12-2022

A mixed methods assessment of menstrual hygiene management and school attendance among schoolgirls in Edo State, Nigeria.

Madeline Tomlinson
University of Louisville

A MIXED METHODS ASSESSMENT OF MENSTRUAL HYGIENE MANAGEMENT AND SCHOOL ATTENDANCE AMONG SCHOOLGIRLS IN EDO STATE, NIGERIA

Madeline M. Tomlinson

MPH, University of Louisville, 2019

BA, Yale University, 2017

A Dissertation Submitted to the Faculty of the School of Public Health and Information Sciences of the University of Louisville in Partial Fulfilments of the Requirements for the Degree of

Doctor of Philosophy in Public Health Sciences

Department of Epidemiology and Population Health

University of Louisville

Louisville, KY

December 2022

A MIXED METHODS ASSESSMENT OF MENSTRUAL HYGIENE MANAGEMENT AND SCHOOL ATTENDANCE AMONG SCHOOLGIRLS IN EDO STATE, NIGERIA

By

Madeline M. Tomlinson

MPH, University of Louisville, 2019
BA, Yale University, 2017

A Dissertation Approved on

November 16th, 2022

By the following Dissertation Committee:

_____

Dr Anne Baber Wallis

_____

Dr Rick Baumgartner

_____

Dr Muriel Harris

_____

Dr Natalie DuPre

_____

Dr Friday Okonofua

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the help and guidance of those around me. I am thankful to my committee members, Dr. Richard Baumgartner, Dr. Natalie DuPre, and Dr. Muriel Harris for your continued support, expertise, and encouragement throughout this process. Dr Dupre, thank you for all the extra meetings and guidance as I wrote up my dissertation, your guidance is always very appreciated.

A special thank you to Professor Friday Okonofua, who kindly hosted us in Benin City, Nigeria with hospitality and kindness while introducing me to the study sites for this project. It was an honor to work alongside your esteemed team and learn more about global health and Nigeria through your vast experience in medical and public health. Thank you also to Mrs. Pat Okonofua for the on-going support and kindness throughout the summer of data collection, your family made my first time in Nigeria a wonderful experience. I would also like to extend my gratitude to Dr Ken Toby, Ms Vivian Onoh, my data collectors, and everyone else at the Women's Health and Research Centre who made my first trip to Nigeria so welcoming and fruitful.

A big thank you to my chair, Dr. Anne Wallis who has acted as much more than an advisor over the past 5 years. Dr. Wallis has been a role model, advocate, and friend as I have navigated new public health skills, new cultures, and new connections during my graduate training. Learning the trials and triumphs of global health research with the leadership of Dr. Wallis has been one of the most rewarding journeys of my academics to date.

A very special thank you for my fellow classmates and colleagues, Lindsey Wood, Kendria Kelly-Taylor, Felicia Pugh, Lyndsey Blair, and Johnnie Newton. There

were many long nights and many more assignments that would have been a lot less fun without your support.

Thank you to all the professors in the School of Public Health who have provided me with the skills to accomplish this dissertation. I hope to continue building on the solid foundation of knowledge I gained through your classes. A special thank you to Ms. Robin Newlon who has answered more questions than anyone and helped me navigate through various administrative processes.

A big thank you to my family who have put up with me being thousands of miles from home for much longer than expected. The video calls and WhatsApp messages have kept me grounded through times of turbulence and uncertainty. A special thank you to my sisters for the constant encouragement, reassurance, and inspiration to keep striving for bigger goals. Finally, a huge thank you to Caleb, who has been by my side since the beginning of my graduate school journey and has weathered more of my stresses than anyone else. Thank you for staying by my side, fixing my computer whenever it broke, and making sure I had the right amount of diet coke, chocolate chips, and pep talks to succeed.

ABSTRACT

A MIXED METHODS ASSESSMENT OF MENSTRUAL HYGIENE MANAGEMENT AND SCHOOL ATTENDANCE AMONG SCHOOLGIRLS IN EDO STATE, NIGERIA

Madeline M. Tomlinson

November 16th, 2022

Background

Menstrual hygiene in lower-middle-income countries (LMICs) is limited and has been linked to many health, educational and social effects. However, the prevalence, details, and impact of menstrual hygiene management have not been well characterized in rural and peri-urban settings across Nigeria. The overall purpose of this research was to investigate menstrual hygiene management (MHM) among adolescent schoolgirls in peri-urban areas of Edo State, Nigeria; and to determine the educational consequences associated with poor MHM.

Methods

MHM was measured using previously validated questions that were adapted after a formative assessment of MHM within the Edo State community. We used a mixed methods study design to assess the knowledge, practices, and attitudes surrounding menstruation among schoolgirls aged 11-19 years old though in-depth interviews and questionnaires. Firstly, descriptive statistics were used to assess the menstrual characteristics and the major barriers to menstrual hygiene management (Aim 1). Next, the association between menstrual hygiene management (i.e., access to sanitary materials, disposal, changing spaces, and water) and school days missed due to menstruation was examined using multivariable logistic regression (Aim 2).

Results

The average age of menarche in our study population was 13 years. The most common reported physical symptoms were stomach pain (73.66%), mood irritability (40.73%), and wet feeling on genitals (37.09%) with no girls reporting no symptoms. Menstruation knowledge was acquired mostly from mothers. The participants correctly answered 76.9% basic questions about menstruation. Almost half of girls (42.63%) felt anxious for their next period, and the girls described cultural myths surrounding menstruation driving them to hide their menstrual products and feel embarrassed to ask for more information or help. Only 27 girls (4.73%) reported complete adequate menstrual hygiene management during their last period. Missing school due to menstruation was associated with inconsistent access to water at school (OR 1.75 95% CI 0.81, 3.78), physical symptoms (headache OR 1.90 95% CI 1.10, 3.28; stomach pains OR 1.43 95% CI 0.71, 2.91; and back pain OR 1.52 95% CI 0.83, 2.75), other symptoms such as mood irritability (OR 1.29 95% CI 0.75, 2.23), stained underwear (OR 1.35 95% CI 0.76, 2.39), never learning about menstruation (OR 2.71 95% CI1.03, 7.14), changing less than 4 times in 24 hours (OR 1.85 95% CI 0.92, 3.73), and a lack of menstruation knowledge (OR 1.18 95% CI0.69, 2.01).

Conclusions

This research has shown that improving menstrual hygiene management requires a multi-faceted response that integrates structural changes, social movements, and early access to menstruation knowledge. In addition, this study has shown the clear impact that poor MHM has on a girl's education, underpinning the need to act. By addressing a root

cause like poor MHM, many girls and women will be lifted up and the gender disparities can begin to be dismantled.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1: INTRODUCTION

THESIS ORGANIZATION

This dissertation has been prepared as a manuscript-format dissertation according to specifications provided by the Department of Epidemiology and Population Health Sciences at the University of Louisville School of Public Health and Information Sciences.

Following the introduction in Chapter 1, Chapter 2 is included as a systematic literature review, Chapter 3 describes the study methodology, Chapters 4 and 5 are individual manuscripts, and Chapter 6 is a discussion and summary of research findings. The Chapter 2 literature review will be submitted for review in the African Journal of Reproductive Health, Versions of Chapters 3 and 4 will be submitted to the International Journal of Women's Health and Healthcare for Women International, respectively.

RATIONALE

The unequal access and poor experiences of women during the natural event of menstrual bleeding play a significant role in the poor education, employment, and health outcomes of women compared to men in developing countries[1]. Adequate menstrual hygiene management (MHM) is defined as "women and adolescent girls using a clean menstrual management material to absorb or collect menstrual blood, that can be changed in privacy as often as necessary for the duration of a menstrual period, using soap and water for washing the body as required, and having access to safe and convenient facilities to dispose used menstrual management materials"[2]. As the number of menstruating women and girls continues to increase with population growth, the Water Supply, Sanitation, and Hygiene (WASH) Poverty Diagnostic Initiative led by the World Bank estimates suggest over 500 million women and girls currently suffer from a lack of adequate facilities for menstrual hygiene management, creating a global crisis of period poverty[3].

Das Gupta (1995) contends that a woman's access to power, opportunity, and autonomy varies over the life cycle and is dependent on big life events and transitions, such as menarche. Despite the variation in other variables such as, socioeconomic status, location, occupation, and cultural norms that significantly impacts a female's vulnerability, the onset of menstruation highlights a significant change in the needs of women. These needs are not always met; for example, existing studies across West Africa show that less than half of girls do not know about menstruation before their first period[4], 37% of girls cannot afford sanitary pads[5], and only 2 out of 5 schools assessed have toilets[6]. These issues are propagated by an overarching taboo around the subject of menstruation and have been

correlated to poor educational, employment, and mental health outcomes for women and girls[7–9]. Although "period poverty" has recently gained more attention within the global health community, there is a sparsity of data assessing the full extent of MHM in Nigeria, especially in rural and peri-urban communities.

Using mixed methods to delve into community members' knowledge, attitudes, and experiences, this research gives a voice to those who are not often heard and provides a higher level of understanding of the status of MHM. In-depth interviews with adolescent girls aged 11 to 19 years old who are currently menstruating gives an insight into the access to knowledge, materials, and facilities within school and the community, as they reflect on the actual usability of the MHM components at present. Cross-sectional surveys distributed to 600 girls aged 11 to 19 years old provide supplementary data to assess the impact of poor MHM on educational outcomes.

The study sample is drawn from schools surrounding Benin City in Edo State, Nigeria to highlight the perspectives and needs of adolescent girls living in peri-urban locations. Benin City is the fourth largest city in Nigeria, with a population of 1,841,084 people and a population density of approximately 278 people per square mile[10]. According to the Nigerian National Economic Empowerment Development Strategy (NEEDs) 2004 publication, the rate of urban growth in Nigeria is one of the fastest in the world.[10] The growing population in Benin City has given rise to cities expanding into peri-urban settlements as populations are pushed outward from the urban city centers to less developed and less resourced areas. These settlements are connected to the urban centers; however, despite being closer in distance to urban resources, such as health and education centers, water sources, and electricity, they often have less access to the resources because of a lack

of transport, poor road quality, and economic hardship among other reasons. In addition, the populations residing in these areas are still exposed to the 'urban' comorbidities correlated with problems like air pollution and overcrowding. For these reasons, it cannot be assumed that the needs of urban populations extend to the peri-urban communities around them; thus, it is important to assess peri-urban communities to evaluate the needs of the populations with a unique set of challenges.

This study will be the powering force behind a larger project to design, implement, and evaluate a community-driven intervention within Edo State, Nigeria. The overall long-term goal of this work is to inform cost-effective, sustainable, and environmentally friendly interventions that can boost female empowerment, reduce female and maternal morbidities, and begin to shift the culture around menstruation to allow a safe menstrual management for all women. This project also contributes towards the attainment of several United Nations Sustainable Development Goals (SDGs), including:

- SDG 3: Good health and wellbeing
- SDG 4: Inclusive and equitable quality education
- SDG 5: Gender equality and women's empowerment
- SDG 6: Clean water and sanitation
- SDG 8: Decent work and economic growth
- SDG 12: Responsible consumption and production

OBJECTIVE

The *objective* of this research is to understand the knowledge, attitudes, and practices surrounding menstrual hygiene management (MHM) and gain new insight into

the relationships between MHM and demographic factors and school absenteeism among adolescent girls in Edo State, Nigeria.

RESEARCH QUESTIONS

1. What is the current status of literature assessing MHM across West Africa? **(Chapter 2)**
2. What are the major themes surrounding MHM knowledge, attitudes, and practices among adolescent girls in rural Edo State? **(Chapter 4)**
3. What are the predictors for poor MHM among adolescent girls? **(Chapter 5)**
4. Are there relationships between MHM knowledge and practices and school attendance? **(Chapter 5)**

SPECIFIC AIMS AND HYPOTHESES

The specific aims include:

- **AIM 1:** Describe the knowledge, attitudes, and practices of MHM among adolescent schoolgirls in peri-urban areas in Edo State, Nigeria.
    - 1a. Describe the demographic make-up of the study participants regarding age, school year, poverty level, and parental education level.
    - 1b. Assess the average age of menarche, main source of knowledge about menstruation, main symptoms during menstruation, most common management methods, most common source of materials, disposal methods, average knowledge of menstruation, average perception of menstruation, and overall menstrual well-being of the study participants.

    - 1c. Describe the major barriers to menstrual hygiene management and most prevalent needs during menstruation using thematic analysis of qualitative interviews.

- **AIM 2:** Identify demographic and other covariates associated with poor MHM (access to safe materials, safe disposal, private space to change in school, and sanitation facilities) and the relationship between poor MHM and school attendance using bivariable and multivariable assessment to adjust for individual and school level confounding.
    - *Hypothesis:*
        - Controlling for individual and school level factors, adolescents with poor MHM will have a higher odds of school days missed during their last period.

The *longer-term goal* of this work is to use this preliminary research to inform the design and implementation of a sustainable intervention to respond to the MHM needs of this community. Next steps of this research include a community informed intervention implementation and evaluation study.

This study was fully funded by the Centre of Reproductive Health Innovation (CERHI) via the World Bank. Funding was acquired through an application process including a concept paper, a written proposal, an oral review, questioning, and a funding decision.

CHAPTER 2: MENSTRUAL HYGIENE MANAGEMENT AMONG ADOLESCENT GIRLS IN WEST AFRICA: A SYSTEMATIC REVIEW

OBJECTIVES

A systematic literature review was conducted to examine all recent academic, peer-reviewed studies of menstrual hygiene management (MHM) across adolescent girls in West Africa. The objective was to assess the current status of the scholarship surrounding the knowledge, attitudes, and practices of MHM across West African countries and identify gaps in the literature for further research. The authors searched the epidemiological literatures indexed in PubMed and cross-referenced bibliographies for studies published between 2010-2022. Of 59 abstracts and articles screened, 35 met the final inclusion criteria. Despite differences in study design, setting, and data sources, the study results concurred on an average age of menarche between 12-15 years old among adolescent girls in West Africa. The knowledge of MHM came from multiple sources, most commonly mothers, female siblings, and teachers and higher knowledge was associated with age, source, wealth, religion, and education level. Less than half of the adolescent girls knew about menstruation before menarche. Many studies showed that girls were shocked by their first period and fearful of staining. Menstruation was associated with dysmenorrhea, fear/embarrassment, and missing school. The existing studies suggest that more implementation and evaluation of menstrual hygiene management materials, education, and facilities are needed to address the educational, physical, and social disparities that exist among girls in West African countries.

INTRODUCTION

Menstruation is a natural process experienced by over 300 million women across the globe[11]. However, despite being biologically the same process, there is increasing acknowledgment that the experience of women during their menstrual period is not equal. Girls in low- and middle-income countries (LMIC) often enter their adolescence ill-equipped with knowledge, materials, and facilities to manage their menstruation[1]. Adequate menstrual hygiene management (MHM) is the safe use and disposal of sanitary material to collect menstrual blood and the option to change this material in privacy as many times as necessary during the period of bleeding (WHO)[12]. Menstrual hygiene management is accompanied by a taboo surrounding menstruation that propagates a lack of understanding, discomfort, and fear around menstruation, especially in low- and middle-income countries (LMIC)[13]. Many studies have highlighted the core challenges of girls' finding clean sanitary material, a place to change and dispose of their used sanitary material, and a general lack of understanding of the menstrual cycle[11,13,14]. These challenges are associated with school attendance[9,15], school participation[16], and mental health[13]. Consequently, issues surrounding menstruation contribute to the persistent gender disparity between girls and boys in relation to education, health, and overall well-being.

While MHM has been in the limelight of academic research with more sophisticated study methods in recent years, the body of literature assessing MHM in West Africa has not undergone a contemporary systematic review. The primary aim of this systematic review is to critically examine the existing literature surrounding MHM among adolescent girls in West Africa and assess gaps in the literature to make

recommendations for future research and interventions. This review aims to answer the following questions: 1) What is the average age of menarche among adolescent girls in West Africa? 2) How knowledgeable are girls in West Africa about menstruation and who are the sources of information? 3) What are the prevalent attitudes and practices surrounding menstruation among girls in West Africa? 4) What factors relate to the knowledge, attitudes, and practices of girl's during their menstruation? 5) How does poor menstrual hygiene management relate to health and educational outcomes among girls in West Africa?

This review synthesizes scientific progress from 2010-2022 on this topic to identify gaps and make recommendations for future research.

MATERIALS AND METHODS

Search Strategy

A systematic literature review was conducted including all studies published in English that assessed menstrual hygiene management (MHM) among adolescent girls in West Africa in accordance with the PRISMA guidelines[17]. The authors searched for articles published by academic, peer-reviewed journals using the PubMed database from January 2010 through April 2022 to assess recent developments in literature. The following Boolean logic was applied: *[(menstrual hygiene management OR menstrual hygiene OR menstruation OR menarche) AND (attitudes OR knowledge OR practices OR experiences) AND (adolescent OR youth OR young OR teenager OR adolescence) AND (girl OR woman OR female) AND (West Africa)]*. Bibliographies of the identified studies were also screened for any other articles.

Screening and Review Process

The authors screened and reviewed the articles retrieved from the search strategy. Articles were screened for studies that reported analyses of original data directly addressing menstrual hygiene management or menstrual practices. Studies with the following characteristics were excluded: 1) inadequate documentation and reporting of study methodology or results; 2) primary study outcome or exposure was something other than menstrual hygiene management and related practices, knowledge, and attitudes; 3) methodology too weak or poorly explained for assessment in a systematic review; 4) duplicate publications; 5) non-female and non-adolescent study samples; 6) methodological papers; 7) study populations outside of West Africa.

Tabulation of Findings

The following information was obtained and tabulated for each included study: first author (year) and setting; study design, data source(s), and sample size; outcome(s) and exposure(s); study sample exclusions; co-variables examined; results; study strengths and limitations. All quantitative studies used bivariate analysis measures or odds ratios for assessment of associations.

RESULTS

Search Findings

The search results and review process are summarized in the flow chart (Figure 1), in accordance with the PRISMA guidelines[17]. The PubMed and bibliography search yielded 59 citations published from January 2010 to April 2022. Thirty-eight of the 59

articles were considered relevant after reviewing the abstracts and were systematically reviewed. After further review, three of the 38 remaining studies were excluded. The specific reasons for exclusion included: unrelated exposure and/or outcome (e.g., menstruation after childbirth, male menstruation, methodology assessment, fertility control, breast milk, femininity and gender role, HPV, contraceptive methods), study sample not located in a West African country, or exposure or outcome not well-defined to measure menstrual hygiene management.

A total of 35 studies met the inclusion criteria: 16 were conducted in Ghana, 14 in Nigeria, 1 in The Gambia, 1 in Cameroon, 1 across all LMICs including some West African countries, and 2 across all Sub-Saharan African (SSA) countries including West African countries. The studies are presented in Table 1 for Ghana studies, Table 2 for Nigerian studies, and Table 3 for other studies. Within each table, the studies are organized in reverse chronological order by year of publication.

Study designs and Sample Populations

As shown in Tables 1-3, 25 of the studies were quantitative cross-sectional, two were qualitative cross-sectional, one was a non-randomized intervention trial, five were cross-sectional mixed methods, and two were literature reviews. In Ghana, 12 of the studies were cross-sectional with quantitative measures, two were cross-sectional with qualitative methods, one incorporated both cross-sectional quantitative and qualitative data collection methods, and one was a non-randomized trial (Table 1). The latter is the only published longitudinal intervention evaluation conducted in West Africa, a decade ago (Montgomery et al., 2012[9]). Among the studies in Ghana, all but one (Anaba et al.,

2022[18]) were school-based studies sampling between 120-760 students (in quantitative studies) from junior schools, seniors schools, and universities, including a range of ages from 11-25 years old. The school populations were reflective of each other with the demographic factors of the girls; however, cultural factors may have differed between populations and were not measured. On a larger scale, Anaba et al. analyzed data from the 2017/18 Multiple Indicator Cluster Survey to give a nationally representative sample (N=10,861) of menstruating women in Ghana, providing more externally valid results than the school-based studies. However, their sample was not exclusive to adolescent girls.

In Nigeria, 11 of the studies were cross-sectional design with quantitative methods, two studies were cross-sectional with qualitative methods, and one study was mixed methods using both quantitative and qualitative cross-sectional data collection methods (Table 2). Among the 14 Nigerian studies, 11 were school-based studies conducted at all levels of education in which adolescents partake with sample sizes ranging from 122-494 individuals (quantitative) and 10 in-depth interviews (qualitative). Similar to Anaba et al.'s[18] large scale study in Ghana, Hennegan et al.[19] used data from the 2015 Performance monitoring and accountability 2020 (PMA2020) dataset (N=1,994) to assess menstruation among a large, representative sample of women of reproductive age. Furthermore, the studies from Cameroon and SSA were quantitative cross-sectional studies with large sample sizes (N=1,157 and N=7,116, respectively) (Table 3). Shah et al.'s study from The Gambia also used a cross-sectional design, with a mix of qualitative and quantitative data collection methods giving a smaller sample size (N=331 survey

respondents; 20 focus groups; 13 in-depth interviews), but a deeper dive into the challenges of menstrual hygiene among adolescents.

Among all 35 studies assessed, male participants were excluded from all studies apart from four (Shah et al., Mohammad et al., Dorgbeter et al., and Finlay et al.)[4,6,14,20]. This excludes a large proportion of populations that play a role in the socio-cultural experience of menstruating girls; thus, an assessment of the male perceptions and attitudes towards menstruation should be assessed in further studies. Pre-menarcheal girls were excluded from all studies. Therefore, the measures of knowledge of menstruation before experiencing menarche may have had a higher chance of recall bias, especially among older girls.

Findings about the age of menarche and cycle length

Out of the 21 studies that reported the age of menarche and the four studies that measured menstrual cycle length, the age of menarche ranged from 12.5-15.0 years and the median cycle length ranged from 21 to 35 days (Tables 1 and 2). The two literature reviews assessing countries in SSA and LMICs reported a mean age of menarche between 11 and 15 years old (Table 3).

Only three studies assessed the factors affecting age of menarche, finding that in Cameroon, rural dwellers had an older age of menarche (13.0 years) when compared to urban dwellers (12.5 years) and those with a higher BMI experienced menarche earlier in Nigeria[21–23]. Moreover, when fully adjusted for father's education and occupation, number of house occupants, number of parents alive, religion, and BMI, participants in an urban setting were 4.35 times (2.27-8.33) more likely to experience earlier menarche

than rural participants[21]. In addition, the age of menarche was more likely to be younger among adolescent girls who live with two parents, have parents with skilled occupations, watched television more, and who have a higher BMI compared to their counterparts;[21] however, these associations were not adjusted for potential confounding. Additional confounders that could be considered in future studies include medication use, physical activity, and urban/rural residence, which have been found to relate to menarche and may relate to age. Furthermore, Anikwe et al. found a significant positive association between lower social class and a younger age of menarche after the age of 13 years, possibly due to urbanicity but this factor was not assessed.[22]

Findings about menstruation knowledge

Knowledge

The assessed studies showed a mixed prevalence of girls with a current general knowledge related to menstruation ranging from 51.9%-97.8%[4,6,14,21,24–27]; however, studies that assessed the level of knowledge showed that although most girls know that menstruation is a monthly flow of blood, arriving around the age of 11-16 years, and lasting 2-7 days each month, only one third of girls knew that a menstrual cycle lasts from one period to the next and only a quarter of girls knew that the length can vary from 30 days[26]. Additionally, Boakye-Yiadom et al., 2018[28], stated that 67.5% of adolescent girls had adequate MHM knowledge, defined as scoring five out the eight questions answered correctly. Oche et al.[29] similarly reported that 35% of adolescent girls in their study had low knowledge of menstruation, answering less than half the questions correctly, with 79% of girls reporting that the blood came from the womb.

In addition, many girls did not know about menstruation before they experienced menarche (33-49.4%) and studies reported that 53-65% expressed fear and shame when they first menstruated[4,6,21,28].

A higher knowledge of menstruation was found to be associated with older age and an older age of menarche, for example, Finlay et al. showed that participants aged 19 were 6.5 times (95% CI 5.203, 8.060) more likely to know about menstruation than 10-year-olds[14]. Those with a school teacher as the main source of menstruation information and those in school were also more likely to know more about menstruation than those with other sources of information (e.g. friend, parent, sibling, other relative, no-one) or those who did not attend school[14,25]. Ssewanyana et al.'s[30] literature review based in countries across Sub-Saharan Africa suggest that low knowledge before menarche ranges from 4-90%. Wealthier socioeconomic characteristics were associated with a higher knowledge of menstruation; for example, having worked in the past year, being in the highest wealth quintile, having a well-educated mother, having attained a higher education level, and owning a television[6,14,24,29]. Girls who identified as Christian instead of Muslim generally had better knowledge[25]. Finally, a surprising finding in Cameroon was that 80.6% of rural participants had correct knowledge of menstruation compared to 63.0% of urban participants[21].

The major sources of menstruation information included mothers (28.0-95.0%), teachers/school (7.4-91%), mass media (34-72.4%), health workers (10.0-46.1%), female relatives (11.4-42.6%), and peers (6.1-57.4%)[4,27,28,31–35]. Iliyasu et al.[33] discussed the hesitation from mothers surrounding sexual reproductive health information because of a fear of sexual experimentation; nevertheless, 81.1% of mothers agreed that girls should

be informed about menstrual hygiene. Similarly, 47.3% of students in a Benin City, Nigeria study advocated for more public awareness and education on menstruation[35].

Attitudes towards menstruation

Feeling unclean and ashamed

The prevalence of positive attitudes towards menstruation (e.g., "I feel confident during my period") was estimated to be 13.6% of adolescent girls in a Ghana study[28]. Across various studies, 70.1-85.8% of girls reported they felt impure or unclean during their menses[4,6,28,36]. For example, Mohammad et al. found that 85.8% of girls believed menstruating was impure and shameful resulting in many girls (73.2%) not attending religious services and a few girls (14.7%) sleeping separately from family members during the time of bleeding[6]. Further, Shah et al. found that girls often do not cook, attend crowded gatherings, or touch the Qur'an during their menses because of feeling impure[4]. Rheinlander et al. reported that the association of menstruation with shame and feeling dirty meant that girls used code names, had a fear of changing, and missed school to conceal their menses from others[36]. Similarly, Boakye-Yiadom et al. reported that over half the adolescent girls (57.5%) thought menstruation is shameful to discuss[28].

Poor body image and low self-esteem and anxiety were found to be significant predictors of respondents' negative attitudes towards menstruation, with some studies alluding this to poor preparation and misinformation surrounding menstruation[13,29]. For example, suspicion around menstruation and its relation to sexual behavior was reported to cast shame over menstruation in some communities. Iliyasu et al. reported that conversations about menstruation were initiated by mothers and were not interactive because questions back from girls were seen as suspicious[33]. In addition, Gyan et al.

reported that adolescents perceived early onset menarche as a sign of sexual and reproductive health risk[37].

Feeling physical and emotional pain

The biggest challenges contributing to the negative attitudes surrounding menstruation included dysmenorrhea, more commonly known as period cramp.[6,21,22,31,33,35,38]. Dysmenorrhea, described in one study as "like two fresh sores being sawed"[38] interfered with daily activities like school attendance[22], sleep[38], and physical activity[39]. The use of contraceptive pills[33] and irregular menstrual flow[22] were significantly associated with an increased odds of dysmenorrhea. In addition, some studies reported an increase in feelings of being "irritable" or "depressed," or having "altered emotions" during their menses[6,35,38].

Practices of menstrual hygiene

Materials Used

The most used menstrual product across studies was commercial disposable pads with use ranging from 21%-87%[6,15,16,18,28,33,35]. Other materials included reusable pads used by 6%-54.2% of respondents, old cloth or pieces of mattresses used by 9%-54% of respondents[6,26,28]. The choice of material was influenced primarily by cost, in addition to comfort, safety, fear of stigma, and availability (presence of a shop and distance to travel)[28]. Salami et al. reported that despite preferring disposable pads, 37% of girls could not afford them[5].

