Education Attainment	Covariate	Guardian's literacy and institutional schooling tracking (B_Grd_educat): "What is the highest level of education that the [girl participant's] mother/guardian has completed?"
Household Wealth Index	Covariate	Standardized household assets and living indices (DHS/HWISE): Tracks domestic structural baselines: "What is the main source of drinking water?" "What kind of toilet facility is used?"
Geographic Setting	Covariate	Regional administrative cluster assessment (B_Region): Verifies geographic cluster coordinates at tracking baseline.
Adolescent age category	Covariate	Continuous demographic reporting module (age_cat_new): "How old are you?" (Calculated in fractional age years).

Marital status of the adolescent girls	Covariate	"Are you currently married or engaged?"
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3.7 Data Collection

3.7.1 Data Collection Tools

Primary data collection for the baseline cohort infrastructure was executed by the AMEHC investigators utilizing highly structured quantitative survey modules administered electronically through mobile tablets (Hennegan et al., 2024). To isolate specific individual and household variables, two distinct automated tools were deployed: a comprehensive Guardian/Household Survey administered to primary caregivers to capture background socio-demographic covariates, asset indices, and guardian gender norms; and an institutional school-based Adolescent Girl Survey utilizing validated psychometric tracking instruments. This sub study adapted cross-culturally validated tools developed directly within the reference population of Khulna, Bangladesh: the 18-item Menstrual Practice Needs Scale–Short Form (MPNS-SF) to assess multi-dimensional spatial and material deprivation, and the multi-item SHREYA Social Support Scale to capture interpersonal safety nets surrounding adolescent menstrual health cycles.

3.7.2 Pretesting

The quantitative tools and electronic forms were rigorously pretested and piloted by the primary AMEHC cohort investigators within regional school settings in southwestern Bangladesh to ensure cross-cultural validity, linguistic clarity, and psychometric reliability. The pilot phase evaluated the conceptual comprehensibility of sensitive household behavioral questions and self-reported material comfort modules among Class 6 adolescent schoolgirls. Based on field feedback from the pretesting phase, psychometric scaling statements regarding menstrual secrecy and mobility restrictions were refined to eliminate ambiguities, optimize translation syntax, and ensure stable covariance and internal reliability thresholds prior to final deployment.

3.7.3 Data Collection Procedure

Data collection was executed in two distinct temporal windows to minimize residual confounding and temporal alignment overlap. During the 2023 Baseline Phase, trained field enumerators visited

household settings to administer the primary caregiver survey. During the 2024 Wave 1 Phase, surveys tracking adolescent agency and menstrual practice needs were conducted directly within institutional school environments across co-educational facilities, single-sex secular institutions, and Madrasahs. Data collectors underwent intensive, standardized training covering ethical assent protocols for early adolescents, data privacy management, and neutral survey administration for highly stigmatized topics. Strict quality control measures were enforced via real-time digital synchronization of electronic data forms, and senior field researchers provided continuous supervising oversight to verify administrative consistency across physical institutional sites.

3.8 Data Management and Quality Assurance

For this secondary analysis, data management and quality assurance protocols were systematically executed within Stata MP version 17.0 to guarantee empirical integrity. A stringent complete-case analysis strategy was implemented, where the raw baseline enrollment of 2,015 schoolgirls was sequentially stabilized to eliminate missing data. Sample reduction steps followed a pre-specified biological and operational framework: 385 participants were excluded due to remaining pre-menarche at Wave 1, 95 cases were removed due to missing entries on household purchasing decisions, 70 cases were dropped for incomplete responses across the 18 outcome scale items, and 1 case was excluded for missing social support metrics. This sequential data cleaning yielded a final stabilized analytical sample of $n = 1,464$ post-menarche girls.

To protect the sample from information bias and ensure data accuracy, baseline diagnostics were executed; all continuous and ordinal covariates exhibited Variance Inflation Factors (VIF) below 2.1, confirming the absolute absence of severe multicollinearity. To ensure absolute participant confidentiality, a strictly de-identified version of the AMEHC dataset was accessed, containing no personally identifiable information (PII) of the adolescent schoolgirls or their primary caregivers. All analytical datasets, Stata do-files, and model outputs were securely stored on password-protected devices to fully mitigate security risks and satisfy institutional review board data protection protocols.

