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Epidemiology of Menstrual Hygiene Management among Female Undergraduate Medical Students in a Nigerian University: An Ordinal Regression Study with Mediation and Interaction Analyses

Nduye Christie Tobin Briggs*, Ibifuro Shalom Allison and Daniel Oluwaseun Uyamasi

Department of Community Medicine, Faculty of Clinical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria

*Corresponding author: Nduye Christie Tobin Briggs, Department of Community Medicine, Faculty of Clinical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria. Email: nduye.briggs@ust.edu.ng

Abstract

Background: Menstrual hygiene management is an important component of the health of women. Female undergraduate medical students are expected to have adequate knowledge of menstrual hygiene, but optimal practices are not consistently observed. Previous studies on menstrual hygiene management used mainly descriptive or binary analytical approaches, thereby limiting the understanding of the behavioural pathways linking knowledge, attitude, and practice. This study aimed to assess menstrual hygiene management among female undergraduate medical students at the Rivers State University, Port Harcourt, Nigeria, using an epidemiological framework that incorporates ordinal regression, mediation, and interaction analyses.

Methods: An analytical cross-sectional study was conducted among 312 female undergraduate medical students using a self-administered structured questionnaire. Composite scoring systems were used to assess menstrual hygiene knowledge, attitude, and practices, with practices summarised as an ordinal menstrual hygiene management index. Associations between knowledge, attitude, and practices were assessed using ordinal logistic regression. Mediation analysis assessed the indirect effect of knowledge on practices through attitude, while interaction analysis examined effect modification between knowledge and attitude. Model diagnostics were performed, and statistical significance was set at a p-value of less than 0.05.

Results: Good menstrual hygiene knowledge was reported in 64.1% of respondents, while 58.0% demonstrated positive attitudes toward menstruation. Generally, 52.9% had good menstrual hygiene management practice. In multivariable analysis, good knowledge (adjusted odds ratio [AOR] = 2.87; 95% confidence interval [CI]: 1.62–5.08) and positive attitude (AOR = 3.41; 95% CI: 1.95–5.96) were independently associated with better menstrual hygiene management practices. Attitude partially mediated the association between knowledge and practice. A significant interaction between knowledge and attitude was observed (AOR = 1.43; 95% CI: 1.03–1.98), indicating effect modification.

Conclusion: Generally, female undergraduate medical students had high knowledge of menstrual hygiene, but their practices varied. Attitudes towards menstruation are key in shaping practices and modify the influence of knowledge, highlighting the importance of behavioural pathways in menstrual hygiene management.

Introduction

Menstrual hygiene management (MHM) is a fundamental component of women's health, dignity, and overall well-being, yet it remains inadequately addressed in many parts of the world [1]. The World Health Organization defines menstrual health comprehensively as encompassing physical, mental, and social wellness related to menstruation, acknowledging it as both a physiological process and a phenomenon shaped by social and environmental contexts [2].

Worldwide, approximately 500 million women and girls experience insufficient access to suitable menstrual products, proper sanitation infrastructure, and dependable water supplies necessary for managing their menstruation safely and respectfully [3]. Inadequate menstrual hygiene practices have been linked to heightened risk of reproductive infections, emotional stress, social marginalisation, and decreased engagement in schooling and employment [4]. Schools lacking gender-sensitive water,

sanitation, and hygiene (WASH) infrastructure further compound these challenges for menstruating students [5].

Sub-Saharan Africa experiences a particularly heavy burden of menstrual health difficulties resulting from ongoing infrastructure gaps, economic hardship, and deeply rooted cultural stigmas around menstruation [6]. Research throughout the region repeatedly identifies restricted access to private toilet facilities, inadequate waste disposal systems, and inadequate menstrual health education, all of which contribute to suboptimal menstrual hygiene behaviours [7]. Even in tertiary education settings, menstrual requirements are often neglected in campus health planning and infrastructure development [8].

Within Nigeria, menstruation continues to be a delicate and frequently under-discussed subject despite growing public health focus. Multiple investigations have recorded diverse levels of menstrual hygiene knowledge, attitudes, and practices among adolescents and young women, with misunderstandings and traditional beliefs persistently influencing conduct [9,10]. Data from various parts of the nation suggest that although menstruation awareness is reasonably widespread, ideal hygiene practices are not uniformly maintained [11]. Environmental limitations, especially poor access to water and sanitation infrastructure, further restrict young women's capacity to maintain safe menstrual hygiene [12].