Changing Materials

Respondents reported that they change their sanitary pad 2-3 times a day and bathe with soap and water 1-2 times a day[29,35]. The changing facility varied by study but most reported was the lack of adequate MHM facilities in schools. Mohammad et al. reported that although toilets were separated by sex, only two out of five schools assessed had handwashing facilities and clean toilets[6]. None of the studies mentioned the presence of locks in the toilet facilities. In addition, none of the schools had a mirror, soap, or a consistent supply of water[6]. Poor sanitation infrastructure was also highlighted in Rheinlander et al.'s study where there was a lack of functioning toilets, no lights in the toilet building, a water shortage, mixed sex toilets with no privacy, and reports of vaginal infections caused by dirty toilet pits[36]. Kumbeni et al. and Ssewanyana et al. also showed concordant results of lack of adequate sanitation facilities in most schools assessed, leading girls to defecate and change their pads outside or not change at all during the school day[16,30]. Furthermore, Hennegan et al. showed that measures of sanitation access may not relate directly to the sanitation available for MHM, so more specific measures need to be assessed[19].

Disposal of Materials

Many studies in the literature have shown that inappropriate disposal of absorbents during menstruation contributes to growing urban waste problems in lower-income countries. Across the studies assessed, only 20-33% of schools had adequate waste disposal facilities at the source; moreover, even at these sites, there was no mention of waste collection or large waste management procedures[6,15]. Respondents reportedly hid their sanitary materials until after school and used domestic waste bins at home

(71.2%), burned the product (24.3%-53.0%), flushed the product down the toilet (0.3%-16.5%), threw the product in open spaces (47.0%) or buried the product at school or home (4.3-46.6%)[4,26,29,35,36]. These methods can cause problems with a lack of sewage systems and waste management infrastructure to remove the waste safely. In addition, burning disposable sanitary pads can release many harmful chemicals into the environment[40].

Use of Medication

The most common symptom of menstruation was cramps and period pains, which were treated with pharmacological agents and/or bed rest (59%)[24], a visit to the doctor (16.3-17.5%)[24,35], or nothing (41-63.9%)[24,32,35].

Factors Associated with MHM Practices

Adequate menstrual hygiene practices were associated with an adequate knowledge of menstrual hygiene[28], increased age[26], increased education of respondents' mother, occupation of respondents' mother, and identifying as a Christian (compared to other religions)[29]. More specifically, the use of disposable sanitary pads was positively associated with a higher educational status, higher wealth, married status, and able-bodied[18].

Educational outcomes (e.g., school attendance) associations with MHM

The most researched outcome across the Ghanian studies assessed was school attendance. Studies suggested that 12.2%-90.0% of girls missed school due to their period[6,7,15,16,22,28,35,41] and one study stated a mean of 2.76±1.56 days missed of school due to period every month[16]. Missing school was primarily due to abdominal pain, in

addition to fear of staining, fear of being teased, no pads available, and a lack of private place to change, no water source, and no disposal for used pads available at school[6,22,28,35]. The use of disposable sanitary pads[15,16], younger age[15], higher wealth of family[15], and higher knowledge of menstruation[14] reduced the odds of girls missing school due to their period. Cultural restrictions, viewing menstruation as a period of impurity, increased the odds of girls missing school due to their period[15]. Furthermore, girls who miss school are less likely to learn about reproductive health and MHM as teachers are often a prominent source of information[14,25]. Although many Nigerian studies allude to poor MHM leading to poor educational outcomes, there are no studies quantitively analyzing the association between MHM and school attendance or school engagement in Nigeria to date. Further research needs to be conducted to scientifically assess the effect of menstrual hygiene on the education of girls to power effective and resource-specific interventions.

Existing intervention evaluations in West Africa

Of the 35 studies assessed, two were intervention evaluations in Ghana. Dorgbetor et al. assessed a MHM themed Play-Based Approach in 60 schools that involved structured educational games using local and foreign materials to engage the individual students[20]. The intervention schools were assessed using mixed methods through school assessments and interviews with teachers, school leaders, and students and compared to 60 non-intervention schools. The intervention schools were shown to have increased levels of menstruation knowledge among schoolgirls, increased confidence to discuss MHM among schoolchildren and teachers, better attitudes and less

embarrassment reported from schoolgirls, and less school absenteeism due to menstruation. In addition, two schools out of 60 in the intervention group had installed changing spaces compared to none of the non-intervention schools.

In addition, a pilot study assessing pad distribution and MHM education and the effect on school attendance was conducted by Montgomery et al. in 2012[9]. The study showed that school attendance rose in the Pads-with-Education group by 6 days per 65-day term, equating to a 9% increase and a significant decrease in missed days when compared to the non-intervention group.

DISCUSSION

In this systematic review, the authors screened 59 journal articles and selected 38 articles which contained information about the knowledge, attitudes, and practices related to menstrual hygiene management and associated factors among adolescent girls in West Africa. The collective evidence of this review indicates that inadequate menstrual hygiene management is prevalent across West Africa with many girls lacking informative menstruation education, access to materials, and access to facilities to change, wash, and dispose materials during menstruation.

Existing reviews have found consistent themes across Sub-Saharan Africa (SSA) and Lower-Middle-Income Countries (LMIC) that have allowed for the design of diverse conceptual models to act as frameworks for developing large scale interventions and guide future research. Hennegan et al., for example, designed a model to guide practice and research to respond to the important factors contributing to poor menstrual hygiene, including sociocultural contextual factors and resource limitations[11]. Similarly, Chandra-Mouli and Patel assessed MHM studies across 25 LMICs giving a large range of

recommendations to address the concurrent themes identified[41]. A wider scope of these other studies allows for a greater generalization of the results; however, their results are limited by the wide cultural variation over these large regions. Due to the large number of studies based in Uganda and other East African countries, assessing only West Africa allows other more populous countries like Nigeria and Ghana to be reviewed more closely.

First, this review showed that most girls (51.9%-97.8%)[4,6,14,21,25,26,29,42] experiencing menstruation know what menstruation is on a basic level. Nevertheless, specifics about the biological changes happening to female bodies through the menstrual cycle were less known. One identified knowledge gap was the origin of the blood; for example, Oche et al. reported that 79% of respondents believed the blood came from the womb[27] and Boakye-Yiadom et al. reported that 47.3% of respondents did not know the origin of the blood[28]. In addition, Lawan et al. reported that less than 33% of girls knew that the menstrual cycle extends from one period to the next suggesting a need for formal education of the biology behind menstruation[26].

Ssewanyana et al. showed a variation in knowledge level based on the socioeconomic status of the family, age of the child, education level, and religion (Christians had higher knowledge than other religions)[30]. This review shows that MHM education is not uniformly available to pre-pubescence adolescents in West Africa; however, few studies assessed specific research questions into the interactions surrounding behavioral expectations and cultural norms that are embedded into acquiring knowledge about MHM. Inadequate knowledge about MHM can lead to increased fear and shame around menstruation, especially among adolescents that do not have access to

open spaces to discuss their personal experiences[27]. In addition, religion can intensify the silence around menstruation; for example, Muslims do not often discuss menstruation openly and girls are sometimes banned from attending the mosque and other religious events during menstruation[12]. It is important that future interventions and evaluations explore the effect of focusing on two-way interactions to grow a social acceptance of discussing MHM.

Across the four West African countries studied in this review, mothers were the most frequently cited source of information for menstruation knowledge provided to girls. Additionally, another dominant source of information was schools and teachers, although this could have been overestimated as most of the studies were school based and do not include girls in the general population, many of whom have not attended any school or may have dropped out prior to the age of 12 years. Iliyasu et al. reported that despite having access to information, the cultural restrictions in Nigeria meant that open discussion about menstruation was frowned upon referring to the importance of "kunya" (a term used to describe modesty in the Islamic religion) and the risk of open MHM discussion leading to sexual promiscuity[33]. Rheinlander et al.'s study based in Ghana also reported the sexualization of menstruation education and the emphasis on the ability to be pregnant without including information about the safe management of menstruation[36]. The type of information received may be due to an increased availability of information online.

Iliyasu et al. reported that 72.4% girls receive most of their information from mass media sources like the internet and social media, showing a generational shift from the 34% of mothers in the study that were said to use mass media as a source of MHM

information[33]. The source of information regarding MHM is an important factor to determine where to intervene with reliable and factual and information to more efficiently dismantle cultural myths and prevent the spread of misinformation. In addition, it is important to note that the accessibility to certain sources, like mass media, will be mixed depending on location and socioeconomic factors. The review highlighted that the studies focused on MHM knowledge ask simple categorical questions about the level and source of information, but few explore the types of information and the way they are distributed. Considering the importance of the content of MHM information, studies that collect qualitative information would be an avenue for further research to help design more efficient education campaigns.

Practices and attitudes towards menstruation were driven by the social acceptance of menstruation. One theme that was highlighted was containment of blood; for example, Rheinlander et al.[36] noted that girls wanted to hide their bleeding and make sure they did not smell during their period. Mohammad et al. and Rheinlander et al. reported study respondents feeling unclean and impure during their menses that led them to miss school, miss religious activities, and even sleep away from family for the period of bleeding[6,36]. In addition, feeling unclean and the desire to hide their menses led respondents to prefer disposable sanitary pads because of a fear of leakage; however, Shah et al. and Salami et al. reported that girls could not afford disposable pads despite their stated preference for disposable pads[4,5]. Fear also influenced the changing practices of girls during school. For example Ssewanyana et al., among other studies, reported that girls did not change their sanitary material in school because of a lack of privacy, lack of disposal, and fear of being seen[28,30]. Ssewanyana's review highlighted the multi-faceted and complex matrix

of society, structures, and individual characteristics that work together to prevent adequate menstrual hygiene management for girls. The studies in this review highlight these important factors individually, but it is important that future research looks at the influence of societal (including religious), structural, and individual behavioral factors on the individual's MHM within one multi-level model.

The final prominent finding was the substantial impact menstruation has on the education of girls. Many of the school-based studies focused on school attendance and engagement as an outcome related to poor MHM[6,15,16,28,35]. Fear of leaking in school and lack of facilities to change and wash in school leads to reluctance to attend school or increases the number of girls who leave to go home when they needed to change, resulting in partial day absences[6,15]. In addition, dysmenorrhea made school attendance and engagement difficult[6,28]. The effect of poor MHM on education contributes to the growing gender disparity between girls and boys and their future economic prosperity. The reduction in girls' attendance and engagement in school is an area that needs to be urgently researched with specific research questions to guide effective intervention design, especially in countries like Nigeria where this has not been statistically assessed yet.

The studies assessed in this review had many strengths including large sample sizes, data collection related to specific study questions, qualitative and quantitative study designs, and very high response rates (>90%). However, there were some limitations to note for further research to address.

First, all the studies but one (Montgomery et al.[9]) were cross-sectional in design, giving no longitudinal data for causal inference over time. Therefore, we cannot know for

certain the direction of associations. In addition, many of the studies were school based which may have underestimated the level of poor MHM because the accessibility to school indicates a level of accessibility that may not be available to those who do not attend school. Furthermore, the studies were based on self-reported measures of experiences and MHM factors, therefore, there may be some social desirability bias in which the participants recall what they think they should say instead of the true answer. Self-reported measures often also fall victim to recall bias, especially with the included studies that exclude pre-menarcheal girls, as some experiences occurred before menarche and respondents may inaccurately remember previous experiences resulting in the misclassification of exposures and outcomes. While non-differential misclassification is not an issue if all girls have a similar poor recall of their outcome or exposures, girls who have had negative or traumatic experiences due to menstruation may disproportionately remember poor MHM exposures or poor outcomes related to menstruation compared to those that have had less issues with menstruation. This would lead to differential exposure or outcome misclassification and can bias the results toward or away from the null. Finally, the absence of males from most of the studies eliminates an important piece of the puzzle for assessing the experience of menstrual hygiene management since the attitudes and practices of girls are related to the social acceptance surrounding menstruation.

In addition to addressing the limitations of the studies highlighted above, there are limited studies that directly assess school facilities through ecological level assessment. Second, only two studies in the review evaluated interventions (Montgomery et al. and Dorgbeter et al.), highlighting the need for more design and longitudinal evaluation of

interventions. Future studies should focus their efforts on progressing forward with community-based intervention design and conducting longitudinal studies for a more robust data collection and sustainable interventions that involve the opinions of those being affected.

This review identified a large body of recent literature from a more specified region than previous systematic studies. The review draws from best practice using the PRISMA guidelines to summarize the status of the literature and highlight gaps for further work. However, in addition to the limitations of the individual studies included, there were a few limitations to review itself. Firstly, although studies from all over West Africa were searched for, only four countries were included in the review, with most from Ghana and Nigeria. This reflects the global focus of menstrual hygiene research in specific geographical areas but may mean our results are more reflective of these countries than West Africa as a whole, as opposed to other literature from low-income countries in general. Also, despite extensive searching, some eligible studies many have been missed, for instance if we had extended the time frame to include earlier studies from 2000 to 2009, there would have been 14 more hits from the search terms. However, when screened, none of these studies provided additional information about menstrual hygiene in West Africa. Studies published in smaller journals that are not online may have also been missed, especially from lesser resourced West African countries.

CONCLUSION

In summary, studies across West Africa over the last decade have identified consistent themes of poor education, poor mental health, and restrictions from social

participation due to a lack of adequate MHM. The large body of evidence highlights the need for more specified and multi-level studies to guide specific policymakers in specified regions. This review highlighted the multifaceted approach needed to explore and act upon MHM as there are a myriad of factors acting together. For example, the knowledge of reproductive health and safe management of menstruation, the structural access to facilities and clean water, the affordable availability of materials, the social perception of menstruation and the perceptions and attitudes of women experiencing menstruation, all acting together to produce the overall impact of menstruation on a girls' life. This review helps to guide future comprehensive studies and intervention evaluations to capture the entire MHM experience across different communities and cultures.

Figure 2.1: Article Search Strategy based on PRISMA guidelines (Moher et al, 2009)

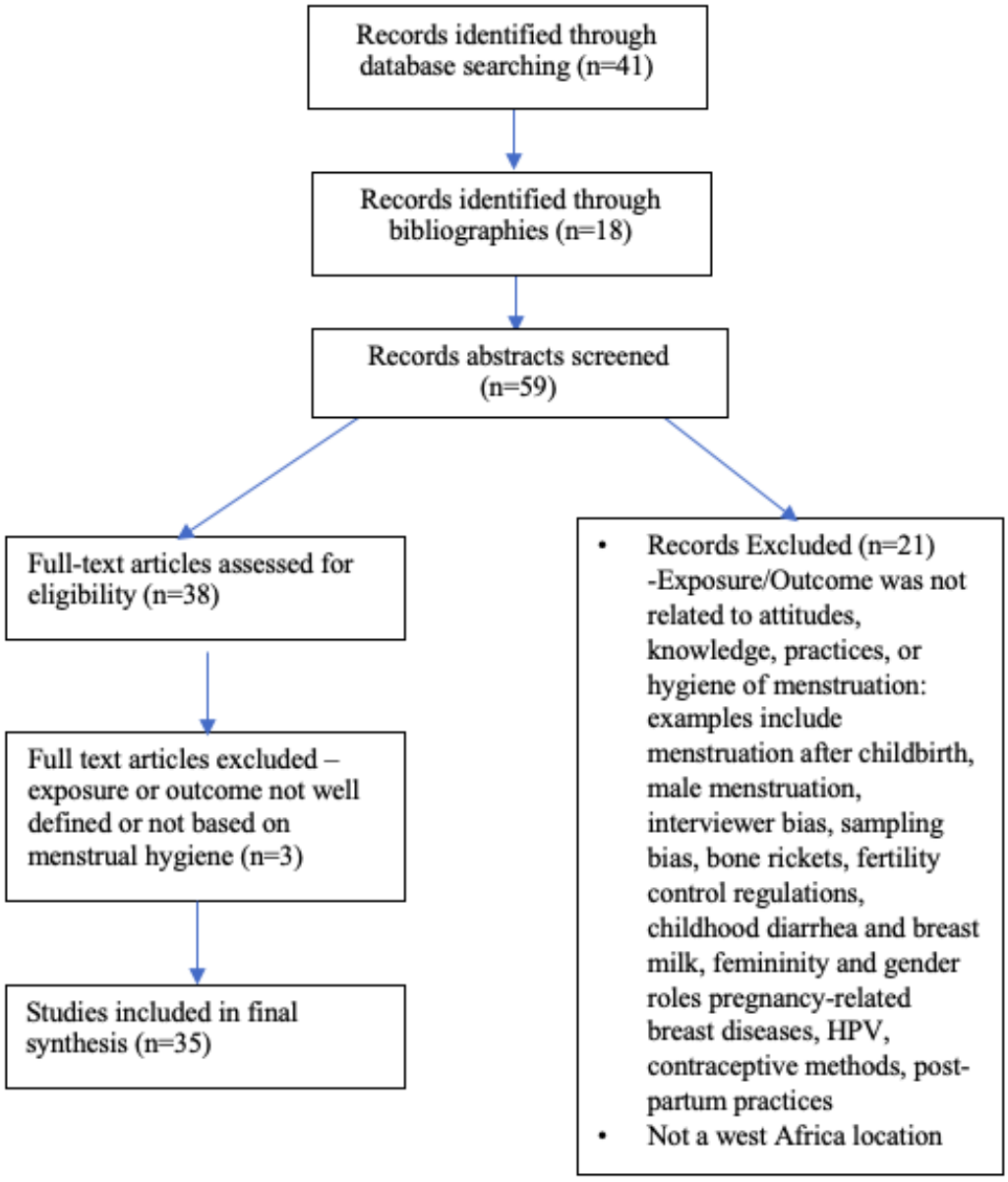


Table 2.1: Systematic Review of Studies Assessing the Knowledge, Attitudes, and Practices Surrounding Menstrual Hygiene Management in Ghana from 2010-2022

Citation	**Study Design Data Source(s) and Sample Size**	**Exposure(s) and Outcome(s)**	**Exclusions**	**Co-variables Examined**	**Results Conclusions**	**Strengths (+) & Limitations (-)**
Anaba et al., 2022[18] *Use of reusable menstrual management materials and associated factors among women of reproductive age in Ghana: analysis of the 2017/18 Multiple Indicator Cluster Survey*	Cross-sectional study N =10, 861 women aged 15-49 years old Nationally representative population from the 2017/18 Multiple Indicator Cluster Survey (MICS) collected via Computer Assisted Personal Interviewing (CAPI)	Exposure: - sociodemographic characteristics (age, educational status, household wealth index, marital status, type of residence, region) - disability status - exposure to mass media. Outcome: the use of reusable menstrual management material (yes, no)	Males Females <15 years old	Sociodemographic characteristics (age, educational status, household wealth index, marital status, type of residence, region), disability status, and exposure to mass media.	29% of women aged 45-49 years used reusable materials compared to 6% of 15–19-year-olds: (COR=5.34; 95% CI 3.47-8.19) Use of reusable materials was significantly associated with educational status (at least primary school education less likely to use reusable materials compared to women with no education): COR=0.51;0; 95% CI 0.38-0.66; wealth (middle wealth quintile less likely to use reusable material compared to poorest quintile): COR=0.51;0; 95% CI 0.38-0.66; marital status (never married more likely to use reusable than current	+Nationally representative data among women of reproductive age giving external validity +Weighting for over and under-sampling +99.8% response rate -Cross-sectional study design -Recall bias and social desirability bias of material used from self-reports -No information on the types of reusable materials used

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					married): COR=0.70; 95%CI 0.52-0.93); disability (women with a disability a more likely to use reusable): (COR=1.36 ;0; 95% CI 1.06-1.76). Shows a higher prevalence of use of disposable materials than in previous studies – influenced by changes in cost, availability, and cultural belief.	
Kumbeni et al., 2021[15] *Prevalence and factors associated with menstruation-related school absenteeism among adolescent girls in rural northern Ghana*	Cross-sectional self-administered survey N = 705 adolescent girls attending junior high school in Talensi district of Ghana aged 12-19 years old	Exposure: -age, religion, mother's education, parent(s) income, type of sanitary material used, privacy in school, and cultural restrictions. Outcome: -menstruation-related school absenteeism defined as "being	Males Pre-menarcheal girls	Age, religion, mother's education, parent(s) income, type of sanitary material used, privacy in school, and cultural restrictions.	65.5% of the girls used sanitary pads, 65.7% had privacy in school during menstruation, 43.5% had faced cultural restrictions during their menses. School absenteeism prevalence was 27.5% (n=194): 49% missing 1-2 days, 37.1% missing 3-4 days and 13.9% missing 5-7 days.	+Large sample size +Good response rate +Assessed school absenteeism at multiple ages -Cross-sectional -Did not consider soap or water availability at school (part of WASH)

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
		absent from school due to menstruating issues during last menstruation (yes or no).			Girls aged 18-19 years were 2.38 (95% CI 1.29-4.40) time more likely to stay away from school during period than those aged 12-15 years. Girls with moderate income parents were 0.57 (0.34-0.94) - times less likely to stay away from school. Cloth use increased the odds of school absenteeism by 3.21 (2.22-4.63) times. Cultural restrictions increased the odds of school absenteeism by 2.54 (1.76-3.67) times.	-Self-reported variables may cause recall bias -Selection bias to those just in school
Mohammed et al., 2020[43] *Menstrual Hygiene Management and School Absenteeism among*	Cross sectional study design N = 250 schoolgirls aged 10-19 years old from five junior High schools in	Exposure: -sociodemographic characteristics Outcome: - menstrual related absence from school; menstrual	Males Pre-menarcheal girls	Age, father's occupation, mothers' occupation, TV/radio ownership, earn money, receive money for MHM	Age of menarche was 13-15 years old. 52.8% had TVs, 58.2% did not receive money for menstrual products 50.8% had good MHM	+Random sampling frame +Informs policy makers -Cross sectional -Recall bias -Social desirability bias

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Adolescents in Ghana: Results from a School-Based Cross-Sectional Study in a Rural Community	the Kumbungu District capital. Pre-tested self-administered questionnaire	hygiene management			Odds of poor MHM was highest among those aged 14-16 compared to those aged 17-19 (AOR: 2.9; 95% CI 1.49, 4.55). Those who did not receive money for menstrual products had a higher odds of poor MHM compared to those that did (AOR 1.81, 95% CI 1.06, 3.09) 40% were absent from school because of menstruation, the most reported reason was pain, fear of staining, fear of being teased, no pads available, and lack of private place to change at school Teachers said that menstruation doesn't affect girls' attendance (not congruent with girl's answers)	-Data on school facilities, household income, parental education, and other potential risk factors for poor menstrual hygiene management were not collected

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Kumbeni et al., 2020[16] *Menstrual hygiene among adolescent girls in junior high schools in rural northern Ghana*	Cross sectional study N = 705 schoolgirls who had reached menarche aged 10-19 years old Self-administered structured questionnaires with closed and open-ended questions	Exposure: - sociodemographic characteristics Outcome: - menstrual hygiene measured on a scale of 8 points using the menstrual hygiene management index	Males Pre-menarcheal girls	Sociodemographic characteristics of respondent and family	The prevalence of good menstrual hygiene was 61.4%. Mothers' education and parents' socio-economic status were significantly associated with menstrual hygiene management. 65.8% of respondents used disposable pads in their last period Burial of the used sanitary material was the most practiced method (46.4%) among the good MHM group whereas throwing used pads in open spaces was common among the poor MHM group (47%) Inadequate sanitation facilities were a major challenge to menstrual hygiene management at schools. -Only one out of the fifteen schools did not have a toilet	+First assessment like this in rural Ghana +Large sample size -Cross-sectional -Recall bias or social desirability bias -Conducted in an area where there was an ongoing free supply of sanitary pads to junior high school girls though the supply was not regular. May not be generalizable to those without a supply of pads.

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					facility. All the toilet facilities were latrines pits. Two schools had their toilet facilities combined for both girls and boys. Only two of the fourteen schools had water supply at the toilet facilities, meanwhile none had soap for cleaning and washing purposes. Three of the schools had dustbins in the toilets for disposal of used sanitary materials Mean of 2.76±1.56 days missed of school due to period The use of sanitary pads was significantly associated with school attendance (p-value < 0.0001)	
Mohammed et al., 2020[6] *Menstrual knowledge,*	Cross sectional Survey to schoolgirls aged 11-19 years old and focus group	Exposure: - age of the adolescents, age at menarche, religious affiliation, and the	Pre-menarcheal girls	Parents occupation and education; religion; age of participant; TV at home wealth proxy	Mean age of menarche was 13.21 years old. 63.9% of girls aged 10-14 years old and 51.9% of girls aged	+ Lots of covariates + Included boys and teachers + Mixed methods

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
sociocultural restrictions, and barriers to menstrual hygiene management in Ghana: Evidence from a multi-method survey among adolescent schoolgirls and schoolboys	discussions/key informant interviews with schoolboys and teachers. N= 250 girls; 30 boys; 5 teachers Random sampling of girls proportionally from 5 schools, purposive sampling of boys and teachers	educational level of their parents Outcome: -adolescents' menstrual knowledge, access to menstrual hygiene materials, sociocultural and religious restrictions on menstruation, and the availability of suitable water, sanitation, and hygiene facilities in the schools			15-19 years old had poor menstrual knowledge (<4 on scale). Menstrual knowledge was improved among girls who: were older, reached menarche later, had mothers who had reached secondary education, and those who owned a TV (OR 2.42 (1.41-4.15)). Most girls used commercial sanitary pads (60.7%) and reusable cloth (54.2%). Choice was influenced by comfort, safety, cost, and availability. Major barrier was cost. Boys had good knowledge of menstruation but saw it as something boys didn't discuss. School teachers said access to pads was a big barrier if NGOs (e.g., CAMPFED)	- Cross sectional - Small sample size

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					and schools did not provide. 85.77% of girls believed menstruating girls were impure and unclean. 73.22% did not participate in religious activities during their period. 14.65% slept separate from family members during menstruation. **SCHOOL FACILITIES:** All schools had toilets separated by girls and boys with doors. However, only 2/5 schools had clean facilities and working handwashing facilities. None had a mirror or soap or regular supply of water (Veronica buckets) outside to carry in from standpipe or nearby houses. 1/5 had disposal in the toilet.	