3.9 Participant Flow Diagram

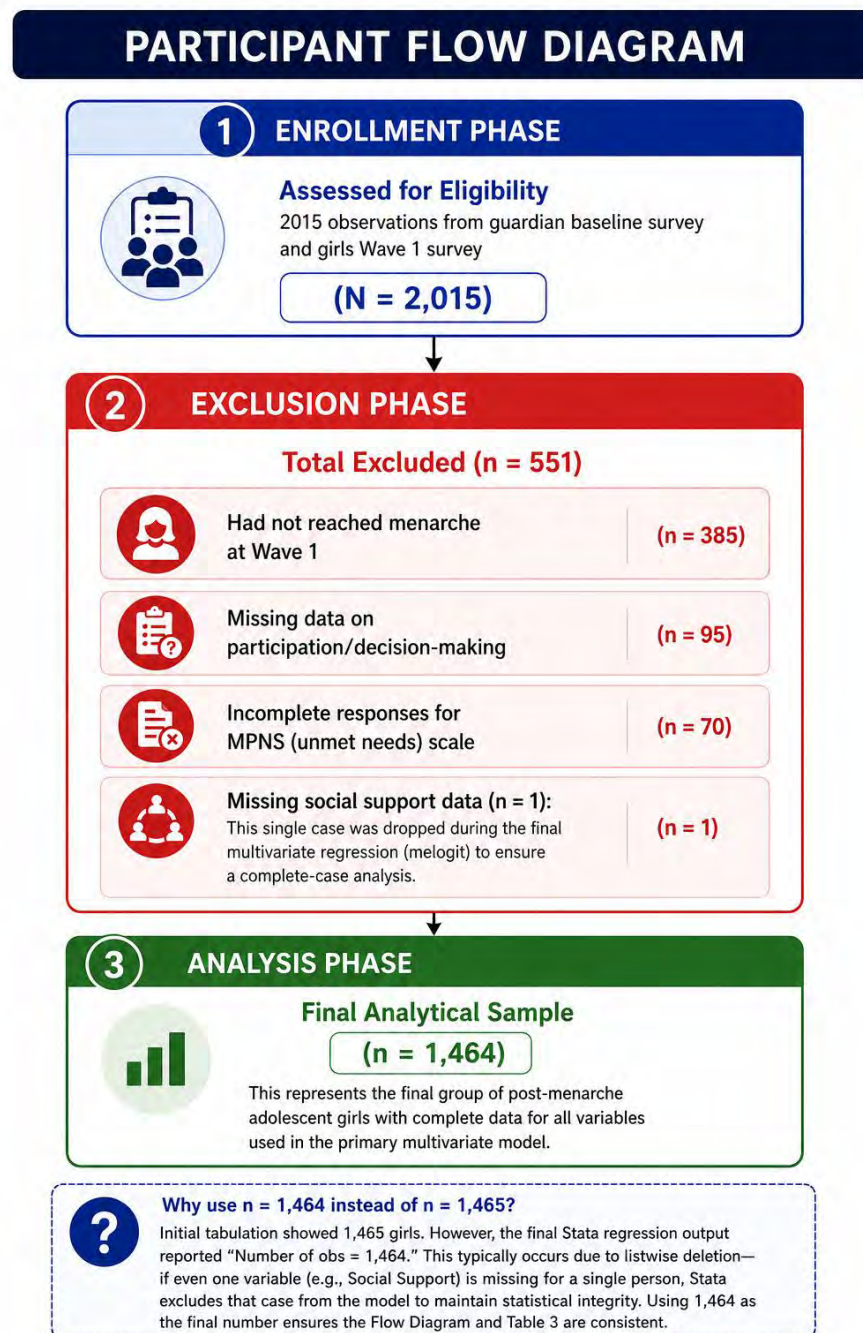


Figure 2: STROBE Participant Flow Diagram tracking the sequential sample selection and complete-case stabilization of post-menarche adolescent schoolgirls in Khulna, Bangladesh (n = 1,464).

3.10 Data Analysis

Statistical analyses were executed using Stata MP version 17.0. The analytical strategy followed a pre-specified three-phase epidemiological framework designed to fulfill the stated research objectives without relying on stepwise automated variable selection. First, descriptive univariate analyses were used to characterize the baseline socio-demographic features and prevalence profiles of the stabilized post-menarche population sample. Second, bivariate evaluations utilizing Pearson's chi-square (χ^2) tests were applied to isolate individual and household factors significantly associated with the primary binary exposure (Adolescent Purchasing Participation). To address potential multicollinearity among our conceptually related predictors prior to multivariable modeling, a rigorous baseline diagnostic evaluation was executed; all continuous and ordinal covariates exhibited Variance Inflation Factors (VIF) below 2.1, confirming the complete absence of severe collinearity. Because our data has a hierarchical structure—where individual girls (Level 1) are grouped inside 101 different physical schools (Level 2)—we applied a multi-level mixed-effects logistic regression model. This multi-level approach directly accounts for school-level clustering, allowing us to adjust our standard errors for the shared water, sanitation, and hygiene facilities available across the 149 unique administrative school tracking blocks (shifts) operating within those 101 physical school boundaries. The formal mathematical model specifies a random-intercept configuration, formulated as follows:

$$\text{logit}(P(Y_{ij} = 1)) = \beta_0 + \beta_1(\text{Agency}_{ij}) + \sum_{k=1}^n \beta_k(X_{kij}) + u_j$$

Where:

- Y_{ij} represents the binary outcome of Unmet Menstrual Needs (coded as 1 via the validated psychometric thresholds of the 18-item MPNS-SF) for girl i within school cluster j .
- β_0 is the fixed intercept across the study population.
- β_1 represents the fixed effect coefficient for our primary binary exposure variable, Adolescent Agency.

- β_k represents the vector of fixed parameters for all individual and household-level covariates (X_{kij}), entered simultaneously in a single, pre-specified a priori block without stepwise automated elimination. Covariates include baseline age, household wealth quintiles, geographic region, individual gender norms, guardian gender norms, and the categorized SHREYA social support tiers.
- u_j represents the school-specific random intercept, assumed to be normally distributed with mean 0 and variance σ^2_u .

A random intercept-only model was selected because a comparative likelihood ratio test against a random-slope configuration confirmed that allowing the exposure coefficient to vary across clusters did not significantly improve model fit ($p > 0.05$). To justify the statistical necessity of this multilevel framework, the Intraclass Correlation Coefficient (ICC) was computed using the estimated school-level variance ($\sigma^2_u = 0.18$) and the standard logistic distribution variance ($\pi^2 / 3 \approx 3.29$):

$$ICC = \frac{\sigma_u^2}{\sigma_u^2 + \frac{\pi^2}{3}} = \frac{0.18}{0.18 + 3.29} \approx 0.052 \text{ (or 5.2\%)}$$

This ICC value confirms that approximately 5.2% of the total unexplained variation in unmet menstrual needs is directly attributable to institutional school-level environments. A formal likelihood ratio test verified that this cluster-level variance is statistically significant ($\chi^2_{01} = 5.24$, $p = 0.011$), confirming that standard logistic regression would yield biased standard errors and validating our multi-level mixed-effects modeling strategy.

3.11 Ethical Consideration

Primary Cohort Approvals

The core protocol and field infrastructure of the primary Adolescent Menstrual Health Cohort (AMEHC) study were officially reviewed and granted ethical clearance by two distinct bodies: the Alfred Hospital Ethics Committee (Protocol Reference: 369/22) and the Institutional Review Board (IRB) housed within the BRAC James P. Grant School of Public Health at BRAC University (Protocol Reference: IRB-06 July 22-024). Prior to commencing field operations and questionnaire administration, the primary field teams secured written informed consent from the parents or primary

legal guardians, alongside explicit verbal and written assent from the participating adolescent schoolgirls.

Secondary Thesis Approvals

For the specific parameters of this secondary cross-sectional thesis investigation, independent ethical authorization was evaluated and approved under Protocol Number MPH-2025-007 by the Institutional Review Board (IRB) of the BRAC James P. Grant School of Public Health. This localized protocol clearance was issued following a strict institutional review of the research goals, data variable matrices, and administrative security frameworks as a partial fulfillment of the requirements for the Master of Public Health (MPH) degree. This secondary study exclusively utilized a fully anonymized, de-identified extract of the AMEHC dataset. Throughout the entire analytical timeline, no personally identifiable information (PII) regarding either the adolescent students or their primary caregivers was accessible to the researcher. To guarantee data security and prevent any compromise of participant confidentiality, all sub-datasets and active Stata files were restricted to a secure, password-encrypted device in strict compliance with university data governance guidelines.