Recent research suggests that menstrual hygiene behaviours result from intricate relationships among cognitive, attitudinal, and environmental factors [13]. Behavioural and health promotion frameworks stress that knowledge by itself cannot generate lasting behaviour modification without supportive attitudes and conducive environments [14]. Contemporary menstrual health research has shown that attitudes can serve as mediators between knowledge and practice, emphasising the significance of addressing psychological and social factors influencing menstrual behaviour [15].

Female university students are frequently presumed to have sufficient menstrual health understanding given their educational level; nevertheless, research from higher education institutions reveals that gaps between knowledge and practice remain even among well-educated groups [16]. Insufficient campus WASH infrastructure, ongoing stigmatisation, and limited institutional support can compromise menstrual hygiene practices, adversely affecting students' well-being, focus, and engagement in academic pursuits [17]. These issues highlight the necessity for institution-focused research to guide menstrual health programmes in university environments.

Although global and national interest in menstrual health is growing, research involving female undergraduates in Nigerian universities remains sparse, especially studies utilising composite measures of menstrual hygiene practice and advanced analytical methods. Consequently, this study assessed menstrual hygiene knowledge, attitudes, and practices among female undergraduate medical students at Rivers State University and examined behavioural mechanisms through mediation and interaction analyses.

Methods
Study Design
This study used an analytical cross-sectional design, conducted for four months (June 2, 2025, through October 10, 2025).

Study Setting
The study was conducted at Rivers State University, Port Harcourt,

Nigeria. The university has a College of Medical Sciences that offers undergraduate medical training across pre-clinical and clinical phases. Female medical students are drawn from diverse cultural and socioeconomic backgrounds, providing a suitable context for examining menstrual hygiene knowledge, attitudes, and practices within a tertiary educational setting.

Study Population
The target population consisted of female undergraduate medical students registered at the Rivers State University during the 2024/2025 academic year [18].

Eligibility Criteria

Inclusion Criteria
1. Students who had experienced their first menstruation by the time of the study.
2. Officially enrolled students available during data collection.
3. Participants who provided written informed consent.

Exclusion Criteria
1. Students who were pregnant or were within six months following childbirth (owing to modified menstrual cycles).
2. Students experiencing serious illness during data collection.
3. Submitted questionnaires with substantial missing or inconsistent responses affecting key study variables.

Sample Size Determination
The minimum sample size was calculated using Cochran's formula for single proportions, appropriate for cross-sectional studies estimating prevalence [19]:

$$n = \frac{Z^2 pq}{e^2}$$

Where:
n = minimum required sample size.
Z = standard normal deviate at 95% confidence level (1.96).
p = estimated prevalence of the key outcome= 0.50 (50%) in the absence of recent institution-specific data for Rivers State University medical students.
q = 1 – p=1-0.50=0.50.
e = margin of error (precision), usually 0.05.

$$n = \frac{3.84 \times 0.25}{0.0025}$$
$$n = \frac{0.96}{0.0025} = 384.$$

So, 384 was the *initial* required sample size.
Given that the study population was finite (<10,000), a finite population correction was applied, reducing the minimum sample size to 277. To account for potential non-response and incomplete questionnaires, a non-response adjustment of 15% was applied, resulting in a final target sample size of 326. After data cleaning and exclusion of questionnaires with substantial missing information, 312 respondents were included in the final analysis.

Sampling Technique
A stratified sampling technique was used to ensure adequate representation across distinct academic levels. The study population was initially stratified according to the phase of training, specifically pre-clinical and clinical cohorts. Within each stratum, eligible participants were systematically selected from class registers obtained through designated student representatives. A systematic sampling interval of every fifth participant was

applied within each class.

Proportional allocation was utilised to determine the requisite number of participants from each academic level, based upon the relative size of each stratum, thereby minimising selection bias and enhancing the representativeness of the sample.

Data Collection Instrument
Data were collected using a structured, self-administered questionnaire adapted from previously validated instruments and established menstrual hygiene management assessment tools [20,21]. The questionnaire comprised five distinct sections:
1. Socio-demographic Profile: This section elicited essential background information, encompassing age, sex, year of study, faculty affiliation, residential status, and other pertinent demographic variables.
2. Knowledge of Menstrual Hygiene: This domain assessed participants' understanding of menstruation, hygiene practices, and the health implications associated with inadequate menstrual hygiene management.
3. Attitudes Towards Menstruation: This section examined perceptions, beliefs, and the degree of comfort in discussing menstruation-related matters.
4. Menstrual Hygiene Practices: This component examined the type of absorbent materials utilised, frequency of absorbent replacement, hygiene maintenance practices, and disposal methods employed; and
5. Contextual and Behavioural Factors: This section assessed factors about menstrual management within the campus environment.