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Obasi et al., 2019[25] *Sexual and reproductive health of adolescents in schools for people with disabilities*	Cross sectional Questionnaire distributed to adolescents aged 15-19 years with disabilities from schools in Ghana Jan-March 2018 N = 357 (response rate=78%)	Exposure: - sociodemographic characteristics -disability type -source of SRH education Outcome: - sexual reproductive health knowledge, defined as good or poor knowledge based on the *WHO Adolescent Sexual and Reproductive Health Survey* and *Ghana Adolescent Survey*	- Participants who could not adequately answer the questions - Males	Sociodemographic variables (age, sex, educational level), religion, disability type, source of information for SRH, relationship with guardian, contraceptive access, sexual behaviors.	- 67.1% of the respondents had good knowledge about SRH, schoolteachers were the main source of information about SRH. - SRH knowledge was significantly associated with an increased age (p value = 0.026), having a visual impartment instead of hearing or intellectual (aOR = 2.37 (1.03-5.49)), having a schoolteacher as the source of information (aOR=4.46 (1.84-10.82)), having non-relative guardians instead of relatives or parents (aOR=5.15 (1.08-24.58)), being of Christian religion instead of Muslim (aOR=2.45 (1.05-5.67)). Conclusions: SRH classes should be taught in schools and encouraged to	+ Good sample size for the population + Collected data on important covariates - Only included adolescents with disabilities so may not apply to all girls - Cross sectional - Only focused on SRH and not MHM specifically meaning the outcome was only loosely defined

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					parents/guardians to increase knowledge.	
Acheampong et al., 2019[39] *Prevalence and Predictors of Dysmenorrhea, Its Effect, and Coping Mechanisms among Adolescents in Shai Osudoku District, Ghana*	Cross sectional study with self-administered questionnaires in selected schools N = 760 healthy adolescents aged 12–19 years	Exposure: - Chronological age, level of education, place of stay, age at menarche, the history of the menstrual cycle, the nature of menstrual flow, length of the cycle, duration of menstruation, and family history of dysmenorrhea Outcome: - history of dysmenorrhea measured with the question: 'have you ever had menstrual pain?' (yes/no)	Married girls Males Pre-menarcheal girls Girls that had given birth	Chronological age, level of education, place of stay, age at menarche, the history of the menstrual cycle, the nature of menstrual flow, length of the cycle, duration of menstruation, and family history of dysmenorrhea	The overall prevalence of self-reported dysmenorrhea in this study was 68.1% (95% CI, 65.0–72.0). Many respondents with dysmenorrhea (70.8%) were between the ages of 16–19 years old. Adolescents who do not live with their parent experienced a 53.1% increase in odds of self-reporting dysmenorrhea (AOR, 1.53 (95% CI, 1.02–2.30; $p < 0.04$)). Similarly, respondents who had irregular menstrual cycle experienced a 72.5% increase in odds of self-reporting dysmenorrhea (AOR, 1.73 (95% CI, 1.16–2.57; $p < 0.01$)). 34.8% of adolescents with dysmenorrhea	+Large sample size +Data collected specifically for these research questions -Involved only schools in the district capital which may reduce external validity. -Cross-sectional -Self-reported measures may lead to recall bias -Very broad outcome, "ever experienced'

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					reported a history of severe menstrual pain, and a significant association was found ($p < 0.04$). Pain lasts more than three days for the majority (63.7%) of respondents, The presence of menstrual pain affects physical activities by 22.5% and is significantly associated with self-reported dysmenorrhea ($p < 0.04$). Only 19.4% of adolescents with dysmenorrhea reported to have consulted a physician for their menstrual pain.	
Rheinlander et al., 2019[36] Secrets, shame, and discipline: School girls' experiences of	Cross-sectional qualitative methods Focus groups = 4 IDIs = 4	Variables: -Hygiene poverty, waste management systems, girl's toilet strategies, managing menstruating and	Girls aged below 15 or over 23 years old Boys	N/A	Infrastructural hygiene poverty - lack of functioning toilets, no lights, no waste management systems, water shortage, vaginal	+Qualitative hearing from girls themselves + School assessments

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
sanitation and menstrual hygiene management in a peri-urban community in Ghana	School walk through = 2 a two public senior schools and contextual insights from the community in the Ningo-Prampram District	menstrual waste, advice on menses			infections caused by dirty toilet pits, girls choosing to defecate outside in open instead Secrecy around menstruation – feeling dirty, embarrassed, not knowing where to change and conceal blood, fear of changing, missing school, code names No waste disposal – hiding it in bags Menstrual education – sexualized about getting pregnant Hard to prioritize hygiene when living in poverty Girls find peer-related solutions in their hard circumstances Need to change the narrative around menstruation from negative to positive Girls felt like they had to lie because of	- Wide range of ages varying levels of MHM - Teachers may select students with better social status to represent their school more -Social desirability bias

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					discipline if missing for period	
Boakye-Yiadom et al., 2018[28] *Assessing the Knowledge, Attitude and Practice of Menstrual Hygiene Management Among Junior High Schools Adolescent Females in the Yendi Municipality in the Northern Region of Ghana*	Cross sectional N = 430 adolescent girls attending junior high school aged 10-19 years old Semi-structured questionnaires	Exposures: - age, parents living with child, amount of money given for MHM resources, knowledge of MHM Outcomes: - knowledge of MHM; attitudes towards MHM; practices during menstruation	Males	Not adjusted	Every female student was aware of MHM 77.9% of the girl's source of MHM information is their mother and 91% also receive information about MHM in school 80.7% know about pad or cloth and 22% know of tampons 49% know menstruation is controlled by hormones, 60% know that pregnancy can occur after menarche, 52.7% know menstrual blood comes from uterus, 73.3% know menstruation is a normal process. 67.5% scored adequate MHM knowledge. 9/10 students ever missed school for menstruation: odor,	+Large sample size -Cross sectional -Not adjusted in logistic regression, potential confounding -Selection bias only school-going adolescents -Recall bias, self-reported measures

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					teased, pain, lack of water, changing facility, disposal, pads. 68.2% believe they should avoid certain foods and 70.1% see menstruation as unclean. 57.5% say menstruation is shameful for discuss Only 13.6% had positive attitudes to MHM 21% used disposable pads, 57% use cloth, and 9.1% use pieces of mattresses. Out of the 258 (72.9%) adolescents who have ever been unable to buy a pad, majority (49.6%), lack of money, followed by unavailability/long distance to shop (31.4%) and fear of stigma (16.7%). 72.9% have parents as main source of funds.	

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					Older girls were significantly more likely to have higher MHM knowledge (OR 2.616 [95% CI, 1.708, 3.526], practice proper MHM (OR 2.030 [95% CI, 1.296, 3.182] There is a marginal association between those who have adequate knowledge of MHM and practice of MHM (OR 1.639 [95% CI, 1.004, 2.674]	
Ameade et al., 2018[24] *Prevalence of dysmenorrhea among University students in Northern Ghana; its impact and management strategies*	Cross sectional study Self-administered questionnaire March-April 2015 N = 293 female students from the Tamale campus of the University of development	Exposure: - dysmenorrhea (pain) Outcomes: - daily activities, hospital referral, pain medication use, severity of dysmenorrhea	Males Non-students	Age, age of menarche, religion, accommodation/residence, irregular flow, length of flow, exercise level	83.6% of girls experienced dysmenorrhea, moderate level for 56.3% and beginning before onset of bleeding for 58.4% and lasts 3 days. Affects daily activities of 61.2%, affecting attendance to lectures in 70.7%. Severe dysmenorrhea was experienced	+ Perceived experiences and many outcomes + Large enough sample size for power -Cross sectional, no causal inference -Only college aged students in college (selection bias)

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					more by those with an irregular flow: (Mild = 9.6%, Moderate = 27.3% and Severe = 36.4%; $\chi 2 = 10.54$, df = 2, p = 0.005) 16.3% reported going to hospital for pain. 41% use no painkiller. Others used bed rest or non-steroidal anti-inflammatory drugs. Pain more prevalent in those whose age of menarche <13 years, older age (or age less than 20 (97.0% vs. 71.8–83.7%; p = 0.016)), Christian, rural dwellers, longer flow time, more exercise.	
Gyan, 2017[37] *Exploring the Causes of Change in Adolescent Girls' Sexual*	Cross-sectional qualitative Interviews and focus groups (N = 54)	Study assessed the changing sexual behavior of the traditional norms of puberty rites, marriage, sex, family	N/A	N/A	The educational system offers opportunities for adolescent girls to learn about their sexuality and manage their sexual experience as stated	+ Talks to community members and boys and girls + The stories align with just different

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Behaviour in Begoro, Ghana					in the following narrative: *They (teachers) teach us those things (sexual and reproductive health) at school. The teachers teach us how to use condoms to protect ourselves and how to access family planning. They also teach us that we can buy medicine at the pharmacy shop to prevent pregnancy* (Adwoa, an adolescent girl) More and more adolescents are experiencing menarche at earlier ages in contemporary times as compared to the traditional era. There was a perception that adolescents in contemporary times tend to experience early onset of menarche a factor that seems to	emphases on the attitudes + More modern perspectives talking to the community before using quantitative methods; an in-depth look into lived experiences - Cross-sectional -Only talks about menarche age pertaining to MHM

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					predispose them to sexual and reproductive health risk. The early onset of menarche is perceived as a factor that increases the likelihood of adolescent girls becoming pregnant when they engage in early sexual activities.	
Ameade et al., 2016[42] *Relationship between Female University Students' Knowledge on Menstruation and Their Menstrual Hygiene Practices: A Study in Tamale, Ghana*	Cross sectional N = 292 female undergraduate students studying Medicine, Nursing, Midwifery, Health Science Education, and Community Nutrition Semi-structured questionnaire	Exposure: - sociodemographic characteristics Outcome: - menstruation knowledge; menstrual hygiene (poor, average, good, excellent)	Males Non-students	Not adjusted	Mean age of menarche=13.66 +/- 1.87 years, most lived in urban areas of Ghana Most were aware of menstruation before the onset of menarche and main source of information was teachers (54.3%) 38.5% were struck by fear and panic when first seeing blood. Overall menstrual practice of participants was 80.2%	+ Simple random sampling of students removes selection bias -Cross sectional -Self report could introduce recall bias and social desirability bias -University students only reduced external validity -No adjusted associations – residual

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					Mean knowledge score was 57.3%, less knowledge on the specific biology of menstruation Females older than 25 years were significantly more knowledgeable about menstruation than their younger colleagues (6.49 versus 5.60–5.73; p = 0.005) Significant difference in knowledge scores among the students based on their courses of study (p = 0.0008) with the medical (6.11) and Midwifery (6.19) students scoring more than 6 out of 10 while Community Nutrition students obtained the least mean knowledge score of 5.08 There was a weak positive but significant relationship between	confounding not controlled for

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					the age of respondents and their knowledge of menstruation (r = 0.14; p = 0.0195) Positive and significant association between the knowledge of respondents about menstruation and their practice of good menstrual hygiene (r = 0.26; p < 0.0001).	
Dorgbeter, 2015[20] *Mainstreaming MHM in schools through the play-based approach: lessons learned from Ghana*	Qualitative and quantitative exploratory evaluation of a lay-based approach to improve MHM – interviews, focus groups, observation, and field level reports N = 120 schools (60 with the approach and 60 control)	Evaluated the opinions of head-teachers, school-based health coordinators, school children. Observed the school activities and updates posted on the WhatsApp group platform in intervention groups.	N/A	N/A	Intervention improved: -Teacher involvement with MHM to 70-90% to not direct all questions to school nurse -Schoolgirls confidences to discuss MHM from 25% to 70% -School boys' confidence to discuss MHM from 10% to 50% -Parent and father involvement	+Widespread study over 7 regions and 120 schools +Evaluation of an intervention – very few exist +Qualitative and quantitative methods +Included all stakeholders-teachers, school nurses, girls, boys, parents +6 month follow up period

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					-Less delay for WASH plans -Increased knowledge, better attitudes, and less embarrassment and stigma from girls and boys regarding MHM -Reduction from 65% of girls going home during menstruation -Materials in school and changing spaces in two school's vs zero in control	-No statistical evaluation of outcomes just observation – lack of clear comparison especially regarding how schools were different in the first place -Action plan was hard to assess
Aziato et al., 2014[38] *The experience of dysmenorrhea among Ghanaian senior high and university students: pain characteristics and effects*	Cross sectional Qualitative assessment using in-depth interviews among female students at a state University and Senior High School in Accra, Ghana N =16	Descriptive assessment of dysmenorrhea and its effect	Males Non-students Females that didn't experience dysmenorrhea	N/A	Pain onset – before or during the bleeding and lasts a few hours to 5 days. Pain was rated at 6-10 severity out of 10 and described as "unbearable", "very severe" "like two fresh sores being sawed". Associated with nausea, vomiting, joint paints, sweating, fear, unable to pass urine and others.	+ In-depth discussions + Lived experiences - Cross sectional - No males or non-students

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					Physical and social effect of the pain – irritable, couldn't undertake normal activities, suicidal ideations, poor sleep, altered emotions, regrets of being female. Absenteeism from class – "I sleep in class", "I can hardly focus in class", "I am at the sickbay". Misconceptions that pain led to infertility.	
Montgomery et al., 2012[9] *Sanitary Pad Interventions for Girls' Education in Ghana: A Pilot Study*	Non-randomized trial of sanitary pad provision with education. N=120 schoolgirls aged 12-18 Self-administered questionnaires	Exposure was 3 intervention levels: 1. Pads and puberty education 2. Education alone 3. Control Outcome: - school attendance from two whole terms from teacher records (unplanned visits to check records)	Males Pre-menarcheal girls	Demographics, poverty index, rurality, time to school	Mean age was 15.7 years, average age of menarche was 14.08 (sd 1.91). Attendance rose in the Pads-with-Education groups by around 6 days per 65-day-term (or 9% of a girls' school year) ($p<0.0001$) Education group attendance also rose but was delayed.	+Assessed change using the ecological model of change +Evaluated an intervention +Peri-urban and rural areas +No loss to follow up +First study to statistically assess pad access and education with school

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					No significant difference between urban and rural sites. Qualitative results showed girls missed 3-5 days a month when menstruating showing the need for intervention.	attendance in Africa -Small sample size -Short follow-up time doesn't allow for assessment of longer-term impact -Limited generalizability and results may reflect the site not the country of SSA overall -Selection bias in those participating were attending school despite menstruating
Gumanga et al., 2012[34] *Menstrual Characteristics in Some Adolescent Girls in Accra, Ghana*	Cross sectional descriptive study N = 456 girls at St Mary's senior secondary school in Accra, Ghana Self-administered questionnaire	Descriptive study of age of menarche, duration of menstruation, length of menstrual cycle, regularity of cycle, source of information, and prevalence of dysmenorrhea	Males Pre-menarcheal girls	N/A	Mean age of menarche = 12.5 years (SD 1.28) Mean menstrual cycle length=27.9 days (SD 0.9) 24% had irregular menses after 6months since menarche	+Large sample size to represent this area -One school in an urban area making external validity limited -Only descriptive, no associations

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					74.4% of girls experienced dysmenorrhea 80.2% received information about menstruation from their parents, less than 10% from health professionals.	

Table 2.2: Systematic Review of Studies Assessing the Knowledge, Attitudes, and Practices Surrounding Menstrual Hygiene Management in Nigeria from 2010-2022

Citation	**Study Design Data Source(s) and Sample Size**	**Exposure(s) and Outcome(s)**	**Exclusions**	**Co-variables Examined**	**Results Conclusions**	**Strengths (+) & Limitations (-)**
Lawal et al., 2020[13] *Menstrual attitude dimensions, Anxiety and Body Esteem in adolescent girls*	Cross sectional Survey distributed to 276 girls aged 12-19 years old attending secondary schools in Ibadan city N = 276	Exposures: - anxiety measured using the self-rated anxiety scale (Zung) -Body esteem using the body esteem scale (Mendelson) Outcome: - attitudes towards menstruation the Menstrual Attitude Questionnaire (MAQ) (Brooks-Gunn and Ruble) – prediction, denial, debilitating, bothersome, natural thoughts about menstruation	Participants who did not correctly answer the questions Males	No other covariables, just anxiety and body esteem measures.	Body esteem-appearance was independently significant for adolescent girls' acceptance of menstruation as debilitating ($p=0.003$), bothersome ($p<0.001$). Anxiety was independently significant for girl's acceptance of menstruation as predictable ($p=0.013$). Interactively, the body esteem and anxiety affected girls' acceptance of menstruation as predictable ($p=0.031$).	+ Looks at the psychological factors associated with MHM + Used validated scales (but they are old) - No other covariates adjusted for - Cross sectional
Anikwe et al., 2020[22] *Age at menarche, menstrual characteristics, and its associated*	Cross sectional Self-reported survey Female students aged 10-21 years old in secondary	Exposure: -sociodemographic characteristics (age, social class, BMI, urban/rural residence, ethnicity, source of menstrual information	Respondents that were pre-menarcheal Males	Socio-demographic characteristics of the respondents such as age, marital status, educational level of the mother, father's occupation, ethnic group, and place of residence.	Main source of information about menstruation is mothers (80.0%), friends (75.0%), and teachers (75.5%) – multiple answers allowed. Dysmenorrhea was present in 82% of respondents, school absenteeism is 56.5% due to	+Data collected for research questions +Included familial factors

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
morbidities among secondary school students in Abakaliki, southeast Nigeria	schools in Abakaliki, southeast Nigeria. N = 400	Outcome: - Menarche and menstrual characteristics and experiences		The height and weight of the study population were obtained using a weighing scale and a stadiometer	dysmenorrhea/ Fatigue was the most common symptom. No medical advice was sought, all medications was provided by parent or guardian. Positive association between lower social class and age of menarche after age 13 years (p value: 0.001).	+Large age range and sample size -Cross sectional -Restricted to those who had started menarche -Self-reported measures
Salau et al., 2019[44] *Pubertal Communication Between School Nurses and Adolescent Girls in Ile-Ife, Nigeria*	Cross sectional mixed methods quantitative and qualitative 5 private high schools located in Ile-Ife, Nigeria N = 10 school nurses; 420 adolescent girls	Exposure: -sociodemographic factors, menstrual characteristics Outcome: -type of information distributed -materials of communication	Pre-menarcheal girls Males	N/A	School nurses paid more attention to physical body changes, menarche, and menstrual hygiene as contents of pubertal communication rather than contraception, prevention of sexually transmitted infection, and teenage pregnancy prevention. Materials for communication were reportedly lacking in many of the schools while the school management censors pubertal information.	+Mixed methods +Data collected based on research question -Small sample size -Lack of teachers to give insight into why the communication has issues - Private schools only
Salami, 2019[5] *Onset of Menarche and*	Cross sectional descriptive study.	Descriptive study of the knowledge of and practices	Males Pre-menarcheal	N/A	Almost one half (49.4%) had received no education about menstruation before menarche.	+Semi-urban population +Large sample size

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Adolescent Menstrual Hygiene Practices in Semi-Urban Ibadan Community, Nigeria	Self-administered questionnaire N = 492 girls	during menstruation			Most (65.3%) of the girls got menstrual information from their mothers, but 40.9% believed that such information should not be discussed openly. A little over one third (37%) of girls could not afford disposable menstrual materials, and 61.8% reportedly dried their reusable menstrual materials indoors.	+Explores attitudes and affordability of menstruation products -Cross sectional -Recall bias -No associations tested or adjustment
Hennegan et al., 2018[19] *The Relationship between Household Sanitation and Women's Experience of Menstrual Hygiene: Findings from a Cross-Sectional Survey in Kaduna State, Nigeria*	Cross-sectional Performance monitoring and accountability 2020 (PMA2020), data from Kaduna, Nigeria for 3 months in 2015 N = 1,994	Exposure: - Different types of sanitation facilities in the household (safely managed or basic, limited, unimproved, or open defecation) - Girl's perception of menstrual hygiene environment Outcome: - Girls' self-reported location of menstrual management including: the main household	<15 or >49 years old Males Females that hadn't had a menstrual period within 3 months before the study	Socio-demographic characteristics, the type of menstrual material used, and the presence of a handwashing facility in the household Contraceptive use	42.59% used a basic or safely managed facility, 15.15% used a limited facility, and 42.26% used an unimproved facility. Women and girls with access to improved (safely managed/basic) sanitation facilities (OR = 1.76 95%CI 1.26–2.46) or limited facilities (OR = 1.63 95%CI 1.08–2.48) had significantly higher odds of using the main household facility to change their menstrual materials than those with an unimproved sanitation facility. Findings of this study suggest that the level of household sanitation does not necessarily indicate	+ Large scale survey data using a diverse range of women not just schoolgirls -Cross sectional design prevents causal inference -Data was not specifically collected for research question

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
		sanitation facility, another sanitation facility, their sleeping area, or no facility (i.e., the backyard or field).			women's menstrual management location or lack of access to a location to change absorbents. For example, access to soap and water may not mean soap and water is available for menstrual hygiene management.	
Adegybayi et al., 2017[32] *Blood, joy, and tears: menarche narratives of undergraduate females in a selected in Nigeria Private University*	Cross sectional Qualitative discussion among undergraduate females in Redeemer's University, Ede, Nigeria N= 136 undergraduate females	Descriptive study of the knowledge of and practices during menstruation	N/A	N/A	Almost all the respondents (95%) received information about menstruation from mothers, female relatives, and school lessons prior to menarche. Most of the respondents first told either their mother or a female relative when they first got their period and viewed menarche as a crisis. Two salient themes emerged from the contents of the narratives: celebration and advice. The advice theme was further explored, and three advice patterns were identified: being a woman, hygiene and changed dynamics in relationships with males. All respondents reported using sanitary towels during their menstrual period with the majority experiencing cramps regularly and (61%) using pharmacological agents for remedy.	+Qualitative gave more depth for lived experiences - Only 1 private university not much external validity and potential selection bias -No males -Small samples size -Cross sectional

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Nwokocha et al., 2016[23] *Pattern of teen menstruation among secondary school girls in south east Nigeria.*	Cross sectional Self-administered questionnaires to girls aged 9-18 years old in secondary school in Enungu, Nigeria. N = 897	Exposure: -age, BMI Outcome: -menarche, cycle length	Males Pre-menarcheal females	Sociodemographic variables, demographics	The study showed that the age of menarche is declining with a mean age of 12.5 (1.2 years). Teens with a higher BMI reached menarche earlier and had longer menstrual cycles than those with lower BMIs.	+Few studies assess menarche specifically +Large sample size - Cross sectional -Recall bias - Only schoolgirls - No males -Large sample and age range
Ajah et al., 2015[7] *Adolescent reproductive health challenges among schoolgirls in southeast Nigeria: role of knowledge of menstrual pattern and contraceptive adherence*	Cross sectional Questionnaires to schoolgirls aged 10-19 years old from two secondary schools – Azuiyiokwu Girls' Secondary School and Ugwuachara Girls' Secondary School, Abakaliki	Descriptive study of the knowledge of and practices during menstruation	Students who were either less than 10 years or more than 19 years old, had not attained menarche, had even serial numbers in the school register, and had declined consent to	N/A	The mean age at menarche was 13.13±1.37 years. The mean menstrual cycle length was 27.8±3.14 days, and the mean duration of menstrual flow was 4.8±1.14 days. Thirty-seven (7.7%) respondents were ignorant of their cycle length, while 29 (6.0%) had irregular cycles. Premenstrual syndrome and dysmenorrhea were major menstrual issues, which resulted in 69 (14.3%) and 59 (12.2%) of respondents resorting to self-medication and absenteeism from school, respectively.	+Large sample size +Random sampling of schools -Descriptive, no associations -Cross sectional -Potential recall bias of the topics

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
	Questionnaires completed in summer 2012 N = 482		participate in the study.		Mothers were the main source of their daughters' adolescent education, while friends and mass media were the main source of contraceptive information. Though there was a high level (75.7%) of awareness of contraceptive information among the girls, usage (8.9%) was poor. Only eight (18.6%) of the 43 respondents who had ever used modern contraception were adherent to modern contraceptives. Students who were more than 15 years old, attained menarche at 13 years or less, and whose families were of low socioeconomic classes were more likely to be sexually active.	
Amu et al., 2014[31] *Prevalence of menstrual disorders among adolescent girls in Osogbo, Southwestern Nigeria*	Cross sectional Adolescent schoolgirls aged 10-19 years from private secondary schools in the Osogbo Local Government	Descriptive study of the knowledge of and practices during menstruation	Girls less than 10 or over 19 years old Males	Socioeconomic characteristics, demographics.	A total of 391 (97.8%) respondents had heard about menstruation before, with the three most important sources of information being their mothers (81.8%), teachers (7.4%), and peer groups (6.1%). The mean age at menarche was 12.5±1.0 years. Menstrual bleeding lasted between 2-7 days in 81.1% and cycle length lasted	+ Large sample size for descriptive analyses + No associations assessed - Cross sectional

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
	Area (LGA) of Osun State Pre-tested, self-administered, semi-structured questionnaire N = 402 girls				for 21-35 days in 81.6% of the respondents. The three most important menstrual disorders they experienced were dysmenorrhea (77.8%), menorrhagia (57.4%) and metrorrhagia (18.6%), among others. Menstrual disorders, especially dysmenorrhea, interfered with the daily activities of the respondents.	- Only girls from private schools
Ghararo, 2013[35] *Menstrual Hygiene Practices among Junior Secondary School Students in Benin City*	Cross sectional descriptive study Self-administered questionnaire N = 494 junior secondary school girls	Descriptive study of the knowledge of and practices during menstruation	Males Pre-menarcheal	N/A	The mean age of the respondents was 14.3 ±1.3 The average age at first menstruation was 12.88 ± 1.1 years Mothers were the major source of information 238 (52.2%), next is teacher 156 (34.2%), and sisters 52 (11.4%). Most respondents 480 (97.4%) think that menstruation is a normal body function, while 13 (2.6%) think it is a disease condition. Majority of the respondents, 395 (84.5%) could explain the function of the menstrual cycle. Abdominal pains and cramps were the major complaints 264 (75.6%), next is feeling depressed, 41(11.7%)	+First study in Benin City, Nigeria +Large sample size -Cross sectional -No associations assessed

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					63.9% do nothing to relieve the discomfort, while 61 (17.5%) visit a doctor for treatment Eighty-three (83.4%) use sanitary pads, while none (0.0%) use the Tampons. Sixty-eight 68 (13.8%) students have absented themselves from school during menstruation. The major reason from absenteeism from school/examinations were severe menstrual pain [dysmenorrhea] 49 (72.1%) students More than half (52.1%) of the student change their sanitary pads twice daily and a majority of 83.9% bathe two or more times a day. Most of the students burn their sanitary material (39.6%) but a small minority (16.5%) flush their sanitary pads in the toilets. 93.9% of the students felt that enough of information is being taught on menstrual hygiene in the school curriculum. To improve awareness of menstrual hygiene practice among teenage girls, a large majority (47.3%) advocated for an increase in public enlightenment and discussion to be organized in the society, 15.8%	

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					suggested an increase in the toilet facility by government in the public schools.	
Iliyasu et al., 2012[45] *Menstrual Patterns and Gynecologic Morbidity among University Students in Kano, Nigeria*	Cross-sectional Self-administered questionnaires to students attending Bayero University Kano N = 383	Exposure: -menstrual characteristics, contraceptive use Outcomes: -Sociodemographic characteristics, menstrual patterns, and associated symptoms. Treatment-seeking behavior and effects of symptoms on academic and social activities	Males Pre-menarcheal girls	Sociodemographic variables	The mean age at menarche was 13.7 ± 1.68 years. Menstrual bleeding lasted an average of 5.2 ± 1.6 days. Cycle length was 21-35 days in 92% of cases (n = 353). Approximately 72% of respondents reported dysmenorrhea. After adjusting for confounding, age at menarche, menstrual cycle length, duration of menstrual bleeding and use of contraceptive pills remained significant predictors of dysmenorrhea. Menstrual disorders interfered with social and academic life of 91% and 84% of respondents respectively.	+Survey made for the research questions +Large sample of adolescents +Associations assessed for dysmenorrhea adjusted for confounding -Cross sectional -Only one university -Selection bias with university students only (more educated)
Iliyasu et al., 2012[33] *Sexual and reproductive health communication between*	Cross sectional Qualitative study interviews and focus groups with mothers and unmarried	Descriptive study assessing menstrual knowledge source and practices	Males	NA	Median age of menarche = 14 years old Sexual and reproductive health discussions took place between 69-74% (daughter-mother report) of mother-daughter dyads, mostly triggered by onset of menstruation and mainly centered on	+ Literate and non-literate respondents +Interviews conducted in the Hausa language

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
mothers and their adolescent daughters in northern Nigeria	daughters in Ungogo town, Kano, Northern Nigeria. N = 184				menstruation (including mandatory religious cleansing). Mothers received information from health workers (46.1%), mass media (34%), and elder sisters (30.3%). Daughters reported gaining knowledge from mass media (72.4%), peers (57.4%), school (31.4%), health workers (26.2%), and mothers/aunts (42.6%) Discussions were initiated by mothers and were not interactive, questions back from the girls were considered suspicious or stubborn. This may lead to girls being sanctioned and married off. Some said discussions were dangerous because it may lead to sexual experimentation. However, 81.1% of mothers agreed that girls should be informed about menstrual hygiene. Only 31% of mothers agreed with school sex education. Few mothers indicating receiving their own sexual and reproductive knowledge from their mother because there was more 'kunya' (modesty_ among unmarried women then. This has been replaced with 'Zamani'	+Grounded theory used for analysis -Participants may have given socially acceptable answers – information bias -Hesitance to discuss some issues

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					(modernity) and changes to traditional values of sex before marriage. Fulani ethnicity mothers do not contemplate discussing reproductive health with their daughters. 81% of daughters used pads whereas 66% of mothers did. Better MHM probably due to formal schooling and peer influence.	
Oche et al., 2012[29] *Menstrual health: the unmet needs of adolescent girls' in Sokoto, Nigeria*	Cross sectional descriptive study Pre-tested structured questionnaire among girls in selected secondary schools in Sokoto metropolis N = 122 girls	Descriptive study Assessed factors (age, education, religion, literacy of mother, source of information) associated with menstruation knowledge (>50% was good knowledge)	Boys Pre-menarcheal girls	N/A	Age of menarche was 13.3 +-1.7 years. 65% of girls had high knowledge whereas 35% had low knowledge. 56.6% got their information from mothers or grandmothers, others from teachers and friends. The ages of the respondents (P = 0.93), education of their mothers (P = 0.173) and the sources of information regarding menstruation (P = 0.575) were found not to be statistically significant with respect to the knowledge of menstruation while there was a statistically significant relationship between religion (P = 0.0001) and level of study of the girls and knowledge of menstruation (P = 0.048).	+Multi-stage sampling with random selection of girls +Raised issues about formal education and further studies -No males -Only secondary school girls aged 15-20 -Cross sectional -Small sample size relative to the population