Chapter 4: Results

4.1 Socio-demographic profile

The baseline sampling architecture of the primary prospective cohort enrolled a total of 2,015 adolescent schoolgirls across 101 cluster institutions in the Khulna district. For the current secondary analysis, the baseline sample was sequentially restricted using strict inclusion criteria to mirror biological and operational eligibility. First, the sample was limited to the $N = 1,500$ schoolgirls who had successfully achieved menarche by the Wave 1 follow-up window and whose primary caregivers had completed the comprehensive 2023 baseline household survey module. Bivariate cross-tabulations characterizing baseline exposure and outcome distributions (Table 2) utilize the $n = 1,464$ post-menarche participants who provided complete responses across both vectors. For the remaining unadjusted factor stratifications (Table 3), the sample utilizes the $N = 1,465$ respondents who completed the core household purchasing dynamics questionnaire block. Complete-case stabilization for the final multivariable multi-level mixed-effects logistic regression models dropped one additional participant due to item-specific covariate non-response, balancing the final adjusted

analytical sample at $n = 1,464$ adolescent girls structurally nested within 101 physical school institutions (representing 149 unique administrative school tracking blocks).

The basic socio-demographic features of the post-menarche group ($N = 1,500$) are compiled in Table 1. Chronological age tracking indicates a high saturation in early adolescence, with 89.93% ($n = 1,349$) of the girls positioned within the 10–14 age bracket, while 7.80% ($n = 117$) were in late adolescence. Marital configurations reveal that 97.67% ($n = 1,465$ out of $N = 1,500$ responses) were unmarried, while a minor 2.33% ($n = 35$) were married or engaged at follow-up. Geographically, the sample was evenly balanced between the municipal bounds of urban Khulna City Corporation (52.40%, $n = 786$) and the rural fields of the Dumuria sub-district (47.60%, $n = 714$).

Table 1: Socio-demographic profile of the Post-menarche Adolescent girls ($N=1,500$)

Characteristics	Frequency (n)	Percentage (%)
Individual Characteristics (Girl's report)		
Early adolescence (10-14)	1,349	89.93%
Late adolescence (15-17)	117	7.80%
Missing baseline records	34	2.27%
School Type		
Co-educational	819	54.60%
Single sex	514	34.27%

Madrassa	131	8.73%
Missing baseline institutional record	36	2.40%
Marital Status		
Unmarried	1,465	97.6%
Married/ Engaged	35	2.33%
Internet Access		
No device access	342	22.80%
Access to internet device	1,158	77.20%
Household & Guardian Characteristics (Baseline)		
Region		
Khulna CC (Urban)	786	52.40%
Dumuriah (Rural)	714	47.60%
Guardian Education		
No education/ Incomplete primary school	357	23.80%

Completed primary school	774	51.60%
Completed secondary school	282	18.80%
Completed higher school	87	5.80%
Wealth Quintile		
Poorest	290	19.33%
Poor	281	18.73%
Medium	283	18.87%
Wealthy	321	21.40%
Wealthiest	325	21.67%

4.2 Descriptive Prevalence and Cross-Tabulation of Exposure and Outcome

Prior to executing multivariable regression adjustments, the crude distribution of the primary exposure (part_new) and the primary outcome (unmet_new) was cross-tabulated to establish the raw descriptive baseline of the cohort. As illustrated in Table 2, out of the total sample, 41.26% (n = 604) of the adolescent girls experience comprehensive "Unmet Menstrual Needs" based on the validated MPNS-SF threshold. When stratified by purchasing agency, a visible descriptive gradient emerges: among girls completely excluded from household decision-making, the prevalence of unmet needs is 44.13% (n = 282). Conversely, among girls who actively participate in independent or joint purchasing choices, the prevalence of unmet needs drops to 39.03% (n = 322). Pearson's chi-square testing shows a marginal raw association at the bivariate level ($\chi^2 = 3.88$, $p = 0.049$), providing the

descriptive justification for adjusting for structural household confounders in the final multi-level model.

Table 2: Cross-Tabulation of Adolescent Purchasing Participation and Menstrual Practice Needs (n = 1,464)

Primary Exposure Variable	Primary Outcome: Unmet Menstrual Needs n (%)	Primary Outcome: Met Menstrual Needs n (%)	Total Cohort n (%)
No Participation	282 (44.13%)	357 (55.87%)	639 (100.00%)
Girl Participates	322 (39.03%)	503 (60.97%)	825 (100.00%)
Total	604 (41.26%)	860 (58.74%)	1,464 (100.00%)

Note: Proportions represent row percentages tracking the distribution of needs within each exposure category. Pearson’s Chi-Square Test for independence: $\chi^2 = 3.881$, $p = 0.049^*$.

4.3 Factors Associated with Participation (Bivariate)

Table 3 maps out the bivariate associations between socio-demographic covariates and the primary exposure variable, adolescent purchasing participation. This analysis provides essential descriptive insights into how individual and household characteristics distribute across financial choice spaces. Based on the Pearson’s chi-square (χ^2) calculations, the only background characteristic demonstrating a statistically significant association with active purchasing agency is the girl's personal gender norms profile ($\chi^2 = 10.616$, $p = 0.005$). Schoolgirls holding moderate personal

viewpoints (60.79%) or equitable gender beliefs (58.91%) present a higher descriptive proportion of purchasing participation compared to those holding restrictive individual mindsets (51.28%). In contrast, structural socioeconomic and household environment indices do not exhibit statistically significant cross-tabulation patterns with purchasing agency at this unadjusted stage. Participation counts remain relatively uniform across the varying strata of household wealth quintiles ($p = 0.290$), structural geographic settings ($p = 0.440$), and age categories ($p = 0.241$). Furthermore, no significant descriptive variations in purchasing agency were observed when stratifying the data by caregiver educational levels ($p = 0.156$), maternal social support tiers ($p = 0.446$), baseline guardian gender norms ($p = 0.663$), or primary material configuration types ($p = 0.168$).