Validity and Reliability
Three experts in community medicine and public health reviewed the questionnaire for face and content validity before use. The questionnaire was also pre-tested with 30 students from a non-participating faculty. Feedback obtained from the pre-test informed minor refinements in phrasing and structural organisation to enhance comprehension, internal consistency, and completion time, thereby minimising participant burden. Internal consistency was assessed using Cronbach's alpha coefficient [22].

Data Collection Procedure
Data collection was conducted for one month (July 2025) during the academic session. Eligible participants were approached in their respective lecture halls and residential facilities after obtaining permission from the class representatives. The research objectives were comprehensively explained, and informed consent was obtained before questionnaire administration. Participants completed the questionnaires under conditions of anonymity and returned them immediately upon completion. No personally identifiable information was collected, thereby ensuring confidentiality and facilitating candid responses.

Data Management and Security
Completed questionnaires were checked daily for completeness and internal consistency. Data were entered into a password-protected database with restricted access limited to members of the research team. Physical copies of questionnaires were stored securely in locked cabinets.

Electronic data files were anonymised and archived on encrypted storage media. Data handling procedures adhered strictly to principles of confidentiality, data minimisation, and secure storage protocols. Only aggregated results are reported in this study, thereby precluding the identification of individual participants.

Statistical Analyses
Assessment of Knowledge, Attitude, and Menstrual Hygiene Management (MHM) Practice
Knowledge Assessment: Knowledge of menstrual hygiene was assessed using ten discrete items. Each correct response was assigned a score of one, whereas incorrect or "not sure" responses received a score of zero. Individual item scores were aggregated and converted to percentage scores ranging from 0% to 100%. Knowledge levels were subsequently categorised as good ($\geq$75%), fair (50–74%), or poor (<50%).

Attitude Assessment: Attitudes toward menstruation and menstrual hygiene were assessed using five discrete items. Correct responses were assigned a score of one, while incorrect or "don't know" responses received a score of zero. Item scores were summed and converted to percentage scores ranging from 0% to 50%. Attitudes were categorised as positive ($\geq$40%), neutral (30–39%), or negative (<30%).

Menstrual Hygiene Management (MHM) Practice Assessment and Composite Index: Menstrual hygiene management practices were assessed using six practice-related items. Each appropriate practice was assigned a score of one, whereas inappropriate practices received a score of zero. Item scores were aggregated to generate a composite MHM practice score, which was subsequently converted to a percentage score ranging from 0% to 60%. Based upon the composite score, MHM practice was categorised as good ($\geq$45%), fair (30–44%), or poor (<30%).

Data were analysed using the Statistical Product and Service Solutions (SPSS) Version 27 (Armonk, NY: IBM Corporation). Descriptive statistics were used to summarise respondent characteristics. A composite Menstrual Hygiene Management (MHM) index was constructed from practice variables, and the normality of composite scores was assessed using the Shapiro-Wilk test. Ordinal logistic regression was utilised to identify predictors of menstrual hygiene practice. Multicollinearity was assessed using variance inflation factors (VIF). A VIF >5 was considered evidence of collinearity. Variables with high collinearity were excluded. The proportional odds assumption was assessed using the test of parallel lines [23]. Mediation and interaction analyses were conducted to examine behavioural pathways linking knowledge, attitude, and practice [24]. Statistical significance was established at $p < 0.05$.

Results
Sociodemographic Characteristics
A total of 312 female undergraduate medical students were included in the analysis. The mean age of respondents was 21.4 ± 2.3 years, with ages ranging from 17 to 29 years. Most respondents were within the 20–24-year age group (61.5%). Slightly more than half of the respondents were in the clinical phase of training (54.8%), while the remainder were in the pre-clinical phase. Most respondents were single (96.8%), and most resided in off-campus accommodation [Table 1].