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					87% used sanitary pads and 60% changed 3 times a day, 66% washed with soap and water and 53% burned pads after use. There was a significant statistically association between education of their mothers (P = 0.015), religion (P = 0.0001) and occupation of respondent's mother (P = 0.0028) with respect to the reported menstrual hygiene practices. 79% believed blood came from the womb showing the need for formal education. When asked how they felt the first time the menstruated, the majority (53%) of the respondents' expressed fear or ashamed which was borne out of the fact that even though the majority were aware of menstruation, they were however, ill prepared for it.	-Urban and well-educated families
Lawan et al, 2010[26] *Menstruation and Menstrual Hygiene amongst Adolescent*	Cross-sectional Questionnaires to female secondary school students from public and private	Exposure: demographic and educational factors Outcome: Knowledge and practices of MHM	Males		Mean age was 14.4 years, 92% had reached menarche. Mean age of menarche was 12.9. Most girls knew that menstruation was a monthly flow of blood, and it came around age 11-16 years and lasted 2 to 7 days a month.	+ 100% response rate + Study designed for the research questions - Cross sectional

Citation	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
School Girls in Kano, North-western Nigeria	schools across Kano State N = 400				Only one-third knew that a menstrual cycle extended from one period to the next and only 25% knew that they vary from 21 to 35 days (most said they last exactly 30 days). 94% knew sanitary products were available and half knew that poor management could lead to infection. 87.5% of girls had a fair knowledge score and 88.7% had good practices. The majority heard of menstruation from their parents, 14% from school. The various methods the students used for dis-posing used menstrual absorbents include disposal with domestic wastes (71.2%); burning (24.3%); burial (4.3%) and flushing in toilet (0.3%). 6.2% used alternatives to pads like old cloth because of the cost. Higher age gave rise to better knowledge and practices (p-value=0.001 and 0.001)	- Only individual level factors

Table 2.3: Systematic Review of Studies Assessing the Knowledge, Attitudes, and Practices Surrounding Menstrual Hygiene Management in Other West African Countries from 2010-2022

Citation Study Setting	**Study Design Data Source(s) and Sample Size**	**Exposure(s) and Outcome(s)**	**Exclusions**	**Co-variables Examined**	**Results Conclusions**	**Strengths (+) & Limitations (-)**
Finlay et al., 2020[14] *Sexual and reproductive health knowledge among adolescents in eight sites across sub-Saharan Africa*	Cross sectional Survey distributed to females and males aged 10-19 years old in 8 sites across SSA (Burkina Faso (rural, Nouna), Ethiopia (rural, Kersa), Ethiopia (urban, Harar), Ghana (rural, Ningo Prampram), Nigeria (rural, Ibadan), Tanzania (rural, Dodoma), Tanzania (urban, Dar es Salam) and Uganda (rural, Iguanga/Mayuge) N = 7,116	Exposure: -social and demographic factors: age, sex, current enrolment in school at interview, whether the participant had worked for money in the past 12 months, whether the respondent's mother was alive, and self-reported sexual debut. -household wealth Outcome: -Menstruation knowledge, HIV knowledge, other STI knowledge	Missing exposures variables, covariates, or sampling weights	Social and demographic factors: age, sex, current enrolment in school at interview, whether the participant had worked for money in the past 12 months, whether the respondent's mother was alive, and self-reported sexual debut, household wealth	From the total sample size, (62.7%; 95% CI 31.8,43.1) self-reported knowing about menstruation. Only 14.3% (95% CI 10.6, 18.9) of 10-year-olds knew about menstruation, while 70% (95% CI 64.4, 76.7) knew about HIV and only 8.5% (95% CI 6.5, 11.0) knew about STIs other than HIV. By the age of 19, nearly everyone knew about menstruation (92.3%, 95% CI 87.3, 95.5) and HIV (97.9%. 95% CI 95.7, 98.9), but still only 70.9% (95% CI 64.7, 76.3) knew about STIs other than HIV. Female adolescents were more knowledgeable about menstruation (67.7%, 95% CI 60.3, 74.4) than male adolescents (56.5%, 95% CI 49.2, 63.6) Poisson results: Participants aged 19 were 6.5 times (95% CI 5.203, 8.060) more likely to know about	+ Large sample size + Many sites across SSA + Included males and females + Asked directly about menstruation and adjusted for many relevant covariates in multilevel analysis - Residual confounding or recall bias - Non validated questionnaire may lead to measurement error - Collected in households could lead to under-reporting if other family are around (social desirability bias)

Citation Study Setting	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					menstruation than their reference group (10-year-olds). Those in school were more likely to know about menstruation (URR 1.099, 95% CI 1.054, 1.147) Those who reported to have worked in the past year were more likely to know about menstruation (URR 1.069, 95% CI 1.029, 1.110) Those in the richest wealth quintile were more likely to know about menstruation (URR 1.276, 95% CI 1.204, 1.352) Those who reported to have ever had sex were more likely to know about menstruation (URR 1.381, 95% CI 1.331, 1.432) Multivariate analysis: - School attendance remains an important correlate of knowledge of menstruation (ARR 1.263, 95% CI 1.214, 1.313)	
Ajong et al., 2020[21]	Cross sectional	Exposure(s): -residing rural/urban; age at	None	Father's education and occupation; number of house	More rural participants had knowledge on puberty and	+ Rural and urban participants

Citation Study Setting	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Knowledge of peri-menarcheal changes and a comparative analysis of the age at menarche among young adolescent schoolgirls in urban and rural Cameroon	Survey to girls aged 10-16 years old February to March 2017 Urban setting (Younde) and rural setting (Bamougoum) Randomized cluster sampling N= 1,157 (570 urban and 587 rural)	menarche; various demographic factors Outcome(s): -knowledge of puberty and menarche; knowledge of menstrual cycle; knowledge of pre-menstrual symptoms; mean age at menarche		occupants; number of parents alive; religion; BMI.	menarche (67.2%) compared to urban participants (46.0%) 80.6% of rural participants had correct knowledge on menarche onset compared to 63.0% of urban participants. Rural dwellers knew less about the menstrual flow timeframe (78.4%) compared to urban dwellers (86.7%). The pre-menstrual symptoms were similar across rural and urban girls, the most common symptom being cramps. Also reported increased breast size, fever, nausea, vomiting, dizziness. Source of menstrual knowledge came mostly from TV/radio or school in urban setting and school or parents in rural setting. Mean age at menarche was higher in rural (13.03) than urban (12.48). When fully adjusted, participants in urban setting were 4.35 times (2.27-8.33) more likely to have early menarche than rural participants. Age of menarche was lower among those with two parents alive, parents with skilled occupations, watched TV more, and who had a higher BMI.	+ Random clustered sampling +Large sample size - Retrospective, self-reported data - Only menstruating females - Cross sectional - Only includes girls attending school

Citation Study Setting	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Shah et al., 2019[4] *A rite of passage: a mixed methodology study about knowledge, perceptions, and practices of menstrual hygiene management in rural Gambia*	Mixed methods In depth interviews and focus groups with adolescents, mothers, and teachers Survey to schoolgirls aged 11-21 years in Rural Kiang West district schools in The Gambia 2015-2016 N = 13 IDIs; 20 focus groups; 331 survey respondents	Exposure: -taboos and secrecy surrounding menstruation Outcome: -views on menstruation, cultural beliefs, sources, and levels of knowledge, MHM practices	N/A	Age, religion, education level of HH household, education level of caregiver, material of walls and floors in the house, main source of income, water source, toilet facilities.	Knowledge of menstruation showed a mixture of knowing what menstruation was, but no one linked it to hormonal changes. Many males and females saw it as a disease (33%) or caused by cultural folklore. 9% did not know what menstruation was. Source of knowledge for menstruation information was teachers (78%) or mothers (28%). Most said men should not know about this kind of subject. They were told information in line with Islamic religion. 33% of girls did not know what menstruation was when they first saw it. 65% were scared when they first saw blood, even among half of those that knew what menstruation was. Most girls wanted to use disposable pads if provided by the school, but they were too expensive to buy otherwise so rags were used. Reusable cloth was used Hid the pads when drying. Girls reported themselves as impure during their menstrual period and said they should not	+Included boys, girls, mothers, and teachers +Mixed methods - Only one Arabic school - Only girls attending schools with access to health care services

Citation Study Setting	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
					cook, attend crowded gatherings, or touch the Qur'an. Fears of infertility if they burned used pads.	
Chandra-Mouli and Patel, 2017[46] *Mapping the knowledge and understanding of menarche, menstrual hygiene, and menstrual health among adolescent girls in low- and middle-income countries*	Literature review of low- and middle-income countries N=81 papers from 2000-2015 across 25 countries (10 in West Africa)	Preparedness for menarche, knowledge of menstruation, sources of information, negative health, and social effects, what practices they develop	N/A	N/A	Adolescent girls are often uninformed and unprepared Information comes from mothers and female family members who often don't know much themselves Exclusion and shame lead to unhygienic practices during menstruation. Girls miss school, self-medicate and refrain from social interaction instead of asking for help. Teachers are not equipped to help.	+Large rage of countries +Many recommendations based on concurrent themes -Wide scope means fewer specific interventions for places -Many countries not represented may not be able to use results
Ssewanyana et al., 2017[30] *Menstrual hygiene management among adolescent girls in sub-*	Literature review, overview of studies	N/A	N/A	N/A	11-15 years as average age of menarche, older among rural individuals. Girls are often unprepared at menarche, low knowledge (4-90%) that differs by SES. Dominant sources are female family members who are not often well-informed.	+Brief and informative overview of the current knowledge of MHM in SSA -Did not address the lack of external validity

Citation Study Setting	Study Design Data Source(s) and Sample Size	Exposure(s) and Outcome(s)	Exclusions	Co-variables Examined	Results Conclusions	Strengths (+) & Limitations (-)
Saharan Africa					Males in charge of resource allocation. Low priority to MHM in households. Access to materials and WASH facilities is a challenge, especially in some rural locations. Girls reported to not change in school because of lack of girl friendly latrines and lack of disposal. Poor MHM disrupts education due to missed days of school, low confidence, and shame. Unsafe alternatives can lead to infection and risky sexual behavior to gain access to pads in some places like Kenya.	of studies but grouped together all SSA studies assuming they can relate to each individual community within each country. -Not a systematic literature review, just a general overview

CHAPTER 3: METHODOLOGY

STUDY DESIGN

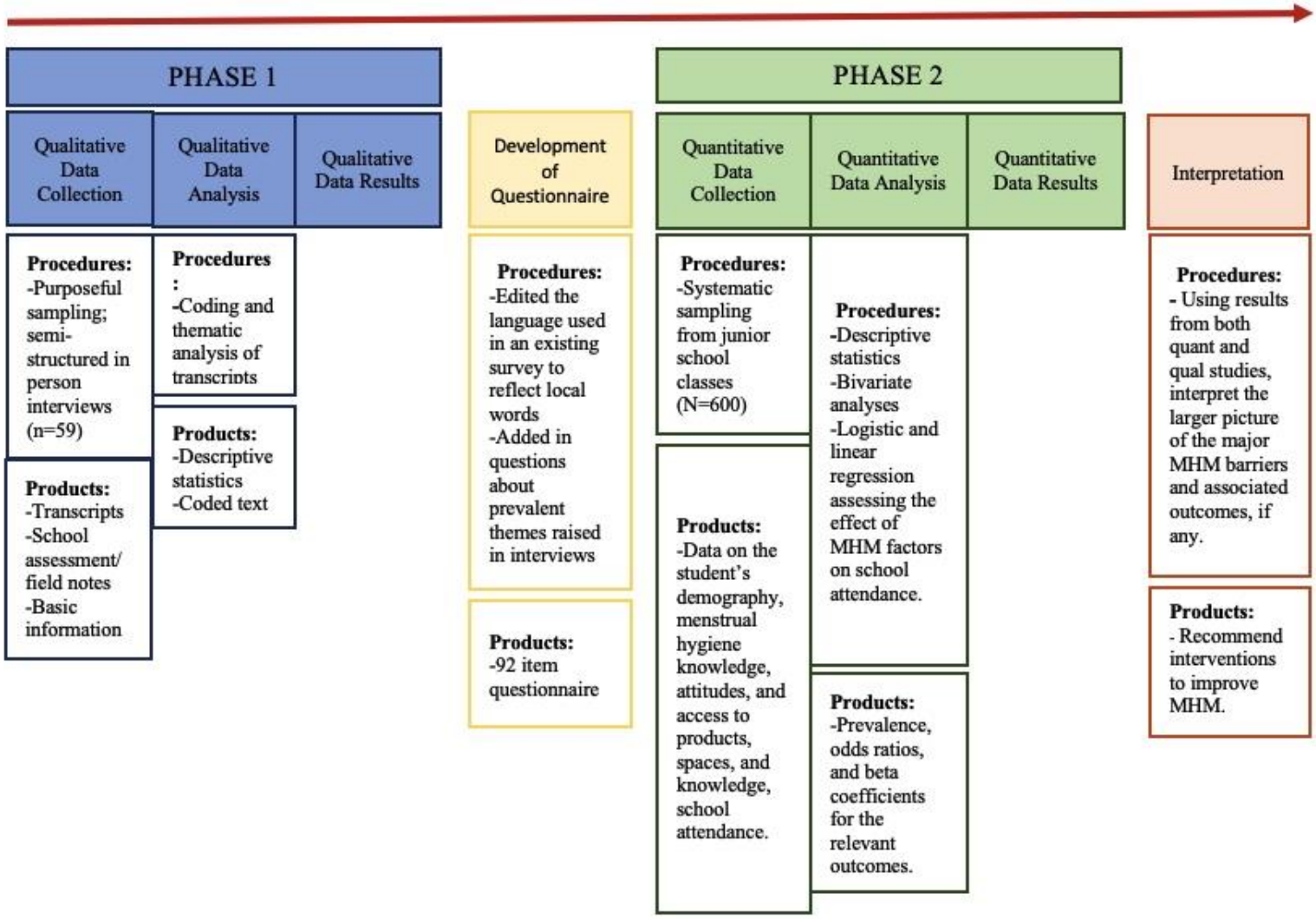
This study employed an exploratory sequential mixed methods study design using both qualitative and quantitative data collection methods (Figure 1). Qualitative methods are used to describe the lived experiences and context surrounding a phenomenon, while quantitative methods assess the magnitude of effect, generalizability, and prevalence of issues within a community[47]. Mixed methods research combines the strengths of both qualitative and quantitative methods and allows a more in-depth assessment of research questions. Creswell and Plano Clark describe the core characteristics of mixed methods as both qualitative and quantitative strands of data collected, to concurrently or sequentially, address the research questions[47]. In this study, an exploratory mixed methods design was used to sequentially address the research questions.

Firstly, qualitative data was collected through in-depth interviews with adolescent schoolgirls for two purposes: 1) to assess the perceptions, cultural beliefs, knowledge, and practices related to menstruation and 2) to help refine a quantitative instrument to further examine the issues surrounding MHM in this community. The initial questionnaire was drafted using study instruments used by previous authors across Sub-Saharan Africa[48]. The qualitative data themes were then used to refine the questions to ensure the correct terminology and any relevant questions assessing themes highlighted in the qualitative assessment were included. The questionnaire aimed to quantify the knowledge, practices, and attitudes of menstruation among schoolgirls and assess their effect on school attendance during menstruation. Questions about demographics, family education, family wealth, menstrual

characteristics, menstrual knowledge, menstruation perceptions, and menstrual symptoms were also included in the questionnaire. In addition, a school assessment of sanitation and menstrual education facilities was conducted. The results from the qualitative and quantitative data collection and analysis were interpreted together to describe the status of MHM and relevant outcomes within this population and the context that surrounds it.

The study was approved by the University of Louisville's Institutional Review Board in April 2021 with revisions approved in November 2021 (IRB Number: 20.0873). In addition, approval for the study was granted by the Edo State School management board and the headteachers of the selected schools. Letters signed by the partnering research centers in Benin City, The Centre of Excellence in Reproductive Health Innovation (CERHI) and The Women's Health and Action Research Centre (WHARC) were sent to the chief of the district school board and the headteachers of the selected schools for approval. On the appointed days, the study participants were informed by the researchers of the objectives of the study and were given the option to not partake. A verbal consent was acquired before data collection commenced in both phases.

Figure 1: Exploratory sequential mixed methods research design



STUDY SETTING

The study was conducted in peri-urban communities close to Benin City, Edo State, Nigeria in three female-only, government funded secondary schools. These schools were sampled because of their proximity to the research center, their student population, and their existing relationship with the research center. This ensured there was a trust between the researchers and the schoolteachers and students and a cooperation for timely data collection meetings. Each school had a student population of 1700-3000 to give a large enough sampling pool for the study. The schools were located within 20km of each other.

STUDY POPULATION

Participants for both the in-depth interview and the menstrual hygiene questionnaire were recruited in equal numbers from each school (20 interviews each and 200 questionnaires each). Eligibility criteria for the individual interviews and the questionnaires included being female, a minimum age of 11 years old and a maximum age of 19 years old, and to have reached menarche prior to the interview.

PHASE 1: IN-DEPTH INTERVIEWS AND SCHOOL ASSESSMENT

Sampling and Recruitment

Recruitment for the in-depth interviews was conducted by the head and teachers within each school. The students were purposively sampled to give a selection of ages and school grades within each school. Once 20 girls had been selected, the data collectors explained the purpose and process of the study to the participants in a group setting. Questions were answered and a verbal consent was provided. Once the participants sat down for their private one-on-one interview, a

written assent was given to them to read and was read aloud to them if requested. After reading the assent, the student was asked if they consent to partaking in the study. The interview continued if they consented (n=60).

In-Depth Interviews

Individual interviews were selected for use instead of focus groups due to the sensitive nature of the questions about menstrual health and practices. The interviews (n=60) were conducted in July 2021. All participants consented to the interview. The interviews were conducted by 12 local, female data collectors recruited from the University of Benin Medical School and the Centre for Reproductive Health Innovation. The data collectors were trained by the author of the dissertation and the two professors overseeing the project over a three-day program that included an overview of the study objectives and ethical requirements, reading over the interview prompts and editing sections to flow better, multiple practice interviews with partners, checking over the recording equipment, and an open discussion to prepare for keeping the participants comfortable and open to sharing their experiences.

The risk of social desirability bias was a concern if the participants answered how they thought they *should* answer. Therefore, time was spent on using tactics to make sure the participant felt safe and at ease during the interviews. The data collectors were also given at home activities to become familiar with the prompts, so they were used as guides and not scripts during the interviews.

Interviews were recorded using a voice recorder and notes were taken during the interview. Participants names were not used during the interviews. Each interviewer interviewed between three and five girls at each school. To ensure more trust and comfortability, all interviews were conducted by the local data collectors,

not the author of this dissertation. The interviews were semi-structured in format using a prompt guide to ensure all topics were covered in each interview.

The interview prompt guide included nine sections concerning the participants' demographic information, knowledge of menstruation, menstrual hygiene practices and facilities, experiences during menstruation relating to health status, social life, and school activities, and preferences regarding intervention types and distribution methods. In addition, the interviewers had three types of sanitary products to show the participants as a visual prompt during the questions. The interview prompt guide was designed based on previous literature, including a study based in Kaduna, Nigeria that showed the lack of sensitivity of household sanitation or availability of soap and water to the true perceptions of the menstrual hygiene management environment. For example, access to soap and water in general was not associated with access to soap and water for menstrual management[19]. Based on this, we asked more specific questions about the level of safety and access to facilities during menstrual management. The interview guide was reviewed by the study team, data collectors, and schoolteachers before use.

Interviews ranged from 20 to 40 minutes in length. Each interview was transcribed verbatim by the author of this dissertation. Notes from the interviews were consulted if questions surfaced during the transcription process. No incentives were used; however, each girl received a surprise gift bag that included hair ties, candy, and mosquito repellent bracelets at the end of the interview.

School Assessment

During the interview days, an assessment of the facilities and the educational materials present in the schools was conducted. A MHM Checklist was created by the research team using the World Bank Menstrual Health and Hygiene Resource

Package as a guide for what variables to include[49]. The checklist was used to quantify how many toilets, hand washing stations, disposal units, and private spaces there were, if any. In addition, the checklist included sections concerning gender and age-separation of toilets (male workers were present in the schools), privacy of toilets, location of water and soap for flushing toilets and washing hands, and waste disposal location. In addition, the MHM checklist included items concerning visual aids for menstrual hygiene present in the school, and the availability of sanitary products in school. The head of the school was also asked what activities and classes at the school included menstrual hygiene, if any. The school assessment variables were used to describe the setting to add context to the interview and questionnaire responses. In addition, they were gathered to include as potential confounding variables during the quantitative data analysis if necessary.

Analysis of In-Depth Interviews

Interview transcripts were analyzed using inductive thematic analysis[50,51]. Each interview transcript was read by one researcher and segments related to the research questions were highlighted and coded. Six transcripts were randomly selected for a second member of the study team to read and code independently. The results were discussed, themes were merged, and a list of 20 distinct key themes evolved to use as the guide for the analysis. Two study team members then recoded the six transcripts independently using the pre-determined codes and calculated inter-coder reliability scores using the Kappa statistic. There were two minor coding disagreements which were resolved through discussion. The remaining transcripts were coded by one research team member using ATLAS.ti version 8.1 software. Categories were created around the codes as the review progressed and meaningful patterns started to emerge around the key research questions. Final checks were made

to ensure the individual data segments adequately supported each theme. The themes were assessed for succinctness and were named. The major themes and supporting quotes are reported in the relevant manuscript (Aim 1 Manuscript).

PHASE 2: MHM QUESTIONNAIRE

Development of the Questionnaire

The questionnaire (Appendix 1) was developed using guidance from the World Bank Menstrual Health and Hygiene Resource Package[49], existing literature[48] assessing similar variables in similar settings, and the interview responses. The phrasing of questions remained alike to the phrasing of other literature to aid in future comparisons between studies. The questionnaire included five sections assessing demographics, school attendance, menstruation experiences, knowledge, practices, and perceptions, and school attendance specifically in relation to menstruation. Questions can be viewed in the Appendix 1 document. The draft MHM Questionnaire was reviewed by the study team members and the questions were edited based on the suggestions provided. In addition, two study team members completed the questionnaire from start to finish to ensure the questionnaire flowed correctly and was efficient to complete. The questionnaire was reviewed and edited based on the feedback. It was not possible to use students for a pre-test because of limited access and travel to the schools.

Sampling and Recruitment

Participants for the second phase of the study were recruited from the same three schools. After securing a date for data collection with the headteachers, the participants were recruited by study team members approaching all students in junior and senior classes asking for interest in participation. The recruitment process took place in January-February 2022. Since most girls were interested in participation in

the study, the teachers and research team members selected girls from each class to make sure there was a variation in age and class grade participating.

Sample Size and Response Rate

Epi Info 6 was used to calculate the sample size at a poor MHM prevalence of 80%, using a 95% confidence interval and a 5% margin of error. The estimated sample size was 460 participants for a power of 90%. To account for incomplete surveys and a low response rate, a total of 200 girls from each school were recruited giving a total sample size of 600. The girls were recruited randomly to reduce selection bias and ensure the selected students reflected the schoolgirls that were not selected. The response rate was 100% of girls starting the survey. 61 (10.17%) of respondents had to be dropped from the sample size because of having not reached menarche (n=17), missing data on menarche (n=6), or missing outcome data (n=38).

Data Collection

The questionnaire was self-administered with the supervision of data collectors (Appendix 1). A school hall or large classroom was used to accommodate 200 students. The study objectives were communicated to the group of students and questions were answered. A verbal assent from each participant was required before the questionnaires were distributed. All the girls consented. The participants completed the questionnaire in one sitting and asked questions if they needed help or guidance on any question. The questionnaires took an average of 41 (IQR 37-44) minutes to complete.

Data Analysis

The questionnaire data was used to answer parts of both specific aims.

<u>Specific Aim 1:</u>

- **AIM 1:** Describe the knowledge, attitudes, and practices of MHM among adolescent schoolgirls in peri-urban areas in Edo State, Nigeria.
    - 1a. Describe the demographic make-up of the study participants regarding age, school year, poverty level, and parental education level.
    - 1b. Assess the average age of menarche, main source of knowledge about menstruation, main symptoms during menstruation, most common management methods, most common source of materials, disposal methods, average knowledge of menstruation, average perception of menstruation, and overall menstrual well-being of the study participants.

Statistical Analysis for Aim 1a and 1b:

Descriptive statistics were employed to calculate the average (mean (SD) or median (IQR)) age, school year, poverty level categories and most prevalent geographical location among the final sample study participants. Crude prevalence estimates were used to assess the MHM characteristics of the participants.

Specific Aim 2:

- **AIM 2:** Identify demographic and other covariates associated with poor MHM (access to safe materials, safe disposal, private space to change in school, and sanitation facilities) and the relationship between poor MHM and school attendance using bivariable and multivariable assessment to adjust for individual and school level confounding.
    - *Hypothesis:*
        - Controlling for individual and school level factors, adolescents with poor MHM will have a higher odds of school days missed during their last period.

Statistical Analysis for Aim 2:

Primary Outcome: School Days Missed Due to Menstruation

School attendance was measured using the variable "Have you ever missed school in the past 3 months because of menstruation periods?". This was modelled dichotomously as Yes/No.

Primary Exposure: Menstrual Hygiene Management:

Menstrual practices were measured by asking questions about the sanitary material used, location of purchasing menstrual products, times participant changes their sanitary material per day, changing space at school, disposal facility at school, and water and soap facilities at school. Individual menstrual hygiene components and a menstrual hygiene management composite score of menstrual hygiene management was measured using a sum of the four components:

1. Used only manufactured products (reusable or disposable) during their last period.
2. Among those that used disposable products, they disposed of them in a bin or incinerator at school.
3. Had consistent access to clean water at school.
4. Had a private space (latrine or private room) to change sanitary products during school.

Although a score of 4 out of 4 is defined as adequate MHM by UNICEF, only 27 girls reported all 4 components, therefore, the results of the composite score are reported as 0-2 components (0-50%) reported as 'yes' and 3-4 components (51-100%) reported as 'yes'. If the girls were missing data, it was not assumed as 'no', their score was a proportion of number of 'yes' answers out of the number of answered questions.

Other Exposure Variables:

1. Menstruation knowledge was measured using thirteen questions asking about the origin of blood, menstrual cycle length, pregnancy during menstruation, pain killers, and rituals associated with menstruation. Since only 4 girls answered all knowledge questions, measuring a knowledge score out of 13 assumes the missing answers were incorrect. To account for this, an average proportion of correct answers out of the number of answered questions was calculated. Three basic menstruation questions from the set of 13 questions were also assessed as their own group, these included "period blood comes from the uterus in response to hormones", "periods happen on a cycle every 28 days", "menstruation in girls and women is normal". These questions were selected based on previous studies[52]. In addition, the source of knowledge and timing of receiving menstrual knowledge was assessed.
2. MHM attitudes were measured using phrases that participants agreed with or not, using a Likert scale, including "I feel anxious about my next period" and "Period days are like any other day". A similar measure was used in previous literature, however, it was shortened for use in this paper and was limited by a lack of validation within this study population.[53]
3. Symptoms during menstruation were asked as individual questions based on known symptoms and other symptoms raised in the qualitative interviews (stomach cramps, back pain, headache, stained underwear, stained outer garments, mood irritability, wet feeling on genitals, unpleasant smell, and genital irritation/rash). The symptom question was phrased: "During your last menstruation, did you experience X symptom", the answer options were Yes/No/Missing for each question.

Previous literature, directed acyclic graphs (DAGs), and bivariable (exposure and potential confounder) regression assessment was used to assess confounding in each relationship. Next, multivariable logistic was used to assess the effect of the each MHM component on school days missed due to menstruation while adjusting for all measured confounders. In addition, the association between other menstrual factors and school days missed due to menstruation were examined using multivariable logistic regression. A sensitivity analysis was also conducted using any school days missed in the past month as the outcome to provide more participants who experienced the outcome for the analysis.