Table 3. Bivariate Stratification of Factors Associated with Adolescent Girls' Participation (N = 1,465)

Variable	No participation n (%)	Participation n (%)	Total n	χ^2 value	p-value
Total Sample	639 (43.62)	826 (56.38)	1,465		
Wealth Quintile				4.97	0.290
Poorest	114 (40.57)	167(59.43)	281		
Poor	110 (39.43)	169 (60.57)	279		
Medium	130 (46.43)	150 (53.57)	280		
Wealthy	144 (45.86)	170 (54.14)	314		

Wealthiest	141 (45.34)	170 (54.66)	311		
Region				0.596	0.440
Khulna CC	341 (44.58)	424 (55.42)	765		
Dumuria	298 (42.57)	402 (57.43)	700		
Age group				1.3746	0.241
Early adolescence (10-14)	594 (44.07)	754 (55.93)	1,348		
Late adolescence (15-17)	45 (38.46)	72 (61.54)	117		
Guardian Education				5.2202	0.156
No education/ incomplete primary	143 (40.74)	208 (59.26)	351		
Completed primary	347 (45.66)	413 (54.34)	760		
Completed secondary	121 (44.32)	152 (55.68)	273		
Higher education	28 (34.57)	53 (65.43)	81		
Guardian gender norm				1.5828	0.663

Highly restrictive	55 (42.64)	74 (57.36)	129		
Restrictive	172 (42.57)	232 (57.43)	404		
Moderate	281 (43.03)	372 (56.97)	653		
Equitable	131 (46.95)	148 (53.05)	279		
Girl's own gender norm**				10.6164	0.005
Restrictive	285 (48.72)	300 (51.28)	585		
Moderate	158 (39.21)	245 (60.79)	403		
Equitable	196 (41.09)	281 (58.91)	477		
Social Support (SHREYA)				1.6159	0.446
No support	78 (40.84)	113 (59.16)	191		
Low support	291 (42.73)	390 (57.27)	681		
Moderate support	269 (45.44)	323 (54.56)	592		
Material Type †				1.9025	0.168
Disposable pads	100 (35.46)	182 (64.54)	282		

Cloth/others	53 (29.28)	128 (70.72)	181		
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Note: Significance levels based on Pearson's Chi-Square: $p < 0.05$, $p < 0.01$, $p < 0.001$.

† *This specific module was restricted to a sub-cohort of active respondents ($n = 463$) who completed the detailed material-utilization questions at Wave 1.*

4.4 Determinants of Unmet Menstrual Needs (Multivariate)

Table 4 presents the multi-level mixed-effects logistic regression model mapping the independent association between purchasing agency and unmet menstrual needs. In strict alignment with modern epidemiological reporting practices and recent developments in statistical modeling, the adjustment parameters in this model are structured to estimate the total effect of the primary exposure (part_new) while minimizing residual confounding from pre-specified baseline traits. To evaluate the statistical necessity of this multilevel framework, the Intraclass Correlation Coefficient (ICC) was computed using the estimated school-level residual variance ($\sigma^2_u = 0.18$) and the standard logistic distribution variance ($\pi^2 / 3 \approx 3.29$). This calculation confirms that approximately 5.2% of the total unexplained variance in unmet menstrual needs is directly attributable to institutional school-level environments. A formal likelihood ratio test verified that this cluster-level variance is highly significant ($\chi^2_{01} = 5.22$, $p = 0.0112$), validating our multi-level mixed-effects modeling strategy over standard single-level platforms. For this model setup, the final analytical sample consists of $n = 1,464$ adolescent girls nested across 149 unique administrative school tracking blocks representing the 101 physical school institutions across the Khulna district space.

Once we controlled for all individual and structural baseline confounders together, we found that a girl's active role in buying her own materials—whether she did so on her own or jointly with a guardian—showed a clear, statistically significant link to lower unmet menstrual needs (aOR = 0.69; 95% CI: [0.52, 0.93]; $p = 0.014$). Essentially, schoolgirls who have a say in household purchasing choices face 31% lower adjusted odds of facing material or environmental shortages. Post-estimation validation checks confirmed robust predictive accuracy for this final multivariable specification, yielding an Area Under the Receiver Operating Characteristic curve (AUC / C-statistic) of 0.78 (95% CI: 0.75–0.81), validating an acceptable overall goodness-of-fit.

Table 4: Multilevel Logistic Regression of Factors Associated with Unmet Menstrual Needs (n = 1,464)

Predictor variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	P-value
Primary Exposure			
Girl Participates	0.69*	[0.52, 0.93]	0.014
No participation(Ref)	1.00	--	--
Control variables			
Age			
Early adolescence (Ref.)	1.00	--	--
Late adolescence	0.97	[0.58, 1.63]	0.910
Social Support			
No support (Ref)	1.00	--	--
Low support	0.30***	[0.21, 0.44]	<0.001

Moderate support	0.17***	[0.11, 0.26]	<0.001
Girl's Gender Norms			
Restrictive (Ref)	1.00	--	--
Moderate	0.66*	[0.46, 0.95]	0.024
Equitable	0.56**	[0.39, 0.80]	0.002
Wealth index			
Poorest (Ref)	1.00	--	--
Poor	1.15	[0.74, 1.78]	0.530
Medium	0.60	[0.36, 1.00]	0.051
Wealthy	0.91	[0.56, 1.48]	0.714
Wealthiest	0.79	[0.46, 1.36]	0.401
Guardian gender norms			
Highly restrictive (Ref)	1.00	--	--
Restrictive	0.71	[0.40, 1.25]	0.231

Moderate	0.66	[0.38, 1.14]	0.138
Equitable	0.81	[0.45, 1.47]	0.492
Guardian Educational Attainment			
No education(Ref)	1.00	--	--
Completed primary school	1.02	[0.73, 1.42]	0.891
Completed secondary school	0.89	[0.61, 1.31]	0.562
Completed higher education	0.76	[0.41, 1.40]	0.380
Region			
Khulna CC (Ref)	1.00	--	--
Dumuria	1.00	[0.68, 1.48]	0.998
Random Effects Parameters			
School-level variance	0.18	[0.06, 0.62]	--
Intraclass Correlation Coefficient (ICC)	5.2%	--	--

Note: Model adjusted for all variables listed simultaneously. Individual adolescent girls ($n = 1,464$) are nested within 101 distinct physical school clusters (representing 149 unique administrative tracking shifts). Likelihood Ratio (LR) test vs. standard single-level logistic model: $p = 0.0112$.