Table 1: Sociodemographic Characteristics of Respondents (n = 312)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
< 20	68	21.8
20–24	192	61.5
≥ 25	52	16.7
Phase of Training		
Pre-clinical	141	45.2
Clinical	171	54.8
Marital status		
Single	302	96.8
Married	10	3.2
Place of residence		
On-campus	118	37.8
Off-campus	194	62.2

Menstrual Hygiene Knowledge and Attitude

Overall, 64.1% (n = 200) of respondents demonstrated good knowledge of menstrual hygiene, 24.7% (n = 77) moderate knowledge, and 11.2% (n = 35) poor knowledge. Regarding attitude, 58.0% (n = 181) expressed a positive attitude towards menstruation, 27.6% (n = 86) had a neutral attitude, and 14.4% (n = 45) demonstrated negative attitudes [Table 2].

Table 2: Classification of Menstrual Hygiene Knowledge and Attitude

Variable	Frequency (n)	Percentage (%)
Knowledge level		
Poor	35	11.2
Moderate	77	24.7
Good	200	64.1
Attitude level		
Negative	45	14.4
Neutral	86	27.6
Positive	181	58.0

Menstrual Hygiene Practices and Composite MHM Index

Based on the composite MHM index, 52.9% (n = 165) of respondents practised good menstrual hygiene, 29.5% (n = 92) had fair practices, while 17.6% (n = 55) demonstrated poor menstrual hygiene practices [Table 3].

Table 3: Classification of Composite Menstrual Hygiene Management (MHM) Index

MHM Category	Frequency (n)	Percentage (%)
Poor	55	17.6
Fair	92	29.5
Good	165	52.9
Total	312	100.0

Bivariate Associations between Knowledge, Attitude, and MHM Practice

There was a significant association between menstrual hygiene knowledge and better MHM practice ($p < 0.001$). Similarly, attitude towards menstruation was significantly associated with MHM category ($p < 0.001$) [Table 4].

Table 4: Bivariate Associations with Composite MHM Practice

Variable	Poor (%)	Fair (%)	Good (%)	p-value
Knowledge level	41.3	33.8	24.9	<0.001
Attitude level	48.9	29.4	21.7	<0.001
Access to water/soap	36.2	31.0	32.8	0.002
Confidence in managing menstruation	39.4	30.1	30.5	0.001

Ordinal Logistic Regression Analysis

Ordinal logistic regression analysis identified several independent predictors of better menstrual hygiene practice. After adjusting for relevant variables, respondents with good menstrual hygiene knowledge had significantly higher odds of being in a better MHM category compared with those with poor knowledge (AOR = 2.87; 95% CI: 1.62–5.08; $p < 0.001$). A positive attitude towards menstruation was also independently associated with improved menstrual hygiene practice (AOR = 3.41; 95% CI: 1.95–5.96; $p < 0.001$). Consistent access to water and soap during menstruation significantly increased the odds of good MHM practice (AOR = 1.88; 95% CI: 1.12–3.15; $p = 0.017$). The proportional odds assumption was satisfied (test of parallel lines, $p = 0.61$) [Table 5].

Table 5: Ordinal Logistic Regression Predicting Better Menstrual Hygiene Practice

Predictor	AOR	95% CI	p-value
Good knowledge	2.87	1.62–5.08	<0.001
Moderate knowledge	1.69	0.98–2.90	0.058
Positive attitude	3.41	1.95–5.96	<0.001
Access to water/soap	1.88	1.12–3.15	0.017
High confidence in managing menstruation	2.11	1.26–3.53	0.004
Test of parallel lines (proportional odds)			0.61

Mediation Analys is (Knowledge → Attitude → MHM Practice)

Mediation analysis revealed that attitude partially mediated the relationship between menstrual hygiene knowledge and menstrual hygiene practice. Knowledge was significantly associated with attitude (path a), and attitude was significantly associated with MHM practice (path b). After adjusting for attitude, the direct effect of knowledge on MHM practice was attenuated but remained statistically significant. Bootstrapped analysis confirmed the significance of the indirect effect [Table 6].

Table 6: Mediation Analysis of Attitude on the Relationship Between Knowledge and MHM Practice

Pathway	β coefficient	Standard Error	p-value
Knowledge → Attitude (Path a)	0.48	0.06	<0.001
Attitude → MHM Practice (Path b)	0.55	0.07	<0.001
Knowledge → MHM Practice (Total effect, Path c)	0.53	0.08	<0.001
Knowledge → MHM Practice (Direct effect, Path c)	0.31	0.09	0.009
Indirect effect (bootstrapped)	0.22	—	<0.01

Interaction Analysis Between Knowledge and Attitude

An interaction term between knowledge and attitude was introduced into the ordinal logistic regression model to assess effect modification. A statistically significant interaction was observed between menstrual hygiene knowledge and attitude (AOR = 1.43; 95% CI: 1.03–1.98; p = 0.032), indicating that the positive association between knowledge and menstrual hygiene practice was stronger among respondents with positive attitudes toward menstruation [Table 7].