CHAPTER 4: KNOWLEDGE ATTITUDES, AND PRACTICES OF MENSTRUAL HYGIENE MANAGEMENT AMONG ADOLESCENT SCHOOLGIRLS IN PERI-URBAN AREAS IN EDO STATE, NIGERIA

Background: Girls in low-income settings face substantial challenges that prevent attainment of adequate menstrual hygiene management (MHM), which can lead to poor health, educational, and social outcomes. Adequate menstrual hygiene is defined as access to sanitary materials, safe changing spaces, safe disposal, and wash facilities. This study aimed to investigate menstruation knowledge, perceptions, and practices, and identify the major menstrual challenges among schoolgirls in peri-urban regions of Edo State, Nigeria.

Methods: Qualitative and quantitative methods were conducted among consenting girls aged 11-19 years old in three secondary schools in Edo State, Nigeria (N=600). Methods included in-depth interview with students, a quantitative questionnaire, and an observation assessment of school water, sanitation, and menstrual hygiene facilities. Inductive thematic analysis was used to assess the qualitative interviews (n=60). Descriptive statistics were used to assess the menstruation characteristics, knowledge, perceptions, and practices among menstruating girls (n=577).

Results: Of the 577 of girls who had started menstruating, the average age of menarche was 13.1 years (SD 1.2), the most common reported physical symptoms were stomach pain (73.7%) and mood irritability (40.7%) with no girls reporting no symptoms. Menstruation knowledge was acquired mostly from mothers. The participants showed an average of 76.9% correct answers when asked basic questions

about menstruation. Almost half of girls (42.6%) felt anxious for their next period. The girls described cultural myths surrounding menstruation driving them to hide their menstrual products and feel embarrassed to ask for more information or help. Only 27 girls (4.7%) reported complete adequate menstrual hygiene management at school (access to sanitary pads, changing and sanitation facilities, and safe disposal methods) during their last period. When assessed individually, most girls (80.4%) used manufactured sanitary pads during their last period, over half the girls changed in a private room (35.5%) or a latrine (23.4%), and less than half the girls disposed of their used products in an incinerator (24.8%) or dustbin (20.3%). Most strikingly, less than a third of girls had consistent water access in school (29.6%). In addition, many girls in the interviews complained of the high cost of sanitary products and of the poor school facilities that were not conducive to a supportive environment for menstruating girls.

Conclusion: In this peri-urban Nigerian schoolgirl population, adequate menstrual hygiene was not attained at school, raising concerns about missing school due to a lack of facilities during menstruation. Menstrual management interventions are needed to address the structural (e.g., improved water and sanitation facilities, adequate sanitary materials) and social (e.g., self-confidence, stigma, perceptions) determinants of menstrual hygiene management.

INTRODUCTION

Girls in low- and middle-income countries (LMIC) often enter their adolescence ill-equipped with the knowledge, materials, and facilities to manage their menstruation[1]. As defined by the United Child's Health Fund (UNICEF), adequate menstrual hygiene management (MHM) is the safe use and disposal of sanitary material to collect menstrual blood and the option to change this material in privacy as many times as necessary during the period of bleeding [12]. Menstrual hygiene management is often accompanied by a taboo surrounding menstruation that propagates a lack of understanding, discomfort, and shame, especially in LMIC[13]. Many studies across West Africa highlighted the core challenges of girls finding clean sanitary materials, a place to change and dispose of their used sanitary material, and a general lack of understanding of the menstrual cycle[11,13,14]. These challenges were associated with school attendance[9,15], school participation[16], mental health outcomes[13], and reproductive tract infections[54]. A literature review assessing MHM across Sub-Saharan Africa emphasised that access to MHM facilities, materials, and knowledge was more difficult in rural locations; however, there is a lack of research in peri-urban settings which may face unique challenges[30].

In addition to rurality, schools are important settings in relation to MHM. Inadequate social and structural support, such as lack of private toilets, safe water and soap supply, can negatively influence a girl's management of menstruation and lead to poor concentration in school, low participation in extracurricular activities, increased missed days at school, and even school dropouts[1,16,55,56]. Education is a top priority in Nigeria's national development strategy, named as an important tool to improve the economic growth of the country by UNICEF[12]. To enable adolescent girls to thrive in their education, the school environment must be supportive to

menstrual hygiene needs. Existing studies have shown that very few schools in Nigeria succeed in providing the water, sanitation and hygiene (WASH) standard recommended number of toilets (i.e., 25:1 girl pupil-to-toilet ratio), and levels of privacy and water access differ by urban and rural region[12,57]. However, the quality and quantity of evidence assessing the usability of resources at school is sparse, with most studies assessing the effect of sanitary materials and their effect on school and health outcomes[9,53,58] and only referencing objective checklists for the presence of sanitation facilities and menstrual hygiene materials at school. The existing studies were limited by small study samples and challenges in assessing the lived experience of the schoolgirls in relation to the menstrual hygiene context around them. It is important that interventions aimed at improving menstrual hygiene management within the school environment are planned with the community to understand the usability of resources. The lack of sufficient evidence-base for the effectiveness of current MHM resources in schools was emphasized by the "MHM in Ten" group, representing the United Nations and other stakeholders. This group highlighted improving MHM as a priority by 2024, by identifying the problems and inventing and implementing cost-effective and sustainable interventions driven by the community[59].

The objectives of this paper are to describe the results of a mixed-methods study among peri-urban secondary school students in Edo State, Nigeria. This paper seeks to understand menstruation characteristics, symptoms, practices, knowledge, attitudes, and biggest challenges among schoolgirls in peri-urban regions of Edo State. The results will be used to help inform the design of community-based participatory intervention for secondary school girls in Edo State.

METHODS

Study Setting

The study was conducted in three government sponsored (public) secondary schools that serve peri-urban areas in Benin City, Edo State, Nigeria. The study was conducted in collaboration with the Center for Reproductive Health Innovation (CERHI). Prior to the data collection, a meeting was held with the permanent Secretary for Education of the state representing the Post-Primary Education Board to discuss the objectives, procedures, and timeline of the study and select the schools. Three schools were purposively selected based on the study objectives and existing relationships and trust with the CERHI research center. All three schools were female only secondary schools with a mixture of boarding and day students. Each school had a total student population between 1700-3000 students, giving a total eligible population size of approximately 6500 girls. We assessed three schools to improve the representation of other schools within Edo State. The study was conducted among female students in junior and senior secondary school years aged 11-19 years old equally sampled across the three schools from July 2021 to February 2022. The in-depth interview sample (N=60) and the questionnaire sample (N=600) were collected from the same schools but at different times, therefore, some of the same girls may have participated in both phases of data collection, but this was not tracked.

Informed Consent

Prior to data collection, the local research collectors explained the study to the heads of school, teachers, and the selected students. Local dialect and phrasing were used when needed to aid with comprehension. To participate in the study, a verbal assent was obtained from each participant before each phase of data collection. All recruited girls consented to participate in the study.

The study was approved by the University of Louisville's Institutional Review Board in April 2021 with revisions approved in November 2021 (IRB Number: 20.0873). In addition, approval for the study was granted by the Edo State School management board and the headteachers of the selected schools.

Data Collection

Study Design

The study followed a sequential exploratory mixed methods study design, where the qualitative data collection and analysis informs the quantitative data collection and analysis before being interpreted together to provide an in-depth understanding of the research question[60]. The qualitative data allows exploration of contextual factors such as perceptions, beliefs, and attitudes in addition to aiding in the development of quantitative measures. In this study, the in-depth interviews were used to adapt the questionnaire to ensure the questions were culturally appropriate and included questions about issues raised by the study population. In this paper, the qualitative and quantitative results are integrated and synthesised as one to describe the menstrual hygiene management of the study population.

Qualitative Interviews

In-depth interviews (IDIs) were conducted with girls from Junior Secondary Class 1, Junior Secondary Class 2, Senior Secondary Class 1, and Senior Secondary Class 2 school years. A teacher randomly selected 20 girls from each school out of all the girls present of the day of the in-depth interviews who had reached menarche (a total of 60 girls across three schools). The interviews were conversational using semi-structured topic guides to explore the terminologies, myths, practices, perceptions, and knowledge surrounding menstruation, in addition to access to facilities, related health and educational outcomes, and views on interventions. The in-depth interviews

were conducted by trained, young, local data collectors using adolescent participatory methods to facilitate participation and help the girls feel at ease.[61,62] The interviews were conducted in private spaces, lasted 20-40 minutes, and were voice recorded.

Quantitative

This project was part of a larger assessment into menstrual hygiene management and educational and health outcomes. A questionnaire (Appendix 1) was distributed to 200 girls at each school (a total of 600 girls across three schools). The participants were randomly selected by their teachers out of all the girls attending school on the day of the survey distribution. The questionnaire collected data on age (years), parental education level (primary or secondary, tertiary), age of menarche (years), family wealth index, MHM knowledge, attitudes about menstruation, menstrual practices, and menstruation symptoms.

Since accurate data on income and cost of living was hard to measure in less developed settings, an age-appropriate, culturally relevant poverty index was constructed to capture the multiple dimensions of poverty in the peri-urban communities that the participants live in. A material wealth index was created guided by Asselin's indicators of household financial poverty.[63] This includes ownership of and access to common consumer goods (TV, car), economic capital (land, livestock), water and sanitation (flush toilet, running water), and electricity.

Menstruation knowledge was measured using thirteen questions asking about the origin of blood, menstrual cycle length, pregnancy during menstruation, pain killers, and rituals associated with menstruation. Since only 4 girls answered all knowledge questions, measuring a knowledge score out of 13 assumes the missing answers were incorrect. To account for this, an average proportion of correct answers out of the number of answered questions was calculated. Three basic menstruation

questions from the set of 13 questions were also assessed as their own group, these included “Period blood comes from the uterus in response to hormones”, “periods happen on a cycle every 28 days”, “menstruation in girls and women is normal”. These questions were selected based on previous studies[52]. In addition, the source of knowledge and timing of receiving menstrual knowledge was assessed.

MHM attitudes were measured using phrases that participants agreed with or not using a Likert scale, including “I feel anxious about my next period” and “Period days are like any other day”. A similar measure was used in previous literature, however, it was shortened for use in this paper and was limited by a lack of validation within this study population.[53]

Menstrual practices were measured asking questions about the sanitary material used, location of purchasing menstrual products, times participant changes their sanitary material per day, changing space at school, disposal facility at school, and water and soap facilities at school. A composite score of menstrual hygiene management was measured using four components of the standard definition included as direct questions in the questionnaire:

5. Used only manufactured products (reusable or disposable) during their last period.
6. Among those that used disposable products, they disposed of them in a bin or incinerator at school.
7. Had consistent access to clean water at school.
8. Had a private space (latrine or private room) to change sanitary product during school.

Symptoms during menstruation were asked as individual questions based on known symptoms and other symptoms raised in the qualitative interviews (stomach cramps, back pain, headache, stained underwear, stained outer garments, mood irritability, wet feeling on genitals, unpleasant smell, and genital irritation/rash). The symptom question was phrased: "During your last menstruation, did you experience X symptom", the answer options were Yes/No/Missing for each question.

The questionnaires were self-administered on paper forms on school premises with a local, young facilitator present in the room to answer any questions. All questionnaires were screened for completeness, coded, and entered into an electronic secure database and paper forms discarded.

Water, Sanitation, and Hygiene Checklist

Each school was assessed by the head researcher using a checklist when visited for the first phase of data collection in July 2021[49]. The assessment included the presence of, access to, and state of the following items: number of toilets, functionality of toilets (flush, water, and toilet paper available), private spaces, sanitation facilities and their location (water, soap), disposal facilities for sanitary waste, menstrual hygiene education materials, and sanitary product vending.

Data Analysis

Qualitative Data Analysis

The interview recordings were transcribed verbatim and the interview transcripts were analyzed using inductive thematic analysis.[50,51] Firstly, six transcripts (10% of the total) were randomly selected for two researchers to code independently to test for inter-rater reliability regarding the themes emerging from the transcripts. A Kappa statistic was used to measure the agreement between coders. The result was kappa = 0.7, showing adequate agreement. The results were discussed, sub-themes

were refined, and a list of 20 distinct key themes evolved to use as the framework for the analysis of the subsequent transcripts. The themes covered access to knowledge and materials, practices, types of knowledge, fears and restrictions, and school and health outcomes with sub-themes elaborating on the rituals, beliefs, and specific practices that occurred within each theme. The themes were used to guide the table organization in the results report below.

Quantitative Data Analysis

The cross-sectional questionnaire was analyzed using descriptive statistics to summarize the frequencies and averages of menstruation characteristics, knowledge, perceptions, symptoms, and practices. Adequate menstrual hygiene management was quantified as girls who used only sanitary products during their last period, disposed of them in a bin or incinerator, had consistent access to clean water, and had a private space to change sanitary material during school. Non-menstruating girls (n=17) and girls with missing data for menstruating status (n=6) were excluded from the analysis to give an analytical sample of 577 menstruating girls. Analyses were conducted using SAS Version 9.4.[64]

RESULTS

Study Participant Characteristics

Among the study participants that had begun menstruating (n=577), the median age of participants was 16.2 years old (SD 2.1) and most of the girls were day students (93.1%), meaning they travel from home to attend school each day (Table 1). The average number of household members residing in the participant's homes was 6 people (IQR 2.0). Fathers were slightly more educated than mothers with 38.0% of

fathers reaching secondary education compared to 35.2% mothers reaching secondary education.

For the most part, the participants had access to these basic needs at home, for example, 96.0% of girls had access to electricity at home and 92.7% of participant's families owned a TV. However, it is important to note that there are still many girls missing resources with 97 (16.81%) of the menstruating girls having no running water at home, and 62 (10.74%) having no flush toilet. In addition, only 59.62% of the menstruating girls reported their family owning a car, suggesting transportation issues may be present.

The study participants that were excluded from the main sample because they had not begun menstruating were slightly younger with a median age of 15 years and had slightly lower poverty index scores. Sociodemographic characteristics of the participants are shown in Table 1.

Table 4.1: Sociodemographic Characteristics of Girls Participated in the Quantitative Questionnaire				
	Menstruating Girls (N=577)		*Non-Menstruating Girls (N=17)**	
Characteristic	**Freq/Median**	**Missing**	**Freq/Median**	**Missing**
Median age (years)	16.21 (2.11)	4 (0.69%)	15.78 (1.58)	1 (5.88%)
Type of student		10 (1.73%)		0 (0.00%)
Day	537 (93.07%)		17 (100%)	
Boarding	30 (5.20%)		0 (0.00%)	
Median household members	6 (2.00)	85 (14.73%)	6 (1.82)	2 (11.76%)
Paternal education		100 (17.33%)		1 (5.88%)
No education	65 (11.27%)		4 (23.53%)	
Basic education	192 (33.28%)		6 (35.29%)	
Secondary education	219 (37.95%)		6 (35.29%)	
Tertiary education	1 (0.17%)		0 (0.00%)	
Maternal education		92 (15.94%)		1 (5.88%)
No education	71 (12.31%)		3 (17.65%)	
Basic education	210 (36.40%)		9 (52.94%)	
Secondary education	203 (35.18%)		4 (23.53%)	
Tertiary education	1 (0.17%)		0 (0.00%)	
Electricity inside the house	554 (96.01%)	4 (0.69%)	16 (94.12%)	0 (0.0%)
Running water inside the house	472 (81.80%)	8 (1.39%)	11 (64.71%)	0 (0.0%)
Flush toilet at home	504 (87.35%)	11 (1.91%)	13 (76.47%)	0 (0.0%)
Land owned by family	414 (71.75%)	14 (2.43%)	12 (70.59%)	1 (5.88%)
Car owned by family	344 (59.62%)	14 (2.43%)	8 (47.06%)	0 (0.0%)
Television in the house	535 (92.72%)	17 (2.95%)	16 (94.12%)	0 (0.0%)
Livestock owned by family	220 (38.13%)	47 (8.15%)	6 (35.29%)	2 (11.76%)
*Values are means (SD) or medians (Q25, Q75) for continuous variables; percentages or Ns or both for categorical variables and missing.				

Values of polytomous variables may not sum to 100% due to rounding and/or the option to select more than one answer. Continuous missing variables were assigned the median value.
6 participants (1.0%) were missing data on reaching menarche.

Menstruation Characteristics, Experiences and Perceptions

Quantitative Findings

The menstrual characteristics, experiences, and perceptions of the participants are presented in Table 2. Of the 577 of girls who had started menstruating, the average age of menarche was 13.1 years old with a range from 8 years to 19 years. The median duration of periods was 4 days (IQR 4-5) and the median number of weeks between each period was 4 weeks (IQR 3-4). The girls were asked if they experienced each symptom listed in Table 2 during their last period. The most common physical symptom reported by the girls was “stomach” pain (73.66%). Other physical symptoms were also reported including mood irritability (40.73%), sticky/wet feeling on genital skin (37.09%), unpleasant smell (28.60%), headache (26.34%), genital skin irritation (25.65%), and back pain (21.32%). No girls reported no symptoms during their period. In addition, over half the girls reported having stained their underwear with blood (58.23%) and around a third (32.58%) had stained outside garments. Among the 36 girls that reported other symptoms, a mix of experiences were recounted including acne, dizziness, bladder and leg pain, frequent urination, loss of appetite, fever, diarrhoea, vomiting, tiredness, and weakness.

Most girls (65.16%) disagreed that period days were like any other day and almost half of girls (42.63%) felt anxious for their next period.

Table 4.2: Menstruation Characteristics, Experiences, and Perceptions of Girls Participating in the Quantitative Questionnaire (N=577)		
Variable	**Freq/Median**	**Missing**
Mean age of menarche	13.11 (1.22)	7 (1.21%)
Average number of days per period	4.00 (1.00)	4 (0.69%)
Average number of weeks between periods	4.00 (1.00)	47 (8.15%)
Symptoms during last period		
Stomach pains/cramps/bloat	425 (73.66%)	44 (7.63%)
Stained underwear	336 (58.23%)	55 (9.53%)
Mood irritability	235 (40.73%)	88 (15.25%)
Wet feeling on genitals	214 (37.09%)	87 (15.08%)
Stained outside garments	188 (32.58%)	78 (13.52%)
Unpleasant smell	165 (28.60%)	87 (15.08%)
Headache	152 (26.34%)	90 (15.60%)
Genital irritation/rash	148 (25.65%)	91 (15.77%)
Back pain	123 (21.32%)	109 (18.89%)
Other	36 (6.24%)	178 (30.85%)
Perceptions		
"Period days are like any other day"		42 (7.28%)
Agreement	159 (27.56%)	
Disagreement	376 (65.16%)	
"I feel anxious about my next period"		47 (8.15%)
Agreement	246 (42.63%)	
Disagreement	284 (49.22%)	

Values are means (SD) or medians (Q25, Q75) for continuous variables; percentages or Ns or both for categorical variables and missing.
Continuous missing variables were assigned the median value.
Values of polytomous variables may not sum to 100% due to rounding and/or the option to select more than one answer.

Qualitative Findings

Menstrual pain was frequently highlighted in the IDIs as a concern during menstruation, and often the pain affected their daily lives by being too severe to attend school, eat, or play sports. In addition, the management of menstrual pain (dysmenorrhea) was inhibited by beliefs that pain medications would not work.

> *"Oh my god, I was in the sick bay because the pain was really, really bad. I couldn't eat and my skin was all irritated. I don't like my body when I'm on it, I don't feel flexible I just feel slow. I feel anger too; like I yell at people and it's really bad and I don't like it."* (Day student, school 2).

> *"No drugs work for my menstrual pain. There are times when I've had a full Paracetamol, but it didn't work. My dad took me to a pharmacy when I felt weak, and the pharmacist said my body just works like this. They said I should just try and make sure I can bear the pain."* (Day student, school 3).

> *"The first and second day I felt so much pain. So maybe during school time I might not even come to school and then I'll come the next day."* (Day student, school 2).

> *"I don't do sports when I am on my period. In school I usually do cricket, but I can't play when I'm on my period because of the pain and if I leak."* (Day student, School 1).

The IDIs also indicated that a fear of staining is related to anxiety and leads to girls not going to school or activities during their menses. A lack of access to reliable protection methods and private places to change to prevent leaks was a concern.

> *"Classmates and friends will laugh if you leak. Once a girl had her period stain her clothes and people made jokes about her, so she was crying. There was no place for her to change or clean herself up, so she went home*." (Day student, school 1).

Menstruation Knowledge

Quantitative Findings

The menstruation knowledge of the participants is presented in Table 3. Among the 577 menstruating girls, just over two thirds reported their mother as their most useful source of information regarding menstruation information (67.48%). The next most reported answer was teachers (12.76%). Other sources of information that are not listed in Table 3 included radio, TV, newspaper, social media, and the internet. Over half the participants said they do not discuss menstruation with their fathers. Some girls also reported not talking about menstruation with "everyone", "men generally" and "strangers." Most girls (77.47%) first heard about menstruation before their first period; however, almost one fifth of girls (17.33%) did not learn about menstruation until they experienced it themselves or after their first period. Moreover, a small but significant number of girls (2.25%) in this sample have still not learned about menstruation.

Of the 577 menstruating girls, 557 answered at least one knowledge question. The average knowledge score was 76.92% (when measured out of number of

answered questions). When only the three basic menstruation questions were assessed, the average score was 53.55% of correct answers.

Table 4.3: Knowledge Related to Menstruation of Girls Participating in the Quantitative Questionnaire (N=577)		
Variable	**Freq/Median**	**Missing**
Most useful source of menstrual knowledge		5 (0.87%)
Mother	386 (67.48%)	
Teacher	73 (12.76%)	
Sister	52 (9.09%)	
Friend	14 (2.45%)	
Health worker	13 (2.27%)	
Aunties	10 (1.75%)	
Other	8 (1.40%)	
Grandmother	7 (1.22%)	
No-one	7 (1.22%)	
First heard about menstruation		17 (2.95%)
Before first menstruation	447 (77.47%)	
At first menstruation start	86 (14.90%)	
After first menstruation	14 (2.43%)	
Never learned	13 (2.25%)	
Do not discuss menstruation with males in the family	365 (63.26%)	88 (15.25%)
Average correct knowledge answers out of all questions (%) *	69.23% (23.08%) (9 out of 13)	20 (3.47%)
Knowledge score (out of all)		0 (0.0%)
0-30%	32 (5.55%)	
31-70%	254 (44.02%)	
71-100	291 (50.43%)	
All three basic menstrual cycle questions correct^	268 (53.55%)	0 (0.0%)
Average correct knowledge answers out of answered questions (%) **	76.92% (17.93%) (equiv. to 10 out of 13)	20 (3.47%)
Knowledge score (out of answered)		0 (0.0%)
0-30%	2 (0.35%)	
31-70%	211 (36.57%)	
71-100%	364 (63.08%)	
Knowledge score (out of total answered) for non-menstruators	69.23% (19.78%)	0 (0.0%)

Values are means (SD) or medians (IQR) for continuous variables; percentages or Ns or both for categorical variables and missing.
Values of polytomous variables may not sum to 100% due to rounding and/or the option to select more than one answer. Continuous missing variables were assigned the median value.

*This measure assumes the missing answers as incorrect answers and calculates the (number of correct answers/13) *100
**This measure calculates the (number of correct answers/the number of answered questions) *100
^The three basic menstrual cycle questions included “menstrual blood comes from the stomach”, “menstrual blood comes from the uterus”, and “a menstrual cycle is 28 days long”.

Qualitative Findings

Almost all girls reported their mother as one of the main sources of menstruation knowledge in the IDIs, which was most frequently described as being shared with them at the time of their first period. In addition, some girls reported their resistance to male family members knowing they were menstruating because of their hostile reactions.

> *"The first time I saw my first period I was like what is this? I was scared to tell anyone about it, I don't know whether they would laugh at me or something. Later on, I told my mum about it, and she told me see how you do it, we were using menstruation pads and she showed me how to use it."* (Day student, school 1).

> *"No, I didn't even expect it and I was at school when I got it and I just saw blood coming so I was just screaming. My mum told me that as a girl child I had passed through, and I had matured."* (Day student, school 2).

> *"They [male family members] don't know because I am shy to tell them. My aunt will know because I won't like to work or do anything I'll be so lazy. My uncle might shout at me and say are you the only one that has periods and that I am not normal."* (Day student, school 2).

Despite some basic knowledge of the menstrual cycle, the IDIs indicated that there were many misunderstandings about menstruation, including pregnancy if females are touched by a male after reaching menarche, money ritual beliefs about

men selling used pads and stained underwear if not discarded discreetly, and the powerful ability of menstruating women to take money from men if they are present during their menses.

> *"I was not prepared for my first period. It was on a Saturday on the weekend, and I was still in primary school. I didn't know it was menstruation so me and my mum were just washing and then I saw blood in my stained pants. I was so scared and told my mum and she told me I should go and have my bath and I should be careful if someone touches me because I will get pregnant."* (Day student, school 3).

> *"No, maybe I don't tell them [males] but if they notice they say they don't need the menstruating girl touching them and if I touch them they won't see the money. They say women are very powerful and can take things away from men, so I have to leave."* (Day student, school 1).

> *"I heard that if you show your pad then it's not good, then maybe there is a money ritual where someone will take it and use it for profit. We must tie used pads in a black nylon and secretly hide them when disposing so no one can see."* (Day student, school 2).

Furthermore, many IDIs indicated the need for further education from health professionals in schools to better prepare girls for menarche.

"The nurses should teach about menstruation, for example now, if everybody knew about it would help. Students don't know anything about menstruation before it is too late." (Day student, school 1).

Menstrual Management

Quantitative Findings

During their last period, 464 (80.4%) girls reported using manufactured disposable sanitary pads (Table 4), 66 (11.4%) used old clothes, and 50 (8.7%) used locally made reusable pads (e.g., Virtuous pads). Most girls (83.6%) changed their pad twice or three times a day; however, still over a third of girls had experienced a leak onto their clothes before. The most common vendor used by girls was the market, local shop, and local pharmacy. Over one-third (37.9%) of girls had someone else purchase sanitary products for them and 62 (10.7%) girls reported only being able to afford pads 3 times a year, if ever.

When experiencing menstruation at school, 205 (35.5%) girls reported changing their sanitary products in a latrine and 135 (23.4%) used a private room. The other girls reported changing at home in their break (19.1%), behind a bush (10.4%), at the back of the classroom (10.2%), or not attending school at all during their period (14.7%).

Among the 476 girls that used disposable sanitary products during their last period, almost half (48.5%) reported taking their products home to dispose, and over a third of girls (34.4%) reported not changing at all during the school day. In addition to disposal issues, less than a third of girls (29.6%) always have access to water at school and even less girls (21.3%) always have access to soap at school. Over three-quarters of the girls reporting having at least two of the MHM components, with the most frequent missing component being access to a private space (latrine or a private room) to change at school. Only 27 girls (4.7%) reported complete adequate menstrual hygiene management during their last period.