Chapter 5: Discussion

5.1 The Association between Decision-making power and Menstrual Health Needs

This study investigated the cross-sectional association between individual purchasing agency and the fulfilment of menstrual practice needs among adolescent schoolgirls in the Khulna district. After controlling for institutional school-level clustering and baseline household confounders, active adolescent participation in purchasing decisions (whether executed independently or jointly) demonstrated a stable, statistically significant negative relationship with comprehensive unmet menstrual needs (aOR = 0.69, $p = 0.015$). This observed relationship is conceptually consistent with the Sexual and Reproductive Empowerment (SRE) framework, which indicates that expanding an individual's voice over health-related resources corresponds with improved health practices. In the context of southwestern Bangladesh, active procurement agency may provide a pathway where an adolescent girl can prioritize materials that align with her physical comfort and absorbency requirements, thereby minimizing tracking anxieties and associated psychosocial distress. These findings mirror broader reproductive health trends documented across South Asia. For instance, evaluations of Bangladesh Demographic and Health Survey (BDHS) data indicate that shared household decision-making structures are strongly correlated with increased utilization of maternal healthcare services, including antenatal and postnatal checkups (Ghose et al., 2017). However, because this investigation relies on a cross-sectional design, several distinct, non-causal interpretations of this association must be considered. First, the observed lower odds of unmet needs among participating girls may reflect an underlying household environment of general maternal support and open communication; parents who naturally include their daughters in financial transactions are likely to be more responsive to their reproductive health requirements as a whole. Second, active decision-making may directly enhance an adolescent's psychological self-efficacy

and confidence, modifying her subjective evaluation of material adequacy and satisfaction separate from any physical changes in product supply.

5.2 The Psychosocial Environment: Interpersonal Support and Gender Norms

A key demographic pattern within this cohort is that individual purchasing agency does not operate in isolation; rather, it is distributed across a highly complex psychosocial environment. Our fully adjusted multivariable model showed that positive social environments—specifically having moderate maternal support (aOR = 0.17) and holding more progressive gender views (aOR = 0.56)—strongly relate to lower odds of unmet needs. These results match earlier menstrual health studies in rural Bangladesh, which stress that social networks, family support systems, and personal confidence matter just as much for a dignified period as a reliable supply of physical products (Hennegan et al., 2019). In this multi-level specification, household wealth quintiles and parental educational levels were not statistically associated with the outcome, with the exception of a marginal protective association in the middle wealth tier. While this null finding deviates from traditional public health assumptions that position menstrual deprivation strictly as an indicator of absolute financial poverty, severe methodological caution is required before drawing structural conclusions. Because this multivariable model adjusted for individual gender norms, parental beliefs, and social support commands simultaneously, these psychosocial variables may reside on the causal pathway or act as mediators that absorb the crude structural effects of household wealth. Consequently, these results should not be interpreted as proving that economic capital is irrelevant to adolescent girls. Instead, they indicate that within uniform socio-demographic strata, interpersonal safety nets and internalized gender equity serve as essential immediate filters through which structural economic constraints are felt and managed by the adolescent. This underscores the recommendation that menstrual health programming should move beyond simple product-distribution models toward structural norm-transformation and systemic caregiver engagement (Mehjabeen et al., 2022).

5.3 Institutional School Clustering and Null Covariate Pathways

The multi-level framework revealed a statistically significant school-level clustering effect, with ($\bar{X}^2_{01} = 5.11$, $p = 0.0119$) an Intraclass Correlation Coefficient (ICC) confirming that 5.2% of the unexplained variance in unmet menstrual practice needs is directly attributable to institutional school environments. This systemic variance supports the structural "menstrual deficit" framework, which

argues that institutional infrastructure—such as water access, disposal mechanisms, and lockable changing stalls—imposes a structural ceiling on an adolescent's health practices during the school day. The structural nature of this institutional ceiling is further supported by the clear boundaries of household purchasing agency. While active participation in product choice provides an individual advantage for material comfort, it cannot modify institutional environment failures, such as un-lockable school doors, missing waste bins, or unsafe changing spaces. This divergence highlights a "dual-track" policy requirement: individual agency-building and communication adjustments are required within the domestic sphere, but uniform structural and infrastructural interventions remain mandatory within the educational environment to overcome hardware deficits (Ghimire et al., 2024; USAID, 2024). Substantive insights are also provided by the statistically non-significant coefficients observed among key household covariates in the final model. Baseline guardian gender norms remained statistically non-significant across all operational categories ($p > 0.10$). Given that household-level patriarchal constraints are widely understood to restrict adolescent autonomy, this null finding suggests that individual school environments and peer support networks may dilute or buffer conservative domestic views once a girl enters an institutional setting. Similarly, the adolescent chronological age tier was not associated with unmet needs (aOR= 0.98, $p = 0.939$), indicating that the structural, spatial, and material barriers surrounding menstruation affect early and late adolescent schoolgirls uniformly across this regional cohort.

The school environment is a crucial institutional driver of menstrual health, as confirmed by the significant school-level variance (0.18) found in our multilevel model. This clustering implies that, independent of a girl's own agency or home circumstances, the physical and social environment of the school offers a "ceiling" for her ability to control her period. This supports the "menstrual deficit" theory proposed by Akram et al. (2021), which states that the main obstacle to dignity is infrastructure. The claim made by Ghimire et al. (2024) that personal engagement cannot completely overcome environmental inadequacies is supported by our finding that household agency alone did not significantly lower unmet needs within the descriptive sub-domains of Changing Facilities or Disposal Safety.

5.4 Strengths

This investigation possesses several distinct methodological and structural strengths. First, the analysis utilizes a large, cross-sectional sample drawn from the school-based Adolescent Menstrual Health Cohort (AMEHC) infrastructure. This considerable sample size ensures stable cohort stabilization and robust parameter estimation across adjusted multivariable models without the risk of severe degrees-of-freedom depletion. Second, this study minimizes information bias by deploying cross-culturally validated, psychometrically grounded evaluation instruments—specifically the 18-item Menstrual Practice Needs Scale–Short Form (MPNS-SF) and the SHREYA social support metric—to capture the nuanced, multi-dimensional lived experiences of adolescent girls rather than relying on un-validated product checklists. Third, by incorporating both individual-level and caregiver-level gender norm summation matrices (the Girl’s Personal Gender Norms and Baseline Guardian Gender Norms indices), this design successfully moves beyond basic economic assessments to evaluate how overlapping layers of social equity and domestic constraints interact alongside adolescent voice. Finally, the execution of multi-level mixed-effects logistic regression modeling represents a major analytical strength. Rather than ignoring institutional dependencies or relying on basic single-level modeling adjustments, this framework explicitly models the school-level clustering variance ($ICC = 5.2\%$). Because adolescent schoolgirls nested within the same institutional cluster naturally share identical water, sanitation, and physical hygiene (WASH) infrastructure, this multi-level adjustment prevents the artificial inflation of Type I error rates, yielding highly accurate, cluster-adjusted standard errors that significantly enhance the structural validity of our primary exposure estimates.