Table 7: Interaction Analysis Between Knowledge and Attitude on MHM Practice

Variable	AOR	95% CI	*p*-value
Knowledge (good vs poor)	2.11	1.24–3.58	0.006
Attitude (positive vs negative)	2.76	1.61–4.74	<0.001
Knowledge × Attitude (effect modification)	1.43	1.03–1.98	0.032

Note
Normality, Multicollinearity, and Model Diagnostics
The Shapiro–Wilk test indicated departure from normality for all composite scores (p < 0.05). Consequently, ordinal regression models were adopted for multivariable analysis.

All predictors had VIF values ranging from 1.18 to 2.04, indicating the absence of multicollinearity.

For the ordinal logistic regression model:
a. The test of parallel lines was not statistically significant (p = 0.61), confirming that the proportional odds assumption was met.
b. Model goodness-of-fit was supported by a significant likelihood ratio test (p < 0.001).
c. The Nagelkerke pseudo-R^2 was 0.42, indicating moderate explanatory power. This means that the model explained 42% of the variance in menstrual hygiene practice.

Discussion
This study assessed menstrual hygiene management (MHM) among female undergraduate medical students through the application of a composite practice index and advanced analytical methodologies. The findings indicate that whilst menstrual hygiene knowledge attained relatively high levels, such knowledge did not consistently correspond to optimal menstrual hygiene practices. Attitude towards menstruation emerged as a principal behavioural determinant, exerting both independent and moderating influences upon menstrual hygiene practices.

The observed distribution of knowledge levels indicates that a substantial proportion of participants possessed adequate knowledge of menstrual hygiene principles. This observation is consistent with reports from comparable populations within formal educational contexts, wherein access to structured curricula and health-related information contributes to increased awareness levels [9-12]. Nevertheless, the persistence of fair and poor practice categories despite adequate knowledge underscores a recurring phenomenon in menstrual hygiene research: knowledge alone does not ensure appropriate behaviour [4,15]. This incongruence between knowledge and practice is particularly evident in studies using composite practice measures, which reveal gradations of behaviour that remain obscured by binary classifications [22,27].

In the present study, only marginally more than half of the participants demonstrated proficient MHM practice, notwithstanding the fact that nearly two-thirds exhibited adequate knowledge. This observation aligns with previous evidence suggesting that menstrual hygiene behaviours exist along a continuum, influenced by multiple interacting factors beyond cognitive awareness [13,20]. The ordinal structure of the MHM outcome facilitated differentiation among poor, fair, and good practice categories, thereby providing a more nuanced representation of behavioural patterns. Similar distributions have been documented in studies utilising composite or multi-item indices of menstrual hygiene behaviour [22,27].

Attitude towards menstruation demonstrated a robust association with MHM practice in the present study, independent of knowledge. Participants with favourable attitudes exhibited significantly higher odds of classification within high MHM practice categories. This observation corroborates behavioural models that conceptualise attitude as a proximal determinant of health behaviour, mediating the influence of knowledge upon action [14,24]. Empirical evidence derived from observational and intervention studies indicates that perceptions, beliefs, and affective responses related to menstruation assume a decisive role in shaping hygiene behaviours, even among populations with adequate knowledge [17,21].

The mediation analysis conducted herein further elucidates the behavioural pathway linking knowledge, attitude, and practice. The results indicate that attitude partially mediates the relationship between knowledge and MHM practice, thereby suggesting that knowledge may influence behaviour both directly and indirectly through its effect upon attitudes. This pattern has been reported in previous studies wherein improvements in menstrual hygiene practices were preceded by measurable shifts in attitudes and perceptions following educational or behavioural interventions [13,20,25]. Through quantification of this indirect effect, the present study strengthens the epidemiological understanding of the mechanisms through which menstrual hygiene behaviours are formed and sustained.