Table 4.4: Menstruation Management of Girls Participating in the Quantitative Questionnaire (N=577)		
Variable	**Freq/Median**	**Missing**
Protection used during last period		
Manufactured disposable pads	464 (80.42%)	21 (3.64%)
Old Clothes	66 (11.44%)	101 (17.50%)
Locally made reusable pads	50 (8.67%)	100 (17.33%)
Toilet Paper	48 (8.32%)	101 (17.50%)
Cotton wool	47 (8.15%)	100 (17.33%)
New clothes	39 (6.76%)	103 (17.85%)
Tampons	18 (3.12%)	101 (17.50%)
Underwear only	18 (3.12%)	108 (18.72%)
Locally made disposable pads	12 (2.08%)	107 (18.54%)
Leaves	3 (0.52%)	106 (18.37%)
Newspapers	3 (0.52%)	104 (18.02%)
Times changed protection per 24hr during last period		47 (8.15%)
No times	3 (0.57%)	
Once	16 (3.02%)	
Twice	225 (42.45%)	
Three times	218 (41.13%)	
Four times	45 (8.49%)	
Five or more times	23 (3.99%)	
Ever had a menstrual blood leak to clothes	386 (66.90%)	19 (3.29%)
Buy sanitary pads from		
Market	404 (70.02%)	51 (8.84%)
Local pharmacy	333 (57.71%)	49 (8.49%)
Local shop	268 (46.45%)	78 (13.52%)
Hospital or clinic	223 (38.65%)	94 (16.29%)
School	43 (7.45%)	114 (19.76%)
NGO	42 (7.28%)	126 (21.84%)
Other	3 (0.52%)	192 (33.28%)
Purchase own menstrual products	358 (62.05%)	92 (15.94%)
Can afford disposable pads		42 (7.28%)
Every period for all days of bleeding	422 (73.14%)	
Every period for heavy days	51 (8.84%)	
>3 times a year	19 (3.29%)	
1-2 times a year	13 (2.25%)	
Never	30 (5.20%)	
Interest in using a locally made pad	372 (64.47%)	65 (11.27%)

Changing location at school		
Inside latrine	205 (35.53%)	128 (22.18%)
Private room	135 (23.40%)	158 (27.38%)
Go home in break	110 (19.06%)	133 (23.05%)
Don't attend school during period	85 (14.73%)	111 (19.20%)
Behind a bush outside	60 (10.40%)	149 (25.82%)
Back of classroom	59 (10.23%)	146 (25.30%)
Other	17 (2.95%)	288 (49.91%)
Disposal of pads during school (N=476)		
Take home	231 (48.53%)	105 (22.06%)
Don't change at school	164 (34.46%)	108 (22.69%)
Incinerator bin	118 (24.79%)	123 (25.84%)
Dustbin	97 (20.38%)	115 (24.16%)
Pit latrine	88 (18.49%)	113 (23.74%)
Water access in school		26 (4.51%)
Always	171 (29.64%)	
Most of the time	108 (18.72%)	
Sometimes	100 (17.33%)	
Never	172 (29.81%)	
Soap access in school		27 (4.68%)
Always	123 (21.32%)	
Most of the time	71 (12.31%)	
Sometimes	120 (20.80%)	
Never	236 (40.90%)	

Values are means (SD) or medians (IQR) for continuous variables; percentages or Ns or both for categorical variables and missing.
Values of polytomous variables may not sum to 100% due to rounding and/or the option to select more than one answer.

Qualitative Results

The IDIs confirmed that most girls in our study had access to sanitary pads; however, some used alternatives when they run out of funds for more. During school, girls reported not having adequate changing spaces or water, sanitation, and hygiene (WASH) facilities. Disposal facilities were also described as limited and often not present or private for girls to use. This prevents girls from changing during the school day, risking the stigma of leaking, and in some cases missing school because of inadequate facilities.

> *"I don't change in school really but if I have to, I go in the toilet cubicles, but it's not that easy because maybe there's no water. You have to go and fetch it yourself and sometimes there's no water at the pump. Then to dispose, I just dig a hole and put in and cover it in dirt so no-one can see."* (Day student, school 1).

> *"I normally don't change at school because we don't have any toilets at school, so I change at home. I sometimes put an extra one in and pray to God that he does not embarrass me with leaking."* (Day student, school 2).

> *"First of all, we don't have a toilet that is good. Secondly, around the bushes people pass. In school I am not ok. I think in school they should have a place to change to have privacy."* (Day student, school 2).

Even when toilets were present, girls reported a lack of water in the toilet to flush and wash and unclean toilets that prevent use.

"In this toilet, we need water system that connects to the toilet so we can flush it. Sometimes people would be too embarrassed to take water to the toilet so they will just do it on the floor and leave it. So, we need a water system to come into the toilets." (Day student, school 3).

"The toilets are very, very dirty so I have to go to the back of the room or outside where nobody sees me because the toilet is very, very messed up." (Day student, school 1).

In addition to sanitary products being a financial burden, girls in the IDIs also revealed a nervousness to purchase pads because of a taboo surrounding menstruation. The girls especially felt uncomfortable purchasing pads in the presence of a male; sometimes giving them enough reason to not purchase the pads at all.

"I feel shy when there's a crowd in the shop and I say, "auntie give me one" and everyone will look round. If the attendant is male, I won't go in, I just hope no one sees me when I leave." (Day student, school 1).

Water, Sanitation, and Hygiene in Schools Checklist

Table 5 shows the facilities present in each school. The World Health Organization recommends 1:25 toilets to female students at schools to limit restrictions to WASH resources. Table 5 shows that even in the schools that did have toilets, there were much less stalls than recommended. In school one, there were 2 toilet stalls serving 1700 students, school two had no day student toilets and 5 toilets

per 30 boarding school students, and school 3 had 7 toilets for 1800 students. No toilets across all three schools had locks, and disposal facilities and soap access were not available at any school. Water access was available at each school; however, it was often far away and not consistently functional. MHM education was offered in one school and sanitary products were available for purchase in one school. In addition, during the IDIs, many girls said that the toilet structures were present but not accessible for students because of a lack of water, rules prohibiting student use, or uncleanliness. All 3 schools had water accessibility, however; often the water source was inconsistent and far from toilet facilities. No schools had soap available. Private spaces were available at two schools; however, students reported that the distance from the classroom to the private space was significant and the fear of male discipliners lurking outside making it feel unsafe. Disposal facilities were not present aside from soakaways (cesspit that it partially covered to let water slowly drain into the ground) and mini landfill piles (pits).

Table 4.5: Menstrual Hygiene Facilities Present on Day of School Visit			
MHM Item	**School 1**	**School 2**	**School 3**
Approx. School Population	1700	3000	1800
Latrines/Toilets	Two toilet stalls, not functional on day of visit	None for day students; 5 per 30 boarding students	Set of seven latrines, not in clean condition
Private space with door and lock	Stalls had a door, no lock	None for day students.	No individual doors on latrines
Water access	One water access point to collect water for flushing, not next to toilet.	Two water access points for flushing toilet and washing hands, not next to boarder toilets	Water access point outside the latrine building, not always functional.
Soap access	No	No	No
Discreet waste disposal	No, waste placed in outside dump	No, waste buried or piled behind school	No, pits used behind the school
Sanitary products at school	No	No	Yes, sanitary vendor
MHM visual education materials	No	No	No
MHM included in curriculum	Yes, Friday afternoon sexual education class	No but have had organizations visit before	No but have had organizations visit before
Funding towards improving MHM within school	Yes, for Friday education	No	No

DISCUSSION

Menstruating girls face many challenges that affect their ability to manage their menstruation adequately while in school. To date, most studies have focused on quantitative data assessing MHM among schoolgirls in urban or rural settings, this study adds to the literature by focusing on secondary students in peri-urban settings using a mixed-methods study design. A total of 577 menstruating girls participated in the questionnaire and 60 girls participated in the in-depth interviews. The mean age of menarche in the study population was 13 years old.

The most frequently reported symptom during menstruation was stomach pains/cramping (73.7%), clinically known as dysmenorrhea. The participants in the in-depth interviews stated that menstrual cramps were distracting in class, the main reason behind school absenteeism during menstruation, and a hinderance to extracurricular activities, especially sports. These findings are in line with other studies[56–58] and are important to note, as pain medication is not always available or known about. For example, a survey conducted in Kaduna, Nigeria, showed that only 37% of reproductive aged women (15-49) have access to pain medication[19]. In addition, other studies have shown that 40% of girls missed school during their period because of pain[6] and up to 63.9% of girls used no pain killer to counteract the cramping[32,35].

General awareness about menstruation was appreciable with 77.47% of respondents knowing about menstruation before experiencing menarche. This is similar to the findings of more urban studies in Nigeria[32,35], suggesting the exposure to menstruation information is similar in both urban and peri-urban settings. These results could be related to the high education level of the participants' parents and a recent increase in mass and social media pathways to disseminate information to

adolescents. Studies conducted in rural settings may report lower awareness. The leading source of menstruation information was mothers, a finding that agrees with most other studies in West Africa[5,22,28]. However, these findings are in contrast to research findings in Ethiopia where most participants found information about menstruation from their friends and mass media[65]. This difference highlights a potential issue with the findings in this study, showing that the taboo around menstruation is so profound that only 2.27% of participants reported health workers and 12.76% reported teachers as the main source of information. Despite the home environment being a safe place for sexual education, it can be concerning that cultural myths and taboos can be passed down through generations and the accuracy of knowledge is a function of the mother's education and cultural beliefs. This can lead to incomplete and misleading information and negative perceptions about menstruation. This could contribute to the overall knowledge scores of the participants in this study, with only 4 girls knowing all the correct answers to thirteen questions about menstruation. Other studies have shared similar concerns about incorrect information being shared with young girls in Nepal[66], Egypt[67], and Nigeria[68]. Nevertheless, studies showed higher rates of menstruation-related school absenteeism among maternal orphans compared to girls with a mother[52]. A lack of knowledge about menstruation was discussed as a source of anxiety among the girls in the in-depth interviews, and the inability to predict when their next period is can lead to inadequate menstrual hygiene, fear, and disturbance to day-to-day activities each month. There is a lack of research surrounding the type of knowledge received by adolescent girls and their educational and health outcomes with different sources.

Furthermore, cultural taboos were prevalent within the study population with most girls discussing 'money rituals' with used sanitary pads and underwear during

their period. The girls expressed fear of leaking, changing in non-private spaces, drying underwear, and disposing of used sanitary materials because of rituals of men picking up and selling used products. No other studies have published details about money rituals and their relation to menstrual hygiene, although other studies have discussed cultural restrictions related to menstruation education leading to sexual promiscuity[33] and cultural restrictions forbidding certain activities during menstruation[15]. The intricacies of cultural beliefs surrounding menstruation are often unknown, quietly but significantly impacting the experience of girls during their menstruation.

Almost two-thirds of the participants disagreed that period days are like any other day, and almost half the participants felt anxious about their next period. The greatest sources of anxiety and discomfort during periods were a fear of leaking, lack of facilities at school, and menstrual cramps/mood swings. In addition, the lack of awareness of menstruation in schools was noted in the interviews as a challenge that could be overcome by improving health education in schools. The negative perceptions during menstruation are mirrored in other studies. For example, a survey conducted in Northern Ghana among Junior High School students showed that only 13.60% of participants had positive attitudes about menstrual hygiene and over half (57.51%) reported menstruation as shameful[28]. One of the few intervention assessments conducted in Ghana showed that increased menstrual hygiene education in schools can decrease stigma and improve attitudes surrounding menstruation[20]. More interventions are needed to dismantle the taboos and stigma and normalize adequate menstrual hygiene.

Menstrual materials are important to assess, as unclean alternatives that girls use can increase vulnerability to urinary tract infections[54]. Over three-quarters

(80.42%) of the peri-urban schoolgirls in this study reported using manufactured disposable pads during their last period, despite many girls highlighting the unaffordable cost of pads during their in-depth interviews. The high use of disposable pads is concordant with, if not higher than other studies across low-income countries[15,18]. Among the girls that used disposable pads in our study, 73.14% reported being able to afford disposable sanitary pads for every day of bleeding, suggesting a mixed use of disposable and reusable or alternative menstrual protection. These results complement other studies in Nigeria by adding more detail to the affordability of sanitary materials, for example Salami et al. reported 37% of adolescent girls could not afford disposable sanitary pads[5], but did not elaborate of the frequency on affordability. In our study, even though the majority of girls (73.14%) could afford disposable sanitary products for every period day, over 85% of girls reported to changing their pad fewer than four times a day, and two-thirds (66.90%) of girls reported having had a menstrual leak onto their clothes. The reason behind the number of times a girl changed her sanitary product is not clear, although it could be related to the cost of the pads, lack of changing facility, or a personal preference.

With regard to methods of disposal during the school day, this study revealed that over a third of girls (34.46%) often choose to not change at school, suggesting a lack of facilities. Moreover, almost half of the participants (48.53%) reported taking their menstrual materials home for disposal. There is a dearth of literature assessing disposal methods within schools; however, other studies in Nigeria report major disposal methods in general as latrines, burning, and dustbins[26]. For example, a study in Kano revealed 73.9% of girls disposed of their products in a dustbin[69]. In this study, the results contrasted other more urban studies with less than half the participants (45.17%) reporting using a dustbin or incinerator bin to dispose of

products. In addition, many girls in the in-depth interviews discussed the importance of using a black nylon bag and hiding the used pad, to make sure no-one could find it in the waste pile. This difference in outcomes to other studies suggests a lack in disposal facilities in schools compared to at home and offers a clear pathway for an intervention.

Essential to adequate menstrual hygiene management in schools is the availability of clean water, sanitation, and hygiene (WASH) facilities and a private changing space. In the questionnaire results, only 29.64% of girls reported consistent access to water and 21.32% reported consistent access to soap in schools. In addition, 29.81% reported no access to water at all and 40.90% reported no access to soap in school. A study in rural Ghana is in agreement with these findings showing only two out of fourteen schools had a water supply and no schools in the sample had soap facilities[16]. Using the checklist for menstrual hygiene management in schools, one school had seven toilets that appeared functional; yet, when asked in the interview about the usability of the toilets at school, the students reported that they prefer to go behind the buildings outside because the toilets are not clean and are often unusable. The lack of agreement between the facilities physically present at the schools assessed and the actual use of them by students highlights the need for more community-informed interventions that collect accurate data on the functionality of certain resources. The lack of WASH facilities at schools has been highlighted as a priority by UNICEF to increase sustainable access to and use of improved water sources and hygiene facilities with a particular attention in schools[70]. The results from this study, among others, show that there is still a great need for sanitation facilities in schools, one that may require structural interventions.

This study was strengthened by the specific questions on both the questionnaire and the interview prompts to gain both an objective and subjective view of the status of menstrual hygiene management. However, this study was limited by the exclusion of other key players in menstrual management. Future studies should include teachers, mothers, fathers, and siblings to gain a more comprehensive perspective of menstruation experiences. In addition, since the study sample was limited to schoolgirls, the results presented here may underestimate the magnitude of poor menstrual hygiene management, as those who cannot afford to attend school are assumed to have less resources.

This study highlighted the biggest challenges to adequate menstrual hygiene among this population of peri-urban schoolgirls are lack of private changing facilities, disposal facilities, and wash facilities at schools shrouded in a general taboo that inhibits learning about menstruation. Future interventions should work within the communities to design and implement school-based interventions to provide a suitable and supportive environment for adolescent girls during menstruation. To address knowledge gaps and cultural myths, school curriculum should include menstrual hygiene practices and schoolteachers should present accurate and understandable information about menstruation. In addition, a sustainable, cost-effective private changing spaces with disposal and sanitation facilities should be designed to ensure hygienic management of menstruation in schools to prevent school absenteeism, anxiety about leaking, and urinary tract infections.

TRANSITION CHAPTER

The overall objective of this dissertation is to understand the knowledge, attitudes, and practices surrounding menstrual hygiene management (MHM) and gain new insight into the relationships between MHM and school absenteeism among adolescent girls in Edo State, Nigeria. In the preceding chapter we used mixed methods to describe the menstruation characteristics, symptoms, practices, knowledge, attitudes, and biggest challenges among schoolgirls in peri-urban regions of Edo State. As described in the previous chapter, the major challenges pertaining to menstrual hygiene management included painful symptoms during menstruation and a lack of accurate menstrual knowledge, impacted by cultural myths that spread shame and anxiety during menstruation. Moreover, during school, most girls reported a lack of adequate facilities to be able to manage their menstruation. The following chapter assesses these factors in relation to school attendance.

Females in low-income countries often miss more school than males. One of the reasons behind this may be the lack of facilities to support menstrual hygiene management during the school day, leading to girls missing school or leaving class during their menses. The next chapter estimates the relationship between menstrual characteristics, symptoms, practices, knowledge, attitudes, and facilities at school and school absenteeism due to menstruation.

CHAPTER 5: MENSTRUAL HYGIENE MANAGEMENT AND SCHOOL ATTENDANCE AMONG ADOLESCENT SCHOOLGIRLS IN PERI-URBAN AREAS IN EDO STATE, NIGERIA

Introduction: The education of women is a cornerstone of economic success for a country. Menstrual management can present challenges for girls during the school day, especially in low-income settings. This study aimed to investigate the menstrual hygiene management factors associated with school attendance to highlight the avenues for future interventions in a peri-urban region of Edo State, Nigeria.

Methods: A total of 600 girls completed a cross sectional questionnaire assessing menstruation characteristics, menstrual knowledge, practices during menstruation, and school attendance. Descriptive statistics and multivariable logistic regression were used the assess the association between menstrual hygiene and school attendance among schoolgirls aged 11-19 years old. The analytic sample (n=539) excluded girls who had not begun menstruating (n=23) and girls who were missing outcome data (n=38).

Results: The 539 girls included in the analytical sample had a median age of 16.1 (SD 1.2), with a median age of menarche of 12.9 (1.3 SD). Of these, 74 reported missing at least one day of school in the past 3 months due to menstruation. Missing school due to menstruation was associated with inconsistent access to water at school (OR 1.75 95% CI 0.81, 3.78), physical symptoms (headache OR 1.90 95% CI 1.10, 3.28; stomach pains OR 1.43 95% CI 0.71, 2.91; and back pain OR 1.52 95% CI 0.83, 2.75), other symptoms (mood irritability OR 1.29 95% CI 0.75, 2.23), stained underwear (OR 1.35 95% CI 0.76, 2.39), never learning about menstruation (OR 2.71

95% CI 1.03, 7.14), changing less than 4 times in 24 hours (OR 1.85 95% CI 0.92, 3.73), and a lack of menstruation knowledge (OR 1.18 95% CI 0.69, 2.01).

Conclusion: In this peri-urban Nigerian population, certain menstrual symptoms and a lack of water access at school were strongly associated with school attendance. This study highlights the need for an intervention that addresses the structural challenges (access to water and sanitation, disposal, and changing facilities), physical challenges (pain management), and educational challenges (e.g., early learning about menstruation).

INTRODUCTION

Despite menstruation being a fruitful sign of fertility and reproductive health, many women face hardships during their menses due to stigma, taboo, and a lack of hygienic products and facilities, especially in low-income countries[71]. Adequate menstrual hygiene management (MHM) is defined as the safe use and disposal of sanitary material to collect menstrual blood and the option to change this material in privacy as many times as necessary during the period of bleeding[12]. Many studies across West Africa have highlighted the core challenges of girls finding clean sanitary materials, a place to change and dispose of their used sanitary material, and a general lack of understanding of the menstrual cycle[4,16,18,23]. Inadequate menstrual hygiene is propagated by a taboo surrounding menstruation, leading to social shame, anxiety, and distraction[36,56]. These factors can harm a girl's ability for educational success by reducing school concentration and attendance[53].

Previous research and existing interventions assessing the effect of poor menstrual hygiene on educational and social outcomes are limited[9,53,72]. Systematic reviews across low-income countries have found that poor MHM may be associated

with an increased risk of urogenital infections[36], mental health outcomes[13], school attendance and participation[9,15,16,53,58]; however, many studies are limited by small study sizes, inaccuracy of school registers, and objective assessment of school facilities when determining MHM. For instance, studies have assessed school facilities using an MHM checklist,[49] yet the presence of toilet structures in a school may not represent the usability of the toilets. In addition, studies have assessed urban[32,35] and rural[15] settings across West Africa, but there is a lack of research in peri-urban communities that may face unique challenges. One study set in a semi-urban population of Nigeria showed that almost one half of the girls in the sample (49.4%) have not received any information about menstruation before menarche[5], much lower than the 97.8% of girls with menstrual knowledge in an urban Nigerian study[31]. It is important to elaborate on the challenges faced by girls in peri-urban communities and how they relate to educational outcomes to develop and evaluate interventions within these communities.

Education is a top priority in Nigeria's national development strategy, named as an important tool to improve the economic growth of the country[12]. The lack of sufficient evidence-base of the effectiveness of current MHM resources in schools has been emphasized by the "MHM in Ten" group, representing the United Nations and other stakeholders. This group highlighted improving MHM as a priority by 2024, by identifying the problems and inventing and implementing cost-effective and sustainable interventions driven by the community[59].

The objectives of this paper are to describe the results of a study among peri-urban secondary school students in Edo State, Nigeria to understand the demographic predictors of poor menstrual hygiene management and the influence of menstrual hygiene management components on school attendance. The results will be used to

help inform the design of community-based participatory intervention for secondary school girls in Edo State.

METHODS

Study Setting

The study was conducted in three government sponsored (public) secondary schools that serve peri-urban areas in Benin City, Edo State, Nigeria. Detailed descriptions for the study setting are mentioned elsewhere (see Aim 1 manuscript). Briefly, in collaboration with the Center for Reproductive Health Innovation (CERHI), three female-only secondary schools were purposively sampled based on the study objectives and existing relationships and trust with the CERHI research center. The total population size of the three schools was approximately 6500 students. From this pool, junior and senior level students aged 11-19 years old were randomly selected in January 2022 (N=600). The sample was restricted to girls who had begun menstruating (excluding n=23) and who had no missing outcome data (excluding n=38) giving an analytical sample of 539.

Data presented in this paper are part of a larger exploratory sequential mixed methods study among schoolgirls focused on menstrual hygiene knowledge, attitudes, and practices with various social and educational outcomes. Descriptive results including both quantitative and qualitative assessment have been reported previously (see Aim 1 manuscript). In this paper we focus on the associations between menstrual hygiene management factors and school attendance using data from the quantitative questionnaire. The results from this study will be used to inform a community-driven intervention aimed at improving menstrual hygiene management among schoolgirls.

Informed Consent

Prior to data collection, the local research collectors explained the study to the heads of school, teachers, and the selected students. Local dialect and phrasing were used when needed to aid with comprehension. To participate in the study, a verbal assent was obtained from each participant before data collection. All recruited girls (N=600) consented to participate in the study.

The study was approved by the University of Louisville's Institutional Review Board (IRB Number: 20.0873). In addition, approval for the study was granted by the Edo State School management board and the headteachers of the selected schools.

Data Collection

Study Design

This study was part of a larger project assessing menstrual hygiene management that used exploratory sequential mixed methods. In this, the qualitative data collection and analysis informed the quantitative data collection by helping aid in the development of the questionnaire to ensure the questions were culturally appropriate and included questions about issues raised by the study population. The questionnaire was cross-sectional and conducted in January-March 2022.

Questionnaire

Detailed descriptions for the questionnaire (Appendix 1) are mentioned elsewhere (see Aim 1 manuscript). In summary, 600 girls were evenly sampled across 3 schools in Edo State. The participants were randomly selected by their teachers out of all the girls attending school on the day of the survey distribution. The questionnaires were self-administered on paper forms on school premises, with a local, young facilitator present in the room to answer any questions. All questionnaires were screened for

completeness, coded, and entered into an electronic secure database and paper forms discarded.

Data Analysis

Outcome

The primary outcome of interest was school days missed during the last 3 months due to menstruation (yes/no/missing). Each schoolgirl was asked “Have you ever missed school in the past 3 months because of menstruation periods?”, the answer (yes/no/missing) was self-reported. Two other questions in the questionnaire helped to confirm the data was correct by asking: “Give the number of days you missed school in the past 30 days for each reason given on the right.”, the reasons included menstruating among others. In addition, the participants were asked: “Of the reasons given above, what is the main reason that you missed school?” If the participants reported days missed due to menstruation in the latter two questions but not in the first question, missing data were filled in as a ‘yes’. School records were not completed regularly and did not report the reason for missing school; therefore, they were not used.

Exposure

The primary exposure of interest was menstrual hygiene management at school, defined using the standard definition from WHO/UNICEF as four major components: use of sanitary products, access to safe disposal at school, access to a private changing space at school, and consistent access to water at school. Only 27 (5.01%) participants attained all four so, this study assesses each component individually to provide enough data for analysis. To assess the use of sanitary pads, the participants were asked: “What did you use during your last menstruation period?”, and the answer choices included “newspaper”, “leaves”, “old clothes”, “toilet paper”, “cotton wool”,

"knickers only", "locally made disposable pads", "reusable pads", "disposable manufactured pads", "manufactured tampons", "new clothes", and "other". Sanitary materials were considered "locally made disposable pads", "reusable pads", "disposable manufactured pads", or "manufactured tampons". To assess safe disposal at school, the participants were asked: "What do you do with your used menstrual absorbents when you are at school?", the answer options included "throw into a dustbin", "throw into an incinerator bin", "take it home", "I don't change at school", "throw into the latrine", and "other". Safe disposal at school was considered "throwing into a dustbin" or "throw into an incinerator bin". To assess access to a private changing space at school, participants were asked: "While at school (from when class starts to when it ends), where do you change your menstrual absorbents?", the answer choices included: "I don't attend school on my period", "inside the latrine", "at the back of the classroom", "I go back home during break", "outside behind a bush", "another private room in school", "other". A private changing space was considered "inside a latrine" or in "another private room at school". Finally, water facilities at school were assessed by asking the participants "How often is water available in your school for you to use while you are menstruating?" The answer choices included: "always", "most of the time", "sometimes", "never". Consistent access to water was considered "always". While the standard definition considers both water and soap as adequate wash facilities, only 37 (6.8%) of girls had access to soap in school so this study considered water access only.

Covariates

Covariate data was collected on the same questionnaire. The questionnaire collected data on age (years), parental education level (primary or secondary, tertiary), age of menarche (years), family wealth index, MHM knowledge, attitudes towards

menstruation, practices during menstruation, and menstruation symptoms. Since accurate data on income and cost of living was hard to measure in less developed settings, an age-appropriate, culturally relevant poverty index (Asselin's indicators of household financial poverty[73]) was used to assess material wealth using seven individual measures and a summed score (Wealth Index Score). This includes ownership of and access to common consumer goods (TV, car), economic capital (land, livestock), water and sanitation (flush toilet, running water), and electricity.

Menstruation knowledge was measured using thirteen questions asking about the origin of blood, menstrual cycle length, pregnancy during menstruation, pain killers, and rituals associated with menstruation. Menstrual knowledge was modelled as a dichotomous measure scoring above the median or scoring below the median. In addition, the source of knowledge and timing of receiving menstrual knowledge was assessed. Menstrual practices were measured asking questions about the sanitary material used, location of purchasing menstrual products, and times participant changes their sanitary material per day (<3 or <=3).

Symptoms during menstruation were asked as individual questions based on known symptoms and other symptoms raised in the qualitative interviews (stomach cramps, back pain, headache, stained underwear, stained outer garments, mood irritability, wet feeling on genitals, unpleasant smell, and genital irritation/rash). The symptom question was phrased: "During your last menstruation, did you experience X symptom", the answer options were Yes/No/Missing for each question. More details about the covariates can be found in a previous descriptive study (See Aim 1 manuscript).

Statistical Analysis

The cross-sectional questionnaire was analyzed using descriptive statistics to summarize sociodemographic and menstruation data comparing those who missed school during the last 3 months due to menstruation to those who did not. In addition, sociodemographic and menstruation data was examined by comparing those who had access to each MHM component to those who did not. In addition, multivariable logistic regression was used to estimate the association between MHM components and school days missed due to menstruation in the last three months. Further analyses were conducted assessing other exposures of interest, such as menstrual knowledge, symptoms during menstruation, menstrual practices, and their association with school days missed due to menstruation. A sensitivity analysis was also conducted to assess any days missed due to any reason in the past month to give a larger sample size of girls with the outcome.

We considered multiple adjustment variables and present results from multiple statistical models to show the magnitude of confounding by adding each potential confounding factor. School attended and other variables associated with the outcome and exposure at $p < 0.10$ were included in an initial multivariable model. Missing data for variables used in the models (e.g., school (n=13), paternal education (n=93), maternal education (n=84), running water at home (n=8), first heard about menstruation (n=16), and headache symptoms experienced (n=82)) were imputed using median values for continuous variables and adding a missing indicator variable in the model. After excluding those who had not reached menarche (n=17) or were missing data on menarche status (n=6) and those who were missing outcome data (n=38), the analytical sample was 539.

All analyses were conducted using SAS 9.4 (SAS Institute, Cary, NC, USA)[64].

RESULTS

Study Participant Sociodemographic and Menstruation Characteristics by School Absenteeism

Among our study sample of 539 schoolgirls, 74 reported missing school in the last 3 months because of menstruation (Table 1). The girls that had reported missing school due to menstruation had a similar mean age (16.24 and 16.02 years) and median age of menarche (12.56 and 12.77 years) as the girls who had not missed school for menstruation. Of the girls who had missed school, more attended school 1 (48.65%) than schools 2 (18.92%) and 3 (28.38%) compared to those who had not missed school. Additionally, those who had not missed school had fewer mothers and fathers that had no education (12.26% and 10.97%, respectively) compared to those who had missed school (14.86% and 12.16%, respectively).