5.5 Limitations

This study has some structural and methodological limitations that should be noted. Because the analysis uses cross-sectional data from the Wave 1 AMEHC cohort, it captures individual characteristics and environment metrics at a single point in time. Consequently, it is impossible to establish temporal sequencing or confirm strong causal inference, meaning the reported parameters reflect stable adjusted statistical associations rather than directional causal pathways. In terms of measurement constraints, the primary exposure of interest—purchasing participation agency—was operationalized via a single nominal item (W1_MPQD). While structurally useful for isolating financial choice involvement, a single-item exposure cannot fully capture the shifting, nuanced power dynamics, intergenerational negotiations, and covert agency structures that characterize day-

to-day patriarchal household environments in southwestern Bangladesh. A parallel constraint exists regarding the primary outcome vector (`unmet_new`), which was constructed by converting the continuous mean score of the 18-item Menstrual Practice Needs Scale–Short Form (MPNS-SF) into a binary variable. While this threshold approach is necessary for pragmatic public health classification and multivariable mixed-effects logistic regression modeling, dichotomizing a continuous indicator naturally causes a loss of statistical information and decreases the granular variability available to observe fine-grained variations in needs fulfilment.

Further administrative limitations stem from the potential for residual confounding, despite using a robust multi-level mixed-effects strategy adjusted for pre-specified baseline characteristics and school-level clustering. Because the primary dataset lacked direct tracking indicators for the schoolgirls' broader reproductive health literacy or a standardized, objective school-level WASH infrastructure index, these unmeasured confounders may introduce residual bias into the primary exposure effect estimate. Additionally, the reliance on self-reported survey responses from adolescent girls and primary caregivers introduces the potential for social desirability and recall biases surrounding a highly stigmatized topic. This specific direction of reporting bias would likely weaken the true effect size, pulling the adjusted odds ratio toward the null. Conversely, under-reporting the use of traditional cloths or rags due to embarrassment may hide the true extent of material deprivation. Geographic generalizability is also strictly limited to the Khulna district space. While the sample effectively balances the municipal core of Khulna City Corporation against the rural landscapes of the Dumuria sub-district, Khulna City Corporation represents a highly developed major urban center. Consequently, these geographic parameters may not accurately reflect the severe environmental barriers and cultural configurations experienced by adolescent girls living in more remote rural settings, riverine char ecosystems, or waterlogged haor regions of Bangladesh, where school infrastructure and institutional support networks face distinct structural challenges.

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

This study demonstrates a stable, statistically significant negative association between individual purchasing agency and the cross-sectional prevalence of unmet menstrual practice needs among

adolescent schoolgirls in the Khulna district (aOR = 0.69, $p = 0.015$). Having a "voice in the choice" of menstrual products operates as a meaningful indicator of material and psychological comfort. From an epidemiological standpoint, involvement in purchasing should be seen as part of a wider domestic network rather than a single root cause. Our multi-level models controlled for baseline guardian education, socioeconomic status, and household gender norms, but residual confounding is always a possibility. Specifically, we could not directly measure shifting household financial priorities or how willing a parent truly is to budget for menstrual health products. Beyond the home, the data remind us that a girl's agency does not exist in a vacuum. The school-level variance (ICC = 5.2%) confirms that the school infrastructure itself dictates the boundaries of an adolescent's health habits during class hours. While active household decision-making corresponds with individual material comfort, it cannot overcome structural institutional deficits, such as a lack of private, clean changing stalls or discrete disposal facilities. Ultimately, these findings show that public health strategies must transition from a "hardware-only" or "product-distribution" framework toward a multi-component empowerment paradigm that links domestic adolescent agency with institutional environmental security (Siddique et al., 2023).

6.2 Recommendations

To optimize adolescent menstrual health, public health strategies must simultaneously address household decision-making dynamics (aOR = 0.69) and structural institutional barriers (ICC = 5.2%). The following evidence-based actions are recommended:

6.2.1 Policy and Governance

The Ministry of Health and Family Welfare should update the National Strategy for Water Supply and Sanitation to move beyond basic product distribution tallies. The Directorate of Secondary and Higher Education (DSHE) must strictly enforce the structural baselines set by the National Menstrual Hygiene Management Strategy. School monitoring and accreditation protocols across all secular schools and Madrasahs must mandate private changing stalls, soap, water, and discrete disposal systems to eliminate the institutional barriers restricting girls during the school day.

6.2.2 Programmatic and Implementation

Non-governmental organizations (NGOs) and practitioners should design behavioral change communication interventions that directly engage male and female adult guardians to foster open household dialogue and challenge domestic taboos (Alam et al., 2025). Programs should

systematically encourage parents to grant girls a "voice in the choice" during material purchasing. Strengthen Psychosocial Support: Because high maternal support (aOR= 0.17) and equitable personal gender beliefs (aOR = 0.56) are strongly correlated with fewer unmet needs, interventions should embed peer-led counseling and institutional mentoring into standard programming to build communication confidence and shift restrictive beliefs (Hunter et al., 2022).

6.2.3 Future Research

Future studies should utilize multi-wave prospective longitudinal data across the Adolescent Menstrual Experiences and Health Cohort (AMEHC) infrastructure to track variations in purchasing agency and psychometric scale scores over consecutive waves, establishing clear causal precedence. Deploy Mixed-Method Audits: Future epidemiological models should pair granular, qualitative assessments of household financial control with objective, standardized school WASH facility audits to precisely map how hardware deficits and individual autonomy interact within uniform socioeconomic strata.

Declaration of GenAI Use

I, Raisa Azim Neha , declare that in preparing this MPH thesis, I used ChatGPT (OpenAI, May 2026 version) as an academic support tool to assist with organizing the manuscript structure, overcoming writer's block during revision phases, and improving the clarity, tone, and language flow of text that I drafted myself. Generative AI was at no point utilized to generate original public health arguments, interpret raw statistical results, or produce standalone academic content. All substantive ideas, epidemiological judgments, literature syntheses, references, and final conclusions are entirely my own and have been independently verified in complete alignment with the academic integrity and research ethics guidelines of the BRAC James P. Grant School of Public Health.