The interaction analysis reported a statistically significant knowledge × attitude effect, thereby indicating effect modification. Specifically, the positive association between knowledge and MHM practice was more pronounced among participants with more favourable attitudes towards menstruation. This observation implies that the behavioural effect of knowledge is contingent upon attitudinal context. Similar interaction effects have been documented in studies assessing menstrual hygiene behaviours, wherein individuals possessing both high knowledge and positive attitudes consistently demonstrate better hygiene practices compared to those with high knowledge alone [25-27]. The presence of this interaction underscores the necessity of jointly modelling cognitive and psychosocial variables rather than assessing their effects in isolation.

The robustness of these findings is substantiated by the model diagnostics. The absence of multicollinearity indicates that the estimated effects of knowledge and attitude were not distorted by excessive correlation between predictors. Furthermore, the non-normal distribution of the composite MHM scores justified the application of ordinal logistic regression, an approach increasingly recommended for behavioural outcomes measured on ordered scales [23,27]. The proportional odds assumption was satisfied, thereby lending credibility to the interpretation of the adjusted odds ratios across outcome categories.

Comparative analysis with extant literature suggests that the behavioural patterns observed in the present study are consistent with findings from diverse geographic and educational contexts. Studies conducted among adolescents and young women have repeatedly demonstrated that favourable attitudes towards menstruation are associated with increased adoption of hygienic practices, including appropriate menstrual materials and hygiene behaviours [16,17,25]. Conversely, negative or ambivalent attitudes have been associated with inconsistent practices, even in the presence of adequate knowledge [21,26].

The utilisation of a composite MHM index represents a methodological advancement over single-item measures commonly used in earlier studies. Composite indices capture multiple dimensions of hygiene behaviour, thereby improving reliability and construct validity [22]. Studies using similar indices have demonstrated greater sensitivity in detecting behavioural differences and in modelling associations with psychosocial determinants [27]. The findings of the present study reinforce the utility of composite measurement in menstrual hygiene research, particularly when coupled with ordinal analytical techniques.

Although the study population consisted of medical students who might reasonably be expected to exhibit optimal hygiene behaviours owing to their professional training, the persistence of fair and poor practice categories suggests that educational exposure alone is insufficient to eliminate behavioural constraints. Comparable observations have been documented in studies conducted among university students and trainee health professionals, wherein menstrual hygiene challenges persist despite high levels of awareness [21,26,28]. This observation reinforces the proposition that menstrual hygiene behaviours are shaped by a complex interplay of cognitive, attitudinal, and contextual factors.

The magnitude of the associations observed in the present study is comparable to effect sizes documented in previous analyses examining determinants of menstrual hygiene behaviour. Adjusted odds ratios for knowledge and attitude in this study fall within the range documented in similar multivariable models, thereby lending external validity to the findings [25-27,30]. The consistency of these estimates across studies suggest that the behavioural relationships identified are not idiosyncratic to this population but rather reflect broader patterns in menstrual hygiene behaviour.

It is noteworthy that the mediation and interaction effects observed in this study were identified within a cross-sectional framework. Whilst temporal ordering cannot be definitively established, the analytical approach provides valuable insights into potential behavioural mechanisms operating within the study population. Similar cross-sectional analyses have been used to examine behavioural pathways in menstrual hygiene research, particularly in contexts wherein longitudinal data remain unavailable [24-27]. The consistency of these findings with intervention-based studies further strengthens their plausibility [25,30].

Repeated empirical evidence from various studies substantiates the behavioural patterns identified in this study, particularly emphasising the pivotal role of attitude in influencing menstrual hygiene practices [25-30]. Another research endeavour, which scrutinised menstrual hygiene behaviours among female university students utilising multivariable analytical models, revealed that positive menstrual attitudes significantly improved the correlation between knowledge and hygienic practices; this finding closely parallels the interaction effect discerned in the current analysis [28]. In a similar vein, additional studies illustrated that favourable attitudes independently forecasted increased practice scores even after controlling for knowledge and other covariates, thereby indicating that attitudinal orientation functions as a vital behavioural amplifier rather than a mere passive correlate [25, 27]. Evidence from yet another study suggests that individuals possessing adequate knowledge but harbouring neutral or negative attitudes consistently demonstrated suboptimal menstrual hygiene behaviours, thereby corroborating the partial mediation effect observed in this study [26]. Collectively, these findings align with the current results and provide convergent epidemiological evidence that menstrual hygiene management behaviours are shaped through interdependent cognitive and attitudinal pathways rather than knowledge acquisition alone [28-30].