On the other hand, Asselin's poverty index question items show that the girls who reported missing school were more likely to have access to electricity, running water, a flush toilet, a television, a car, and family-owned livestock and land than the girls who reported no missed days of school due to their period in the last 3 months. Nevertheless, the overall poverty score showed that the girls who missed school and the girls who did not miss school both had a high material wealth index score of 5.64 and 5.22, respectively out of seven components. Participants that missed school were more likely to have experienced stomach pains (82.43%), stained underwear (62.16%), mood irritability (48.65%), headache (40.54%), and back pain (28.38%) during their last menstruation. Additionally, those who missed school were more likely to change their sanitary materials less than four times in 24 hours during their menstruation (81.51%) and were more likely to have never learned about menstruation (5.41%).

Table 5.1: Sociodemographic and Menstruation Characteristics of Schoolgirls in Edo State, Nigeria (N=539) by their School Days Missed During the Last 3 Months Due to Menstruation		
Variable	School Days Missed	
	Yes (N=74)	No (N=465)
Age (yrs), mean (SD)	16.24 (0.96)	16.02 (1.11)
Missing	0	2
Age of menarche (yrs), mean (SD)	12.56 (1.32)	12.77 (1.35)
Missing	2	5
School, n (%)		
School 1	36 (48.65%)	188 (40.43%)
School 2	14 (18.92%)	125 (26.88%)
School 3	21 (28.38%)	142 (30.54%)
Missing	3 (4.05%)	10 (2.15%)
Type of student, n (%)		
Day	72 (97.30%)	433 (93.12%)
Boarding	0	25 (5.38%)
Missing	2 (2.70%)	7 (1.51%)
Paternal Education, n (%)		
No education	9 (12.16%)	151 (10.97%)
Basic education	31 (41.89%)	148 (31.83%)
Secondary education or higher	28 (37.84%)	179 (38.49%)
Missing	6 (8.11%)	87 (18.71%)
Maternal Education, n (%)		
No education	11 (14.86%)	57 (12.26%)
Basic education	32 (43.24%)	163 (35.05%)
Secondary education or higher	25 (12.32%)	167 (35.91%)
Missing	6 (8.11%)	78 (16.77%)
Wealth Index Score (out of 7), mean (SD)	5.64 (1.38)	5.22 (1.52)
Missing	0	2
Electricity inside the house, n (%)		
Yes	72 (97.30%)	446 (95.91%)
No	2 (2.70%)	15 (3.23%)
Missing	0	4 (0.86%)
Running water inside the house, n (%)		
Yes	66 (89.19%)	370 (79.57%)
No	8 (10.81%)	87 (18.71%)
Missing	0	8 (1.72%)
Flush toilet at home, n (%)		
Yes	69 (93.24%)	400 (86.02%)
No	5 (6.76%)	54 (11.61%)
Missing	0	11 (2.37%)
Land owned by family, n (%)		
Yes	55 (74.32%)	329 (70.75%)
No	18 (24.32%)	123 (26.45%)
Missing	1 (1.35%)	13 (2.80%)
Car owned by family, n (%)		
Yes	47 (63.51%)	273 (58.71%)
No	24 (32.43%)	181 (38.92%)
Missing	3 (4.05%)	11 (2.37%)
Television in the house, n (%)		
Yes	70 (94.59%)	429 (92.26%)
No	2 (2.70%)	21 (4.52%)
Missing	2 (2.70%)	15 (3.23%)
Livestock owned by family, n (%)		
Yes	38 (51.35%)	168 (36.13%)

No	30 (40.54%)	258 (55.48%)
Missing	6 (8.11%)	39 (8.39%)
Knowledge score, n (%)		
0-70%	31 (43.24%)	181 (38.92%)
71-100%	42 (56.76%)	284 (61.08%)
Symptoms during last period*, n (%)		
Stomach pains	61 (82.43%)	338 (72.69%)
Stained underwear	46 (62.16%)	267 (57.42%)
Mood irritability	36 (48.65%)	187 (32.41%)
Headache	30 (40.54%)	115 (24.73%)
Genital irritation	18 (24.32%)	120 (25.81%)
Back pain	21 (28.38%)	93 (20.00%)
Times changed protection per 24hr during last period, n (%)		
<=3 times	379 (81.51%)	53 (71.62%)
>=4 times	52 (11.18%)	13 (17.57%)
Missing	34 (7.81%)	8 (10.81%)
First heard about menstruation		
Before first menstruation	59 (79.73%)	361 (77.63%)
After first menstruation	8 (10.81%)	84 (18.06%)
Never learned	4 (5.41%)	7 (1.51%)
Missing	3 (4.05%)	13 (2.80%)

*Asked as individual questions for each symptom; will not add to 100%
Values are means (SD) or medians (IQR) for continuous variables; percentages or Ns or both for categorical variables and missing.
Values of polytomous variables may not sum to 100% due to rounding and/or the option to select more than one answer.

Study Participant Sociodemographic and Menstrual Characteristics by Menstrual Hygiene Management Components

Adequate menstrual hygiene management was measured using four components: access to sanitary products, a private changing space, safe disposal, and consistent water facilities at school. Although adequate menstrual hygiene is defined as the presence of all these factors, only 27 (5.0%) girls reported having all four factors in this study. In addition, missing data was aggravated when the MHM components were summed. Therefore, we examined the components individually, firstly by assessing sociodemographic factors and menstruation characteristics comparing participants with and without access to sanitary materials, a private changing space at school, safe disposal at school, and water access at school. The results are shown in Table 2.

Access to Sanitary Materials

Among the 539 menstruating girls, 464 (86.09%) reported access to sanitary materials (Table 2). Despite having the similar mean age and similar mean age of menarche, the participants with access to sanitary materials were more likely to attend School 3, have more educated parents, and have a higher wealth index. In addition, those who had access to sanitary materials were more likely to have a higher menstruation knowledge score, have learned about menstruation before their first menses, and less likely to have reports of stomach pains and genital irritation during their last period. However, those with access to sanitary materials were less likely to change their sanitary material 4 or more times during 24 hours, and more likely to have experienced mood irritability, stained underwear, headache, and back pain during their last menstruation.

Access to a Private Changing Space at School

Almost half the participants reported access to private changing facilities at school (n=268, 49.72%). Those who did not have access to private changing facilities (n=161) were more likely to attend School 1, be a day student, and have less educated parents than those that did report access to private changing spaces at school. Furthermore, those without access to private changing spaces were more likely to have lower menstruation knowledge scores, experience more menstruation symptoms such as stomach pains, headache, and mood irritability, change less than 4 times/day during menstruation, and have learned about menstruation after menarche compared to those who did report access to private changing facilities.

Access to Safe Disposal at School

Less than a third of girls (n=173, 32.09%) reported access to safe disposal at school. Compared to those that did report access to disposal, those that didn't were more likely to attend School 1, be a day student, have less educated parents, and have a lower wealth index. In addition, those with no disposal were more likely to have a lower knowledge score, change sanitary materials three or fewer times per day, and have never learned about menstruation compared to those that did have access to disposal. However, those who reported no access to disposal were more likely to experience menstruation symptoms like stomach-ache, back pain, and headache than those who did report access to disposal facilities at school.

Access to Consistent Water Facilities at School

Less than a third of girls (n=155, 28.76%) reported access to consistent water facilities at school. Compared to those that reported consistent water access, girls that reported inconsistent or no access at school were more likely to attend School 1, have less educated parents, and a lower wealth index. In addition, those without consistent

water access at school were more likely to have a low menstruation knowledge score and have learned about menstruation after menarche, when compared to those who reported access to consistent water at school.

Table 5.2: Sociodemographic and Menstruation Characteristics of Schoolgirls in Edo State, Nigeria (N=539) by their Menstrual Hygiene Management Components (N=539)

Variables	Access to Sanitary Material			Changing Facilities at School			Adequate Disposal at School			Consistent Water Access at School		
	Yes (n=464)	No (n=55)	Missing (n=20)	Yes (n=268)	No (n=161)	Missing (n=110)	Yes (n=173)	No (n=245)	Missing (n=121)	Yes (n=155)	No (n=364)	Missing (n=20)
Age (yrs), mean (SD)	16.1 (1.1)	15.8 (1.1)	16.1 (1.3)	16.3 (1.0)	15.9 (1.1)	15.7 (1.2)	16.3 (1.0)	15.9 (1.2)	15.9 (1.1)	16.3 (1.0)	16.0 (1.1)	15.8 (1.4)
Missing	2	0	0	0	1	1	1	0	1	1	1	0
Age of menarche (yrs), mean (SD)	12.6 (1.3)	13.2 (1.2)	13.6 (1.6)	12.5 (1.3)	12.9 (1.2)	13.0 (1.4)	12.6 (1.3)	12.8 (1.4)	12.8 (1.3)	12.6 (1.3)	12.8 (1.3)	12.5 (1.2)
Missing	5	2	0	3	2	2	2	1	4	3	4	0
School, n (%)												
School 1	192 (41.4)	22 (40.0)	10 (50.0)	83 (31.0)	88 (54.7)	53 (48.2)	50 (28.9)	121 (49.4)	53 (43.8)	40 (25.8)	174 (47.8)	10 (50.0)
School 2	119 (25.7)	18 (32.7)	2 (10.0)	64 (23.9)	40 (24.8)	35 (31.8)	43 (24.9)	64 (26.1)	32 (26.5)	45 (29.0)	92 (25.3)	2 (10.0)
School 3	142 (30.6)	13 (23.6)	8 (40.0)	115 (42.9)	27 (16.8)	21 (19.1)	73 (42.2)	56 (22.9)	34 (28.1)	64 (41.3)	91 (25.0)	8 (40.0)
Missing	11 (2.4)	2 (3.6)	0	6 (2.2)	6 (3.7)	1 (0.9)	7 (4.1)	4 (1.6)	2 (1.7)	6 (3.9)	7 (1.9)	0
Type of student, n (%)												
Day	431 (92.9)	54 (92.9)	20 (100)	240 (89.6)	158 (98.1)	107 (97.3)	156 (90.2)	233 (95.1)	116 (95.9)	143 (92.3)	343 (94.2)	19 (95.0)
Boarding	24 (5.2)	1 (1.8)	0	20 (7.5)	3 (1.9)	2 (1.8)	12 (6.9)	9 (3.7)	4 (3.3)	9 (5.8)	16 (4.4)	0
Missing	9 (1.9)	0	0	8 (3.0)	0	1 (0.91)	5 (2.9)	3 (1.2)	1 (0.8)	3 (1.9)	5 (1.4)	1 (5.0)
Paternal Education, n (%)												
No education	52 (11.2)	4 (7.3)	4 (20.0)	23 (8.6)	19 (11.8)	18 (16.4)	15 (8.7)	29 (11.8)	16 (13.2)	13 (8.4)	44 (12.1)	3 (15.0)
Basic education	145 (31.3)	25 (45.5)	9 (45.0)	81 (30.2)	50 (31.1)	48 (43.6)	50 (28.9)	84 (34.3)	45 (37.2)	53 (34.2)	119 (32.7)	7 (35.0)
Secondary education or higher	190 (41.0)	13 (23.6)	4 (20.0)	126 (47.0)	51 (31.7)	30 (12.3)	74 (42.8)	90 (36.7)	43 (35.5)	69 (44.5)	130 (35.7)	8 (40.0)
Missing	77 (16.6)	13 (23.6)	3 (15.0)	38 (14.2)	41 (25.5)	14 (12.7)	34 (19.7)	42 (17.1)	17 (14.1)	20 (12.9)	71 (19.5)	2 (10.0)

Maternal Education, n (%)												
No education	56 (12.1)	8 (14.6)	4 (20.0)	28 (10.5)	24 (14.9)	16 (14.6)	20 (11.6)	30 (12.2)	18 (14.9)	14 (9.0)	53 (14.6)	1 (5.0)
Basic education	161 (34.7)	25 (45.5)	9 (45.0)	81 (30.2)	63 (39.1)	51 (46.5)	52 (30.1)	94 (38.4)	49 (40.5)	49 (31.6)	140 (38.5)	6 (30.0)
Secondary education or higher	174 (37.5)	15 (27.3)	3 (15.0)	123 (45.9)	41 (25.5)	28 (25.5)	71 (41.0)	85 (34.7)	36 (29.8)	72 (46.5)	111 (30.5)	9 (45.0)
Missing	73 (15.7)	7 (12.7	4 (20.0)	36 (13.4)	33 (20.5)	15 (13.6)	30 (17.3)	36 (14.7)	18 (14.9)	20 (12.9)	60 (16.5)	4 (20.0)
Wealth Index, mean (SD)	5.4 (1.5)	4.9 (1.4)	4.0 (2.1)	5.7 (1.4)	4.9 (1.6)	4.9 (1.5)	5.6 (1.3)	5.1 (1.6)	5.2 (1.4)	5.8 (1.1)	5.0 (1.6)	5.5 (1.7)
Missing	2	0	0	2	0	0	5	1	1	0	2	0
Electricity inside the house, n (%)												
Yes	445 (95.9)	55 (100)	18 (90.0)	259 (96.6)	153 (95.0)	106 (96.4)	166 (96.0)	237 (96.7)	115 (95.0)	152 (98.1)	346 (95.1)	20 (100)
No	15 (3.2)	0	2 (10.0)	6 (2.2)	8 (5.0)	3 (2.7)	7 (4.1)	7 (2.9)	3 (2.5)	1 (0.7)	16 (4.4)	0
Missing	4 (0.9)	0	0	3 (1.1)	0	1 (0.9)	0	1 (0.4)	3 (2.5)	2 (1.3)	2 (0.6)	0
Running water inside the house, n (%)												
Yes	384 (82.8)	40 (72.7)	12 (60.0)	236 (88.1)	120 (74.5)	80 (72.7)	151 (87.3)	188 (76.7)	97 (80.2)	140 (90.3)	278 (76.4)	18 (90.0)
No	73 (15.7)	15 (27.3)	7 (35.0)	26 (9.7)	49 (24.8)	29 (26.4)	20 (11.6)	54 (22.0)	21 (17.4)	10 (6.5)	83 (22.8)	2 (10.0)
Missing	7 (1.5)	0	1 (5.0)	6 (2.2)	1 (0.6)	1 (0.9)	2 (1.2)	3 (1.2)	3 (2.5)	5 (3.2)	3 (0.8)	0
Flush toilet at home, n (%)												
Yes	408 (87.9)	47 (85.5)	14 (70.0)	244 (91.0)	134 (83.2)	91 (82.7)	164 (94.8)	202 (82.5)	103 (85.1)	145 (93.6)	306 (84.1)	18 (90.0)
No	49 (10.6)	6 (10.9)	4 (20.0)	19 (7.1)	24 (14.9)	16 (14.6)	8 (4.6)	39 (15.9)	12 (9.9)	6 (3.9)	51 (14.0)	2 (10.0)
Missing	7 (1.5)	2 (3.6)	2 (10.0)	5 (1.9)	3 (1.9)	3 (2.7)	1 (0.6)	4 (1.6)	6 (5.0)	4 (2.6)	7 (1.9)	0
Land owned by family, n (%)												
Yes	340 (73.3)	36 (65.5)	8 (40.0)	216 (80.6)	100 (62.1)	68 (61.8)	135 (78.0)	168 (68.6)	81 (66.9)	126 (81.3)	243 (48.1)	15 (75.0)

No	114 (24.6)	18 (32.7)	9 (45.0)	43 (16.0)	60 (37.3)	38 (34.6)	32 (18.5)	75 (30.6)	34 (28.1)	26 (16.8)	110 (30.2)	5 (25.0)
Missing	10 (2.2)	1 (1.8)	3 (15.0)	9 (3.4)	1 (0.6)	4 (3.6)	6 (3.5)	2 (0.8)	6 (5.0)	3 (1.9)	11 (3.0)	0
Car owned by family, n (%)												
Yes	288 (62.1)	25 (45.5)	7 (35.0)	194 (72.4)	75 (46.6)	51 (46.4)	120 (69.4)	132 (53.9)	68 (56.2)	112 (72.3)	196 (53.9)	12 (60.0)
No	165 (35.6)	30 (54.5)	10 (50.0)	68 (25.4)	83 (51.6)	54 (49.1)	50 (28.9)	110 (44.9)	45 (37.2)	40 (25.8)	157 (43.1)	8 (40.0)
Missing	11 (2.4)	0	3 (15.0)	6 (2.2)	3 (1.9)	5 (4.6)	3 (1.7)	3 (1.2)	8 (6.6)	3 (1.9)	11 (3.0)	0
Television in the house, n (%)												
Yes	436 (94.0)	48 (87.3)	15 (75.0)	252 (94.0)	146 (90.7)	101 (91.8)	162 (93.6)	223 (91.0)	114 (94.2)	150 (96.8)	330 (90.7)	19 (95.0)
No	16 (3.5)	4 (7.3)	3 (15.0)	6 (2.2)	12 (7.5)	5 (4.6)	5 (2.9)	17 (6.9)	1 (0.8)	1 (0.7)	21 (5.8)	1 (5.0)
Missing	12 (2.6)	3 (5.5)	2 (10.0)	10 (3.7)	3 (1.9)	4 (3.6)	6 (3.5)	5 (2.0)	6 (5.0)	4 (2.6)	13 (3.6)	0
Livestock owned by family, n (%)												
Yes	184 (39.7)	16 (29.1)	6 (30.0)	196 (39.6)	62 (38.5)	38 (35.6)	66 (38.2)	95 (38.8)	45 (37.2)	61 (39.4)	138 (37.9)	7 (35.0)
No	242 (52.2)	36 (65.5)	10 (50.0)	136 (50.8)	91 (56.5)	61 (55.5)	87 (50.3)	142 (57.9)	59 (48.8)	80 (51.6)	195 (53.6)	13 (65.0)
Missing	38 (8.2)	3 (5.5)	4 (20.0)	26 (9.7)	8 (5.0)	11 (10.0)	20 (11.6)	8 (3.3)	17 (14.1)	14 (9.0)	31 (8.5)	0
Knowledge score, n (%)												
0-70%	163 (35.1)	39 (70.9)	11 (55.0)	76 (28.4)	82 (50.9)	55 (50.0)	51 (29.5)	111 (45.3)	51 (42.2)	46 (29.7)	158 (43.4)	9 (45.0)
71-100%	301 (64.9)	16 (29.1)	9 (45.0)	192 (71.6)	79 (49.1)	55 (50.0)	122 (70.5)	134 (54.7)	70 (57.9)	109 (70.3)	206 (56.6)	11 (55.0)
Symptoms during last period*, n (%)												
Stomach pains	343 (73.9)	43 (78.2)	13 (65.0)	209 (78.0)	111 (68.9)	79 (71.8)	130 (75.1)	178 (72.7)	91 (75.2)	124 (80.0)	260 (71.4)	15 (75.0)
Stained underwear	273 (58.8)	29 (52.7)	11 (55.0)	171 (63.8)	87 (54.0)	55 (50.0)	102 (59.0)	140 (57.1)	71 (58.7)	89 (57.4)	211 (58.0)	13 (65.0)
Mood irritability	200 (43.1)	19 (34.5)	4 (20.0)	131 (48.9)	59 (36.7)	33 (30.0)	75 (43.4)	99 (40.4)	49 (40.5)	78 (50.32)	139 (38.2)	6 (30.0)

Headache	130 (28.0)	12 (21.8)	3 (15.0)	79 (29.5)	39 (24.2)	27 (24.6)	50 (28.9)	62 (25.3)	33 (27.3)	57 (36.8)	84 (23.1)	4 (20.0)
Genital irritation	113 (24.4)	20 (36.4)	5 (25.0)	64 (23.9)	40 (24.8)	34 (30.9)	47 (27.2)	63 (25.7)	28 (23.1)	33 (21.3)	103 (28.3)	2 (10.0)
Back pain	102 (22.0)	10 (18.2)	2 (10.0)	61 (22.8)	35 (21.7)	18 (16.4)	42 (24.3)	51 (20.8)	21 (17.4)	39 (25.2)	67 (18.4)	8 (40.0)
Times changed protection per 24hr during last period, n (%)												
<=3 times	379 (81.7)	36 (65.5)	17 (85.0)	212 (79.1)	139 (86.3)	81 (73.6)	136 (78.6)	204 (83.3)	92 (76.0)	123 (79.4)	296 (81.3)	13 (65.0)
>=4 times	53 (11.4)	9 (16.4)	3 (15.0)	36 (13.4)	15 (9.3)	14 (12.7)	18 (10.4)	31 (12.7)	16 (13.2)	18 (11.6)	43 (11.8)	4 (20.0)
Missing	31 (8.0%)	10 (18.2)	0	20 (7.5)	7 (4.4)	15 (13.6)	19 (11.0)	10 (4.1)	13 (10.7)	14 (9.0)	25 (6.9)	3 (15.0)
First heard about menstruation, n (%)												
Before first menses	371 (78.0)	33 (60.0)	16 (80.0)	220 (82.1)	118 (73.3)	82 (74.6)	132 (76.3)	189 (77.1)	99 (81.8)	125 (80.7)	277 (76.1)	18 (90.0)
After first menses	79 (17.0)	11 (20.0)	2 (10.0)	36 (13.4)	38 (23.6)	18 (16.4)	34 (19.7)	46 (18.8)	12 (9.9)	24 (15.5)	66 (18.1)	2 (10.0)
Never learned	7 (1.5)	3 (5.4)	1 (5.0)	3 (1.1)	5 (3.1)	3 (2.7)	3 (1.7)	6 (2.5)	2 (1.7)	3 (1.9)	8 (2.2)	0
Missing	7 (1.5)	8 (14.6)	1 (5.0)	9 (3.4)	0	7 (6.4)	4 (2.3)	4 (1.6)	8 (6.6)	3 (1.9)	13 (3.6)	0

*Asked as individual questions for each symptom; will not add to 100%
Values are means (SD) or medians (IQR) for continuous variables; N (%) for categorical variables and missing.
Values of polytomous variables may not sum to 100% due to rounding and/or the option to select more than one answer.

Adequate Menstrual Hygiene Management Components and School Absenteeism

Table 3 shows the results for the menstrual hygiene management components associated with school days missed due to menstruation in the past 3 months (n=539). When modelled individually, access to sanitary materials (OR 0.79 95% CI 0.31, 2.00) and access to adequate disposal at school (OR 0.95 95% CI 0.51, 1.79) showed no association with school days missed after adjusting for school, parental education, household water access, headache symptoms during last menstruation, and timing of first learning about menstruation. Surprisingly, lack access to private changing facilities at school was protective for school days missed (OR 0.37 95% CI 0.18, 0.77), suggesting that girls who reported no private changing space at school had 0.37-times fewer odds of missing school due to menstruation than girls who did report access to private changing facilities; however, this measure is likely influenced by the low number of events (n=14), thus, replication is needed to understand the true relationship. On the other hand, girls who reported a lack of consistent water access at school, were almost twice as likely to miss school due to menstruation than girls who reported access to water (OR 1.75 95% CI 0.81, 3.78), though this measure was not statistically significant.

Since many of the results were not statistically significant or not associated with the outcome, a sensitivity analysis was conducted to assess menstrual hygiene management components and any school day missed in the last month (Appendix Table 1). Despite a larger number of participants who had experienced the outcome in this analytic sample, the results remained similar. However, lack of private changing space was not significantly associated with missed school (OR 0.70 95% CI 0.43, 1.13), suggesting the former analysis results may have been influenced by low

numbers of events in the outcome group. In addition, the association between lack of consistent water at school and missed school was amplified when any school day missed in the past month was modelled (OR 3.55 95% CI 1.71, 7.38).

Table 5.3: The Association Between MHM Components and Missing At Least One School Day During Last 3 Months Due to Menstruation Among Schoolgirls in Edo State, Nigeria (N=539)

	n/events	Model 1^	Model 2^^	Model 3^^^	Model 4^^^^
Sanitary product used during last period	539/74				
Yes	464/64	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
No	55/7	0.91 (0.40, 2.10)	0.92 (0.40, 2.13)	0.91 (0.39, 2.16)	0.79 (0.31, 2.00)
Missing	20/3	1.10 (0.31, 3.87)	1.06 (0.30, 3.75)	1.17 (0.32, 4.35)	1.35 (0.36, 5.04)
Private space to change at school	539/74				
Yes	268/45	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
No	161/14	0.47 (0.25, 0.89)	0.41 (0.21, 0.79)	0.43 (0.22, 0.85)	0.37 (0.18, 0.77)
Missing	110/15	0.78 (0.42, 1.47)	0.73 (0.38, 1.41)	0.69 (0.35, 1.36)	0.69 (0.35, 1.39)
Disposal at school	539/74				
Yes	173/21	1.00 (REF)	1 (REF)	1 (REF)	1.00 (REF)
No	245/31	1.05 (0.58, 1.90)	1.02 (0.56, 1.88)	1.03 (0.56, 1.92)	0.95 (0.51, 1.79)
Missing	121/22	1.61 (0.84, 3.08)	1.60 (0.83, 3.09)	1.55 (0.79, 3.03)	1.45 (0.72, 2.90)
Consistent water access at school	539/74				
Yes	155/32	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
No	364/40	1.19 (0.69, 2.05)	2.00 (0.99, 4.01)	1.86 (0.89, 3.91)	1.75 (0.81, 3.78)
Missing	20/2	0.78 (0.17, 3.60)	1.00 (0.21, 4.70)	0.86 (0.18, 4.17)	0.95 (0.19, 4.73)

Odds Ratios and 95% Confidence Intervals are reported.
^Model one is a crude model with just the exposure and outcome
^^Model 2 is adjusted for the school attended during data collection (1, 2 or 3, missing). A missing indicator variable was also included for school (n=13).
^^^Model 3 is adjusted for the school attended, maternal education (none, primary, secondary, or above, missing), paternal education (none, primary, secondary or above, missing), and the presence of running water at home (yes, no, missing). Missing indicator variables were also included for school (n=13), paternal education (n=93), maternal education (n=84), and running water at home (n=8).
^^^^Model 4 is adjusted for the school attended, maternal education (none, primary, secondary, or above, missing), paternal education (none, primary, secondary or above, missing), and the presence of running water at home (yes, no, missing), headache symptoms reported (yes, no, missing), and timing of first learning of menstruation (before menarche, after menarche, never, missing). Missing indicator variables were also included for school (n=13), paternal education (n=93), maternal education (n=84), running water at home (n=8), first heard about menstruation (n=16), and headache symptoms experienced (n=82).

Other Menstruation Characteristics and School Absenteeism

The timing at which girls heard about menstruation affected the odds of missing school due to menstruation. Girls that had never learned about menstruation before had almost 3-times higher odds (OR 2.71 95% CI 1.03-7.14) of missing days of school during the last 3 months due to menstruation compared to those who learned about menstruation before menarche, after adjusting for school, parental education level, and household poverty. Furthermore, although not statistically significant, participants who scored lower scores (70% or lower) on the 13 menstruation-based questions had 1.18-times higher odds of missing school in the last 3 months due to menstruation, compared to those who scored over 70% (OR 1.18 95% CI 0.69-2.01).

Reports of stomach cramps, stained underwear, mood irritability, headache, and back pain during the last period were all exposure factors that increased the odds of missing school due to menstruation; however, only the presence of headache symptoms were significantly associated with missed school. Girls who reported headaches during their last period were almost twice as likely to report school days missed due to menstruation in the last 3 months (OR 1.90 95% CI 1.10-1.60) compared to those who did not report a headache symptom. In addition, those who reported changing sanitary material less times than 4 times in 24 hours had 1.85-times higher odds of missing school due to menstruation than those that changed 4 or more times, although this measure was not statistically significant (OR 1.85 95% CI 0.92-3.7). When further adjusted for consistent water access, the results were similar.