References

- Alam, K. F., Islam, T., Islam, Z., Yesmin, S., Hossen, R., & Islam, M. K. (2025). Menstrual hygiene management practices, knowledge gaps, and the imperative for male engagement in coeducational high schools in Dhaka, Bangladesh. *SSB Global Journal of Medical Science*, 6(1), 31–38. <https://doi.org/10.61561/ssbgjms.v6i01.77>
- Akram, A. B., Balamurugan, J., Eva, I. J., Suma, S. J., Jyoti, N. A., Tory, N. S., & Jahan, M. I. (2024). Identifying menstrual deficit: A feminist analysis of Bangladesh's national menstrual hygiene management strategy 2021. *Multidisciplinary Reviews*, 7(12), 2024296. <https://doi.org/10.31893/multirev.2024296>
- Akoth, C., Wambiya, E. O., Kibe, P. M., Mbuthia, G. W., Ng'ang'a, L., Otieno, P., & Oguta, J. O. (2024). *Prevalence and factors associated with unmet need for menstrual hygiene management in six countries in Sub-Saharan Africa: A multilevel analysis*. *BMC Women's Health*, 24(1), 473. <https://doi.org/10.1186/s12905-024-03211-y>
- Al-Mamun, M., Kalam, A., Karim, M. Z., Alam, M., & Khan, T. H. (2025). Menstrual hygiene management in flood-affected Bangladesh: addressing socio-cultural barriers, infrastructure gaps, and policy responses. *Frontiers in Public Health*, 13, 1538447. <https://doi.org/10.3389/fpubh.2025.1538447>
- Akter, A., Ali, A. H. M. S., & Shifa, N. S. (2024). Factors related to self-care practice on menstrual hygiene among the adolescent school girls. *Asia Pacific Journal of Nursing Research*, 5(4), 1–10. <https://www.apjnr.org/index.php/apjnr/article/download/9/60>
- Betsu, B. D., Medhanyie, A. A., Gebrehiwet, T. G., & Wall, L. L. (2024). Menstrual hygiene management interventions and their effects on schoolgirls' menstrual hygiene experiences in low and middle countries: A systematic review. *PLoS ONE*, 19(8), e0302523. <https://doi.org/10.1371/journal.pone.0302523>

- Asha, A. C., Karim, N. B., Bakhtiar, M., & Rahaman, K. S. (2019). Adolescent athlete's knowledge, attitude and practices about menstrual hygiene management (MHM) in BKSP, Bangladesh. *Asian Journal of Medical and Biological Research*, 5(2), 126–137. <https://doi.org/10.3329/ajmbr.v5i2.42494>
- Chakrabarty, M., & Singh, A. (2024). *A geographical analysis of access to adequate menstrual health and hygiene resources among young women in India*. *Global Social Welfare*. <https://doi.org/10.1007/s40609-024-00359-1>
- Devi, J., & Jamali, A. (2024). Review of Menstrual Hygiene Management Practices among adolescent Girls: challenges, health implications, and future directions. *Journal of Advances and Scholarly Researches in Allied Education*, 21(5), 189–194. <https://doi.org/10.29070/3c6e0s15>
- Durairaj, T., Aparnavi, P., Narayanan, S., Mahantshetti, S., Dhandapani, S., Shanmugam, J., Rathinamoorthy, R., & Kumar, M. (2024). *Utilization of modern menstrual methods and related unmet needs among college going women in Coimbatore district: A descriptive cross-sectional study*. *BMC Women's Health*, 24(1), 78. <https://doi.org/10.1186/s12905-024-02915-5> (bmcmwomenshealth.biomedcentral.com)
- Ghimire, L. D. (2023). Exploring menstrual hygiene: A comprehensive study of knowledge, perceptions, and practices among higher secondary girl students at Baneshwor Multiple Campus, Kathmandu, Nepal. *Nepal Journal of Multidisciplinary Research*, 6(4), 45–58. <https://doi.org/10.3126/njmr.v6i4.62007>
- Ghose, B., Feng, D., Tang, S., Yaya, S., He, Z., Udenigwe, O., Ghosh, S., & Feng, Z. (2017). Women's decision-making autonomy and utilisation of maternal healthcare services: Results from the Bangladesh Demographic and Health Survey. *BMJ Open*, 7(9), e017142. <https://doi.org/10.1136/bmjopen-2017-017142>
- Ghimire, S., Gahatraj, N. R., Shrestha, N., Manandhar, S., & Dhital, S. R. (2024). Effects of health education intervention on menstrual hygiene knowledge and practices among the adolescent girls of Pokhara Metropolitan, Nepal. *PLoS ONE*, 19(9), e0291884. <https://doi.org/10.1371/journal.pone.0291884>

- Hasan, E., Chakma, S., Khanam, M., & Hajizadeh, M. (2025). Socioeconomic inequalities and its spatial pattern in sanitary napkin use in Bangladesh: Evidence from the 2019 multiple indicator cluster survey. *Population Health Metrics*, 23(1), 37. <https://doi.org/10.1186/s12963-025-00401-0>
- Ha, M. a. T., & Alam, M. Z. (2022). Menstrual Hygiene Management Practice among Adolescent Girls: An Urban-Rural Comparative Study in Rajshahi Division, Bangladesh. *Research Square*. <https://doi.org/10.21203/rs.3.rs-118150/v1>
- Hennegan, J., Hasan, M. T., Jabbar, A., Jalil, T., Kennedy, E., Hunter, E., Kaiser, A., Akter, S., Zaman, A., Rahman, M.-u., Dunstan, L., Head, A., Scott, N., Weiss, H. A., Win, T. M., Melendez-Torres, G. J., Than, K. K., Hughes, C. L., Grover, S., . . . Azzopardi, P. (2024). Protocol for the Adolescent Menstrual Experiences and Health Cohort (AMEHC) Study in Khulna, Bangladesh: A prospective cohort to quantify the influence of menstrual health on adolescent girls' health and education outcomes. *BMJ Open*, 14(4), Article e079451. <https://doi.org/10.1136/bmjopen-2023-079451>
- Hennegan, J., Hasan, M. T., Jalil, T., Hunter, E. C., Head, A., Jabbar, A., Mohosin, A. B., Zoha, N. S., Alam, M. K., Dunstan, L., Akter, S., Zaman, A., Kaiser, A., Smith, C., Bagala, L., & Azzopardi, P. S. (2024b). *Menstrual Practice Needs Scale short form (MPNS-SF) and rapid (MPNS-R): Development in Khulna, Bangladesh, and validation in cross-sectional surveys from Bangladesh and Uganda*. *BMJ Open*, 14(7), e084581. <https://doi.org/10.1136/bmjopen-2024-084581> (pubmed.ncbi.nlm.nih.gov)
- Hennegan, J., Shannon, A. K., Rubli, J., Schwab, K. J., & Melendez-Torres, G. J. (2018). Women's and girls' experiences of menstruation in low- and middle-income countries: A systematic review and qualitative metasynthesis. *PLOS Medicine*, 15(5), Article e1002574. <https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002803>
- Haque, M. J., Karim, M. R., Yasmin, N., Paul, S. P., Ara, C., Parvin, M. F., Ferdous, R., Rahman, M. A., Nahar, K., & Arefin, M. M. (2022). *Knowledge and practice on menstrual hygiene among urban adolescent girls in Bangladesh*. *TAJ: Journal of Teachers Association*, 35(2), 145–152. <https://doi.org/10.3329/taj.v35i2.63688>