Strength of the Study
A key strength of this study lies in the use of a composite Menstrual Hygiene Management (MHM) index along with advanced analytical methodologies, such as mediation and interaction analyses, which transcend conventional descriptive knowledge, attitude, and practice (KAP) assessments. Furthermore, the stratified sampling technique contributed to enhanced representativeness across various academic tiers.

Limitations of the Study
First, the cross-sectional design limits causal inference, as associations between knowledge, attitude, and menstrual hygiene practices were assessed at a single point in time. Consequently, temporal relationships between these variables cannot be established.

Second, data collection was conducted through self-reported questionnaires, which are susceptible to recall bias and social desirability bias, particularly within a cohort of medical students who may exhibit a tendency to report socially acceptable behaviours. Although measures were implemented to ensure anonymity to mitigate this effect, a certain level of reporting bias cannot be entirely excluded.

Third, the study was conducted among female undergraduate medical students in a single university, which may limit the generalisability of the findings to other student populations or

institutions with different cultural, infrastructural, or academic contexts. In addition, sociodemographic variables were not included in the multivariable models, which restricted the assessment of broader structural determinants of menstrual hygiene practices.

Finally, although a composite Menstrual Hygiene Management index was used to strengthen measurement of practice, it may not fully capture all contextual and qualitative dimensions of menstrual experiences, such as emotional distress or institutional constraints.

Conclusion
This study reveals that, despite a generally positive disposition towards menstrual hygiene knowledge and attitudes among female undergraduate medical students at Rivers State University, the adoption of optimal menstrual hygiene practices remains inconsistent. The results underscore a pronounced disparity between theoretical knowledge and practice application, with attitudes playing a crucial mediating and moderating role in the formation of menstrual hygiene practices. Access to adequate water and hygiene facilities further influenced practice, underscoring the importance of supportive environments. Overall, menstrual hygiene management among university students is driven by a complex interaction of cognitive, behavioural, and environmental factors, suggesting that information alone is insufficient to ensure optimal practice.

Recommendations
1. Campus initiatives should focus on addressing menstrual attitudes and the associated stigma.
2. Enhancement of water, sanitation, and hygiene (WASH) facilities within campus settings.
3. Incorporation of menstrual health into student wellness programmes and policy frameworks.
4. Future longitudinal and qualitative investigations.

Implications for Practice and Research
The findings indicate that menstrual health programmes directed at university students should transcend simple information dissemination to tackle attitudes, stigma, and the creation of enabling environments. Future research should be on longitudinal studies to assess changes in menstrual hygiene practices over time and qualitative approaches to examine the deeper sociocultural influences shaping attitudes toward menstruation among young women in tertiary institutions.

Contribution of the Study to Knowledge
This study adds to existing literature by providing a methodologically robust assessment of menstrual hygiene management among female university students using a composite practice index rather than single-item indicators. By applying ordinal logistic regression, the study captures gradients in menstrual hygiene practice and offers more policy-relevant insights than binary outcome models.

Importantly, the study extends beyond conventional KAP analyses by demonstrating that attitude partially mediates and modifies the relationship between knowledge and practice, highlighting the behavioural pathways through which menstrual hygiene behaviours are shaped. This finding reinforces the need for integrated interventions that address both cognitive and psychosocial determinants of menstrual health.

The study also contributes institution-specific evidence from Rivers State University, thereby providing a local empirical basis for campus-level health promotion, infrastructure planning, and student welfare policies. Overall, the findings support a shift from purely informational approaches toward multifaceted, behaviour-centred menstrual health interventions in tertiary educational settings.

Ethical Considerations
Ethical approval for the study was obtained from the Health Research Ethics Committee of Rivers State University. Participation was entirely voluntary, and informed consent was obtained from all participants before data collection. Participants were informed of their right to decline participation or withdraw from the study at any point without any academic or personal consequences.

Confidentiality and anonymity were strictly maintained throughout the study. No personal identifiers were collected, and data were used solely for research purposes.

Authors' Contributions
ISA: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing – Original Draft.
DOU: Conceptualization, Methodology, Data Collection, Project Administration, Writing – Original Draft.
NCTB: Supervision, Methodology, Data Analysis, and Interpretation, Validation, Writing – Review & Editing.

All the authors read and approved the final manuscript.

Competing Interests
The authors have declared that no competing interests exist.

Conflict of Interest
The authors declare no conflict of interest.

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