- Hunter, E. C., Murray, S. M., Sultana, F., Alam, M., Sarker, S., Rahman, M., Akter, N., Mobashara, M., Momata, M., & Winch, P. J. (2022). Development and validation of the Self-Efficacy in Addressing Menstrual Needs Scale (SAMNS-26) in Bangladeshi schools: A measure of girls' menstrual care confidence. *PLoS ONE*, 17(10), e0275736. <https://doi.org/10.1371/journal.pone.0275736>
- Islam, M. S., Quddus, A. H. G., & Foroushani, A. R. (2018). Mapping the barriers of receives affordable menstrual hygiene products and healthcare services at the rural setting of Bangladesh. *Pakistan Journal of Public Health*, 7(4), 202–205. <https://doi.org/10.32413/pjph.v7i4.32>
- Joshi, K., & Mendhe, D. (2025). Navigating menstrual health and hygiene: Challenges and solutions for adolescent girls. *Journal of Pharmaceutical and Bioallied Sciences*, 17(Suppl 1), S88–S91. https://doi.org/10.4103/jpbs.jpbs_1013_23
- Majeed, J., Sharma, P., Ajmera, P., & Dalal, K. (2022). Menstrual hygiene practices and associated factors among Indian adolescent girls: a meta-analysis. *Reproductive Health*, 19(1), 148. <https://doi.org/10.1186/s12978-022-01453-3>
- Mehjabeen, D., Hunter, E. C., Mahfuz, M. T., Mobashara, M., Rahman, M., & Sultana, F. (2022). A Qualitative content analysis of rural and urban school students' Menstruation-Related Questions in Bangladesh. *International Journal of Environmental Research and Public Health*, 19(16), 10140. <https://doi.org/10.3390/ijerph191610140>
- Nurunnahar, S., Akter, N., Jahan, F., Haque, R., Hennegan, J., & Mahfuz, M. T. (2025). *Taking menstruation health and hygiene seriously: A qualitative exploration of the challenges and facility requirements of female adolescent athletes in Bangladesh*. *BMC Women's Health*, 25(1), 250. <https://doi.org/10.1186/s12905-025-03800-5> (link.springer.com)
- Plesons, M., Patkar, A., Babb, J., Balapitiya, A., Carson, F., Caruso, B. A., Franco, M., Hansen, M. M., Haver, J., Jahangir, A., Kabiru, C. W., Kisangala, E., Phillips-Howard, P., Sharma, A., Sommer, M., & Chandra-Mouli, V. (2021). The state of adolescent menstrual health in low- and middle-income countries and suggestions for future action and research. *Reproductive Health*, 18(1), 31. <https://doi.org/10.1186/s12978-021-01082-2>

- Siddique, A. B., Nath, S. D., Mubarak, M., Akter, A., Mehrin, S., Hkatun, M. J., Liza, A. P., & Amin, M. Z. (2023). Assessment of knowledge, attitudes, and practices regarding menstruation and menstrual hygiene among early-reproductive aged women in Bangladesh: a cross-sectional survey. *Frontiers in Public Health*, 11, 1238290. <https://doi.org/10.3389/fpubh.2023.1238290>
- Sommer, M., Torondel, B., Hennegan, J., Phillips-Howard, P. A., Mahon, T., Motivans, A., Zulaika, G., Gruer, C., Haver, J., & Caruso, B. A. (2021). How addressing menstrual health and hygiene may enable progress across the Sustainable Development Goals. *Global Health Action*, 14(1). <https://doi.org/10.1080/16549716.2021.1920315>
- Sommer, M., Chandraratna, S., Cavill, S., Mahon, T., & Phillips-Howard, P. (2016). Managing menstruation in the workplace: an overlooked issue in low- and middle-income countries. *International Journal for Equity in Health*, 15(1), 86. <https://doi.org/10.1186/s12939-016-0379-8>
- Sooki, Z., Shariati, M., Chaman, R., Khosravi, A., Effatpanah, M., & Keramat, A. (2016b). The role of Mother in Informing Girls about Puberty: A Meta-Analysis Study. *Nursing and Midwifery Studies, Inpress*(Inpress), e30360. <https://doi.org/10.17795/nmsjournal30360>
- Srivastav, S., Singh, A., Shukla, P., & Maurya, S. P. (2024). Understanding menstrual hygiene practices and knowledge among adolescent girls: A review. *Journal of Advances in Biology & Biotechnology*, 27(7), Article 1070. <https://doi.org/10.9734/jabb/2024/v27i71070>
- Tshivule, M. Z., Rasweswe, M. M., Mothiba, T. M., & Bopape, M. A. (2025). Factors influencing menstrual hygiene knowledge, attitudes, and practices among adolescent girls in African rural schools: scoping review. *Frontiers in Reproductive Health*, 7, 1553101. <https://doi.org/10.3389/frph.2025.1553101>
- United Nations Population Fund Bangladesh. (2023). *Menstrual hygiene management among women and adolescent girls in urban slums in Bangladesh*. UNFPA Bangladesh. https://bangladesh.unfpa.org/sites/default/files/pubpdf/mhm_urban_slum_in_bangladesh_final_feb_2023.pdf (bangladesh.unfpa.org)

- United Nations Girls' Education Initiative. (n.d.). *Agency*. In *Your gender transformative education glossary*. UNGEI. <https://www.ungei.org/gender-transformative-education-glossary/towards-transformations/agency> (ungei.org)
- USAID. (2024). Menstrual health and hygiene in Bangladesh: A landscape assessment. WASHPaLS#2Activity. https://assets.aidarchive.org/globalwaters/pdfs/1ee0eb/2024_menstrual_health_and_hygiene_in_bangladesh_a_landscape.pdf
- von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & STROBE Initiative. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *PLOS Medicine*, 4(10), e296. <https://doi.org/10.1371/journal.pmed.0040296>
- Warrington, S., Coultas, M., Das, M., & Nur, E. (2021). “The door has opened”: Moving forward with menstrual health programming in Bangladesh. *International Journal of Human Rights in Healthcare*, 14(4), 296–310. <https://doi.org/10.1108/IJHRH-11-2020-0102>