Table 5.4: The Association Other Menstruation Factors and Missing At Least One School Day During Last 3 Months Due to Menstruation Among Schoolgirls in Edo State, Nigeria (N=539)

	n/events	Model 1^	Model 2^^	Model 3^^^
First heard about menstruation	539/74			
Before first menstruation	420/59	1.00 (REF)	1.00 (REF)	1.00 (REF)
After first menstruation	79/5	0.41 (0.16, 1.07)	0.44 (0.17, 1.15)	0.41 (0.16, 1.08)
Never learned	24/7	2.50 (1.00, 6.34)	2.59 (1.02, 6.56)	2.71 (1.03, 7.14)
Missing	16/3	1.41 (0.39, 5.12)	1.46 (0.40, 5.30)	1.58 (0.42, 6.01)
Knowledge score	539/74			
0-70%	213/32	1.20 (0.73, 1.96)	1.18 (0.70, 1.97)	1.18 (0.69, 2.01)
71-100%	326/42	1.00 (REF)	1.00 (REF)	1.00 (REF)
Missing	0	N/A	N/A	N/A
Symptoms during last period*	539/74			
Stomach pains	399/61	1.46 (0.74, 2.89)	1.45 (0.73, 2.88)	1.43 (0.71, 2.91)
Missing	40/2	0.43 (0.09, 2.01)	0.40 (0.09, 1.91)	0.43 (0.09, 2.10)
Stained underwear	313/46	1.33 (0.76, 2.33)	1.34 (0.76, 2.36)	1.35 (0.76, 2.39)
Missing	52/8	1.40 (0.58, 3.40)	1.36 (0.56, 3.33)	1.37 (0.55, 3.39)
Mood irritability	223/36	1.23 (0.73, 2.06)	1.28 (0.75, 2.17)	1.29 (0.75, 2.23)
Missing	80/6	0.52 (0.21, 1.29)	0.50 (0.20, 1.25)	0.47 (0.19, 1.19)
Headache	145/30	2.00 (1.18, 3.40)	2.01 (1.18, 3.44)	1.90 (1.10, 3.28)
Missing	82/8	0.83 (0.37, 1.86)	0.80 (0.36, 1.81)	0.78 (0.34, 1.79)
Genital irritation/rash	138/18	0.88 (0.49, 1.58)	0.88 (0.49, 1.59)	0.88 (0.48, 1.60)
Missing	85/10	0.78 (0.38, 1.62)	0.75 (0.36, 1.57)	0.74 (0.35, 1.57)
Back pain	114/21	1.52 (0.85, 2.69)	1.47 (0.82, 2.63)	1.52 (0.83, 2.75)
Missing	101/11	0.82 (0.41, 1.66)	0.78 (0.38, 1.59)	0.76 (0.37, 1.58)
Times changed protection per 24hr during last period	539/74			
<=3 times	432/53	1.79 (0.91, 3.50)	1.73 (0.88, 3.40)	1.85 (0.92, 3.73)
>=4 times	65/13	1.00 (REF)	1.00 (REF)	1.00 (REF)
Missing	42/8	1.68 (0.74, 3.83)	1.80 (0.78, 2.40)	1.73 (0.74, 3.73)

Odds Ratios and 95% Confidence Intervals are reported.
^Model one is a crude model with just the exposure and outcome
^^Model 2 is adjusted for the school attended during data collection (1, 2 or 3, missing). A missing indicator variable was also included for school (n=13).
^^^Model 3 is adjusted for the school attended, maternal education (none, primary, secondary, or above, missing), paternal education (none, primary, secondary or above, missing), and the presence of running water at home (yes, no, missing). Missing indicator variables were also included for school (n=13), paternal education (n=93), maternal education (n=84), and running water at home (n=8).
*No report of the respective symptom is the referent group.

DISCUSSION

Menstruating girls face many challenges that affect their ability to manage their menstruation adequately while in school, especially in low-income countries. The impact of poor menstrual hygiene management on the educational outcomes of women and girls has prompted mobilization of funds and research focus in the multiple countries, for example Ghana[9] and Uganda[53]. In addition, UNICEF has highlighted the need to improve menstrual hygiene management in schools as a global health research priority by 2024[12]. Despite increasing action, there is a dearth in the body of literature quantitatively assessing the magnitude of school absenteeism due to menstruation, especially in peri-urban regions that may face unique challenges. This study adds to the body of literature by examining menstrual hygiene management and school attendance among schoolgirls aged 11-19 years old in peri-urban regions of Edo State.

Despite the often-used statistic that one in ten girls miss school during their menstruation in Sub-Saharan Africa, few studies have assessed the association between menstrual hygiene management and school absenteeism with statistical analysis[52,58,65,74]. Furthermore, only four intervention trials assessing school attendance as an outcome have been conducted to date across low income countries in Nepal[58], Ghana[9], Kenya[75], and Uganda[53], showing the need for more research to lead into community-driven intervention trials. This study showed that 13.7% of girls missed school due to their menstruation in the past 3 months and 26.3% of girls missed school in the past month for any reason. Moreover, these results may be underestimated because social desirability bias may have underreported the number of girls attributing their absenteeism to menstruation due to the social shame surrounding menstruation.

The study results suggest a strong association between certain components of menstrual hygiene management and school absenteeism due to menstruation among schoolgirls, despite some results being statistically non-significant due to small sample sizes. Unlike most other studies to date, this study assessed menstrual hygiene management components and menstruation characteristics individually with the outcome of school attendance, allowing for a deeper understanding of the reasons behind school absenteeism. Strikingly, when measured as a composite score, only 27 girls (5.0%) reported having all four components of menstrual hygiene management, showing a clear need for interventions to tackle these factors.

Most prominently, a lack of access to consistent water in school almost doubled the odds of missing school due to menstruation (OR 1.75 95% CI 0.81, 3.78). This association was even stronger when assessing the odds of missing any school day in the past month regardless of reason (OR 3.55 95% CI 1.71, 7.38)). Many studies have highlighted the lack of sanitation facilities in schools, for example, two studies in Ghana report a lack of water supply, with one showing only two out of fourteen schools assessed had water facilities and no schools had soap[16,36]. A recent literature review across Sub-Saharan Africa also showed concordant results of lack of adequate sanitation facilities in most schools assessed, leading girls to defecate and change their pads outside or not change at all during the school day[30]. However, despite qualitative research underlining the lack of sanitation facilities as a reason for girls missing school[76], in the few studies quantitatively assessing menstrual hygiene and school attendance, inconsistent results have been reported. With regards to water facilities, a study in Nepal suggested that improving water facilities has no effect on school attendance[58], while a study in Ethiopia reported that 22.98% of girls missing

school during menstruation attributed the absence to a lack of consistent water[65]. No study to date has statistically assessed the presence of consistent water and school absenteeism due to menstruation in West Africa. This novel finding provides a gateway to interventions to potentially improve girls' attendance at school.

Access to sanitary pads and access to disposal at school were not associated with school absenteeism in this study. This finding supports community-driven research to guide intervention design because much of the previous guidance has recommended increased dissemination of sanitary products as the primary fix for poor menstrual hygiene management. While this is still important, it may not be the most vital need for schoolgirls in Edo State.

Surprisingly, a lack of adequate changing spaces at school was significantly protective for school attendance due to menstruation (OR 0.37 95% CI 0.18, 0.77), however, this association was no longer statistically significant when assessing the outcome as any school day missed in the last month. Although we cannot be certain, the protective effect measure is most likely an artefact due to a small number of girls missing school due to menstruation who also reported no changing spaces (n=14). In addition, the 110 missing answers to this variable could mean no access, however, replication of this study question is required to know. No other studies to date have individually assessed changing spaces and school attendance, but qualitative data suggests a lack of safe spaces to change, resulting in girls using bushes, clothing covers, and outside spaces to find privacy[56]. Previous reports from this project describe the results of the qualitative data from this sample more (see Aim 1 manuscript)[56,77].

Aside from the main menstrual hygiene management exposures of interest, this study supported other findings that menstrual symptoms including headaches,

stomach pains, back pain, stained garments, and mood irritability increased the odds of missing school due to menstruation. A recent study in Uganda also reported headache, stomach pain and back pain as predictors for missing school due to menstruation; however, in both this study (OR 1.90 95% CI 1.10, 3.28) and in the Ugandan study (OR 2.15 (95% CI 1.20–3.86), only headache was a statistically significant predictor[52]. In earlier iterations of this project, qualitative interviews assessed the main challenges of schoolgirls during menstruation in the same schools, and access and knowledge of painkillers was low, a potential avenue to intervene to reduce school absenteeism through reducing painful symptoms during menstruation.

In addition to symptoms, a lack of knowledge of menstruation and the timing of first learning about menstruation were also highlighted as predictors for school absenteeism due to menstruation. This finding agrees with other studies showing that a lack of knowledge about menstruation may lead to anxiety and fear during the bleeding which, in turn, can lead girls to hide and miss school due to the shame[36,52,56]. An inability to predict the onset of the next period, a lack of engagement from teachers and guardians, and a lack of access to more information compile together to undermine adequate menstrual hygiene management[71]. It is important that interventions involve a greater involvement of education and shared experiences during menstruation to allow girls to feel comfortable asking questions and learning more. In addition, more research is needed on the interaction between parents, teachers, peers, and males to fully understand the taboo and shame surrounding menstruation.

Due to the cross-sectional nature of this study, we cannot establish causal relationships between predicting and outcome variables because of a lack of temporality. In addition, the retrospective reporting of school attendance is challenged

by recall bias if participants incorrectly remember the days missed. In addition, social desirability bias may play into the low numbers of school absenteeism reported, with girls under-reporting school days missed or not naming menstruation as a reason for absenteeism. Furthermore, it is difficult to measure school attendance objectively because school registers are not always consistent or accurate and do not name the reason for absences. Moreover, this study is limited by only measuring school days missed due to menstruation, but not individual classes missed, school engagement during school, or educational performance. This could help to quantify the magnitude of the effect that menstruation has on the education of girls and merits further research that could, for example, use school examination data. The most significant limitation of this study was the missing data on many of the predictor factors. This may be attributed to having 300 participants complete the questionnaire at one time in a room in which they may have felt uncomfortable asking questions. More resources could help conduct more personalized and guided questionnaires. The missing data gave rise to a relatively small sample size when assessing the number of participants that experienced the outcome (n=74), thus, many of the measures are less precise than they could be with more participants.

This study added to the body of literature by being the first to statistically assess the association between components of menstrual hygiene management and school attendance in Nigeria, joining very few other studies assessing this research question in low-income countries. The major findings point to school attendance being affected by menstruation because of a lack of consistent water supply at school, a lack of knowledge surrounding menstruation before menarche, and poor management of symptoms like headaches. In earlier phases of this study, qualitative interviews agreed with the results shown in this paper, in addition to highlighted fears

of others knowing about menstruation and a lack of toilets and changing spaces available at school (See Aim 1 Manuscript). Based on these findings, we propose that a community-driven, multifaceted intervention should be piloted within peri-urban settings to improve the knowledge and attitudes surrounding menstruation in addition to the infrastructural support that is offered at schools to allow for safe changing and washing during menses.

Appendix Table 5.1: The Association Between MHM Components and Missing At Least One School Day During Last Month Among Schoolgirls in Edo State, Nigeria (N=539)			
	n/events	Model 1^	Model 4^^^^
Sanitary product used during last period	539/142		
Yes	464/123	1.00 (REF)	1.00 (REF)
No	55/11	0.71 (0.35, 1.42)	0.88 (0.41, 1.90)
Missing	20/8	1.84 (0.74, 4.62)	3.24 (1.18, 8.85)
Private space to change at school	539/142		
Yes	268/87	1.00 (REF)	1.00 (REF)
No	161/35	0.58 (0.37, 0.91)	0.74 (0.44, 1.25)
Missing	110/20	0.47 (0.27, 0.82)	0.58 (0.32, 1.05)
Disposal at school	539/142		
Yes	173/57	1.00 (REF)	1.00 (REF)
No	245/54	0.57 (0.37, 0.88)	0.70 (0.43, 1.13)
Missing	121/31	0.70 (0.42, 1.18)	0.85 (0.48, 1.49)
Consistent water access at school	539/142		
Yes	155/55	1.00 (REF)	1.00 (REF)
No	364/79	5.28 (2.97, 9.38)	3.55 (1.71, 7.38)
Missing	20/8	6.80 (2.40, 19.24)	5.72 (1.87, 17.5)
Odds Ratios and 95% Confidence Intervals are reported. ^Model one is a crude model with just the exposure and outcome ^^^^Model 4 is adjusted for the school attended, maternal education (none, primary, secondary, or above, missing), paternal education (none, primary, secondary or above, missing), and the presence of running water at home (yes, no, missing), headache symptoms reported (yes, no, missing), and timing of first learning of menstruation (before menarche, after menarche, never, missing). Missing indicator variables were also included for school (n=13), paternal education (n=93), maternal education (n=84), and running water at home (n=8).			

CHAPTER 6: DISCUSSION

Through this dissertation we have aimed to describe the challenges regarding menstrual hygiene management and related educational outcomes among schoolgirls in peri-urban regions of Edo State, Nigeria. Specifically, we focused on describing the characteristics about menstruation, menstruation practices, knowledge and attitudes about menstruation, and the main challenges during menstruation among schoolgirls aged 11-19 years old (Aim 1). In addition, we examined the association between menstrual hygiene practices and school days missed due to menstruation (Aim 2). The major findings are summarized below.

AIM 1: *Describe the Menstrual Hygiene Management Practice, Knowledge, and Attitudes Among Schoolgirls in Edo State*

To better understand the menstrual hygiene management (MHM) challenges within the Nigerian communities we were working in, we conducted a mixed methods assessment including in-depth interviews and questionnaires. The average age of menarche was 13.1 years old (SD 1.2). The most common reported physical symptoms were stomach pain and mood irritability with no girls reporting no symptoms. Menstruation knowledge was acquired mostly from mothers. The participants showed an average of 76.9% correct answers when asked basic questions about menstruation. Almost half of the girls felt anxious for their next period. The girls described cultural myths surrounding menstruation leading them to hide their menstrual products and feel embarrassed to ask for more information or help. Only 27 girls (4.7%) reported complete

adequate menstrual hygiene management (access to sanitary pads, changing and sanitation facilities, and safe disposal methods) during their last period. When assessed individually, most girls used manufactured sanitary pads during their last period, over half the girls changed in a private room or a latrine, and less than half the girls disposed of their used products in an incinerator or dustbin. Most strikingly, less than a third of girls had consistent water access in school.

AIM 2: *Examine the Relationship Between Menstrual Hygiene Management and School Days Missed Due to Menstruation*

In the first aim, we observed that some girls missed school and activities during menstruation because of painful symptoms, embarrassment about leaking, and a lack of facilities at school, therefore, we examined the association between menstrual hygiene facilities, practices, knowledge, and symptoms in relation to school days missed due to menstruation. Seventy-four girls (13.7%) reported missing at least one day of school in the past 3 months due to menstruation. Missing school due to menstruation was most strongly associated with inconsistent access to water at school and experiencing headache symptoms during their last menstruation. In addition, stomach pains, back pain, mood irritability, experiencing stained underwear, never learning about menstruation, changing less than four times in 24 hours, and a lower knowledge about menstruation were all factors that increased the odds of girls missing school due to menstruation. Albeit these latter associations were not statistically significant because of small sample sizes. These results suggest that interventions such as providing pain remedies (e.g., acetaminophen, heat packs etc.), education about menstruation in school before the age of 9/10 years old and making sure there is a consistent water supply at school, would be beneficial and

could influence MHM among schoolgirls and reduce the days missed due to menstruation.

STRENGTHS AND LIMITATIONS

This dissertation research has many strengths worth mentioning. A major strength of this work is that the primary data collection and study design was planned around the main research questions, allowing us to collect covariate data based on previous literature to adjust for potential confounding. The largest study to data that has assessed this research question (menstrual hygiene and school attendance) was based in Uganda; however, it was designed around male circumcision, not menstrual hygiene[52]. The exploratory sequential mixed methods study design also allowed for a more thorough assessment of MHM within this community as we combined interview and questionnaire data. The assessment of physical components of MHM (e.g., presence of toilets at school) did not always tell the entire story of MHM, as the girls that were interviewed added that the toilets were often not working, out of bounds, or too messy to use. Future studies assessing MHM would benefit from using this study design for a more in-depth understanding.

In addition, the study was conducted nearby and in collaboration with a large research center which allowed for more resources than stand-alone studies. These resources included a research team, funding sources, security teams, existing relationships with community members and schools, and a centralized study headquarters. A respected research team was set up that helped to facilitate relationships within the schools and include a relatively large sample size of menstruating girls, compared to similar studies[9,53,72]. The sample size meant that there were enough girls that

experienced the event in each exposure group to conduct assessments with statistical analysis, making the study one of very few in low-income countries that adjusted for potential confounding when assessing the relationship between MHM and school days missed[9,48,72]. This will help to advance the literature in this field forward from descriptive results to hypothesis-testing association-based results to allow for broader and more comprehensive conclusions and recommendations.

In addition, the proximity to a large research center gave space for an intensive 3-day training with the data collectors including an overview of the objectives and aims of the study, consent processes, and interview/questionnaire materials. In addition, rehearsal interviews were conducted to enhance more proficient data collection. The use of local, female data collectors is also important in this work to ensure that girls feel at ease talking about sensitive issues that are not often openly discussed.

Finally, the study was conducted in a peri-urban region of Edo State that may face unique challenges that differ from rural and urban experiences. It is important to research new communities and not assume that a one size intervention fits all. In this sense, assessing the association between school attendance and menstrual hygiene management components individually gave rise to more precise conclusions of where resources are needed within these communities. It is important for future studies to assess individual exposures to give more tailored intervention recommendations.

Despite the many strengths, the findings of this dissertation are subject to several limitations. Like most studies in this field, this study was cross-sectional in design, providing no longitudinal data for causal inference over time. Therefore, we cannot know

for certain the direction of the observed associations since the exposure and outcome variables were measured at the same time point.

Furthermore, the study was school-based, which may have induced some selection bias that underestimates the magnitude of poor menstrual hygiene management when compared to the total population of girls that live in peri-urban regions of Edo State. Since accessibility to school indicates a level of privilege that may not be comparable to girls who do not attend school, the associations and conclusions formed from the results of this study may not be relevant to the wider community. Further studies should assess the MHM and related factors of non-school going girls. The study was conducted near a large research center that may have also given rise to more resources than other places. Other studies in the literature have also faced this problem with most large studies being conducted in Ghana, Uganda, and Nigeria, all of which are large African countries that have research centers to aid in the facilitation of studies. Future studies should look into the feasibility of assessing MHM in smaller communities and countries with less research infrastructure.

Additionally, the study results may be skewed by information bias. Firstly, the missing data in the questionnaire may be a result of the girls being too scared to ask for clarification because of being in a large exam-hall room with 200 girls present. With more resources, the questionnaires could have been completed in smaller settings.

Moreover, many of the measures reported were self-reported and retrospective and therefore, the results could be influenced by exposure or outcome misclassification if the girls did not remember correctly. It may be the case that the girls who had endured traumatic menstruation experiences (e.g., lack of facilities or painful symptoms) may

remember missing school due to menstruation more than those who did not have adverse menstrual experiences but still missed school for menstrual reasons, resulting in recall bias or differential outcome misclassification. This would lead to the results being biased away from the null value and overestimate the association between poor MHM and school attendance. On the other hand, all the girls may have misremembered their experiences because of a time gap between the event and the questionnaire which could bias the results towards a null association. Longitudinal studies should be conducted to mitigate these biases.

During the qualitative interviews, the participant's answers may have been biased by social desirability, or a desire to present themselves in a way that is suitable for the situation rather than presenting the truth. This could have meant the girls did not share all their negative menstruation experiences because of a general taboo and shame surrounding the topic of menstrual hygiene, therefore, they may not have felt comfortable delving into details. However, social desirability bias may have also presented itself by the girls exaggerating their negative experiences in the hope of receiving help from a research organization. The use of local, female data collectors helped to mitigate these issues and should be used in future studies.

Finally, future studies should assess more than just menstruating girls to describe the wider context of menstrual experiences. This study was limited using only adolescent girls which did not consider the influence of males, teachers, parents, and others in the practices, knowledge, and attitudes surrounding menstruation.

BROADER CONCLUSIONS

Despite many underlying challenges to attaining adequate menstrual hygiene management in low-income countries, the literature often simplifies the problems to a lack of sanitary materials and education[9,58,78]. This study has shown that there are many sociocultural undercurrents and infrastructural problems that are more significant barriers to MHM than access to sanitary pads in this community. By focusing solely on westernized ideas of interventions, the less-apparent problems in menstrual hygiene management have often been overlooked, hindering the efforts in improving menstrual hygiene for girls.

The multiple factors that work synergistically to burden girls during their menstruation begin at an early age. This research showed that many girls do not learn about menstruation until menarche and are shocked by the first sight of blood. The vulnerability of girls during this time is heightened by the cultural taboos and shame that shroud menstruation and deter girls from seeking help. In addition, the lack of sanitation and private changing facilities at school plays into a broader picture of the barriers to female health and opportunity. Often women are denied the opportunity to uninterrupted education as well as economic and social power in communities, and poor MHM in schools has been highlighted as a downstream issue that, if solved, could help lift women up within their communities. In turn, the more valuable a woman becomes through education and economic gain, the more valuable the community becomes.

The many reports of painful symptoms during menstruation speaks to the collective attitudes surrounding menstruation as more girls feared the pain, embarrassment, and annoyance of menstruating instead of focusing on the safe

management of menstruation and the importance of a healthy reproductive system. It is important that the narrative around menstruation is altered to allow for a greater appreciation of the importance reproductive health.

Understanding MHM within a context of human rights allows us to see the broader picture of gender inequality. Most importantly, this study showed that women and girls often miss school because of the school environment that does not enable adequate menstrual hygiene management, for instance because of inconsistent water sources. This leads to females missing educational opportunities and can have many upstream effects, including reduced economic power, decrease in the value of the female life, poor reproductive health outcomes, and increased maternal mortality.

For these reasons, it is important to bring menstruation to the forefront of research and action through community-based research projects. This study highlighted needs such as using a mixed methods approach in future research within communities to gain the perspectives and quantitative measures of menstrual health, putting in place tactics to minimize missing data, and including other community members and girls that may not have the opportunity to attend school.

PUBLIC HEALTH SIGNIFICANCE AND FUTURE DIRECTIONS

In our first aim we found that the main challenges pertaining to menstruation were painful symptoms, a lack of adequate sanitation facilities at school, and a general taboo around discussing menstrual hygiene. In addition, there were frequent reports of the need to hide used menstrual products and stained underwear because of money rituals that involved stealing women's garments and used pads. This account of lived experiences of menstrual hygiene may help inform future studies and community-wide interventions to

target the awareness of menstrual hygiene and dismantle the taboos and sociocultural myths surrounding menstruation, in addition to increasing access to sanitation facilities.

The second aim further developed the need for interventions within schools by providing empirical evidence for the menstrual hygiene management determinants of school absenteeism. The results give reason to recommend community driven interventions that can improve menstrual hygiene and reduce school days missed through providing water access, remedies for painful symptoms, and early education about menstrual hygiene.

The next phase of this research will include the design of a novel cross-sectoral intervention that responds to the needs of this peri-urban community. With the help of stakeholders in both the United States and Nigeria, we will assist a community-driven implementation of the intervention and a longitudinal evaluation assessment.

To combine the overall findings of this dissertation, a holistic response to menstrual hygiene is needed to improve the larger picture of women's health and rights in Nigeria and other low-income countries. Increasing women and girls' access to menstrual hygiene is central to achieving at least six Sustainable Development Goals designed by the United Nations[12]. Firstly, improvement in knowledge surrounding menstruation and reproductive health can reduce unwanted pregnancies, decrease maternal morbidities, and diminish reproductive tract infections through the use of safer menstrual materials (Goal 3). Girls may also be more attentive in school and miss less school days due to menstruation, affecting educational success (Goal 4). In addition, less women may miss work or economic opportunities (Goal 8). Gender equality (Goal 5) is improved when women and girls can menstruate safely and are not restricted from their society because

of taboos and myths. Finally, creating adequate water, sanitation, and disposal facilities impacts the entire community while improving menstrual hygiene management for women and girls (Goal 6 and 12).

The onset of menstruation coincides with new vulnerabilities and opportunities for adolescent girls. Improving menstrual hygiene management has a transformational potential by strengthening girls' self-efficacy and helping them overcome obstacles to their health, education, and freedom. By investing in young girls today, we are empowering the girls they are today, the women they will become, and the next generation that they will raise.

REFERENCES

1. Sommer M, Hirsch JS, Nathanson C, Parker RG. Comfortably, Safely, and Without Shame: Defining Menstrual Hygiene Management as a Public Health Issue. *Am J Public Health*. 2015;105(7):1302-1311. doi:10.2105/AJPH.2014.302525

2. UNICEF-Guidance-menstrual-health-hygiene-2019.pdf. Accessed August 11, 2022. https://www.unicef.org/media/91341/file/UNICEF-Guidance-menstrual-health-hygiene-2019.pdf

3. Menstrual Hygiene Management Enables Women and Girls to Reach Their Full Potential. World Bank. Accessed August 11, 2022. https://www.worldbank.org/en/news/feature/2018/05/25/menstrual-hygiene-management

4. Shah V, Nabwera HM, Sosseh F, et al. A rite of passage: a mixed methodology study about knowledge, perceptions and practices of menstrual hygiene management in rural Gambia. *BMC Public Health*. 2019;19(1):277. doi:10.1186/s12889-019-6599-2

5. Salami KK, Mettu JC, Azeez A. Onset of Menarche and Adolescent Menstrual Hygiene Practices in Semi-Urban Ibadan Community, Nigeria. *Women's Reproductive Health*. 2019;6(2):102-117. doi:10.1080/23293691.2019.1601903

6. Mohammed S, Larsen-Reindorf RE. Menstrual knowledge, sociocultural restrictions, and barriers to menstrual hygiene management in Ghana: Evidence from a multi-method survey among adolescent schoolgirls and schoolboys. *PLoS One*. 2020;15(10):e0241106. doi:10.1371/journal.pone.0241106

7. Ajah LO, Onubogu ES, Anozie OB, et al. Adolescent reproductive health challenges among schoolgirls in southeast Nigeria: role of knowledge of menstrual pattern and contraceptive adherence. *Patient Prefer Adherence*. 2015;9:1219-1224. doi:10.2147/PPA.S89258

8. Prevalence and factors associated with menstruation-related school absenteeism among adolescent girls in rural northern Ghana - PubMed. Accessed April 21, 2022. https://pubmed.ncbi.nlm.nih.gov/34340667/

9. Montgomery P, Ryus CR, Dolan CS, Dopson S, Scott LM. Sanitary Pad Interventions for Girls' Education in Ghana: A Pilot Study. *PLOS ONE*. 2012;7(10):e48274. doi:10.1371/journal.pone.0048274

10. Nigeria - National Economic Empowerment and Development Strategy and joint IDA-IMF staff advisory note. World Bank. Accessed August 12, 2022. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/234301468290438608/Nigeria-National-Economic-Empowerment-and-Development-Strategy-and-joint-IDA-IMF-staff-advisory-note

11. Hennegan J, Shannon AK, Rubli J, Schwab KJ, Melendez-Torres GJ. Women's and girls' experiences of menstruation in low- and middle-income countries: A systematic review and qualitative metasynthesis. *PLoS Med*. 2019;16(5):e1002803. doi:10.1371/journal.pmed.1002803

12. UNICEF-Guidance-menstrual-health-hygiene-2019.pdf. Accessed May 10, 2022. https://www.unicef.org/media/91341/file/UNICEF-Guidance-menstrual-health-hygiene-2019.pdf

13. Lawal AM, Idemudia ES, Balogun SK. Menstrual attitude dimensions, Anxiety and Body Esteem in adolescent girls. *Psychol Health Med*. 2020;25(4):418-425. doi:10.1080/13548506.2019.1640885

14. Finlay JE, Assefa N, Mwanyika-Sando M, et al. Sexual and reproductive health knowledge among adolescents in eight sites across sub-Saharan Africa. *Trop Med Int Health*. 2020;25(1):44-53. doi:10.1111/tmi.13332

15. Kumbeni MT, Ziba FA, Apenkwa J, Otupiri E. Prevalence and factors associated with menstruation-related school absenteeism among adolescent girls in rural northern Ghana. *BMC Womens Health*. 2021;21(1):279. doi:10.1186/s12905-021-01418-x

16. Kumbeni MT, Otupiri E, Ziba FA. Menstrual hygiene among adolescent girls in junior high schools in rural northern Ghana. *Pan Afr Med J*. 2020;37:190. doi:10.11604/pamj.2020.37.190.19015

17. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi:10.1136/bmj.b2535

18. Anaba EA, Udofia EA, Manu A, Daniels AA, Aryeetey R. Use of reusable menstrual management materials and associated factors among women of reproductive age in Ghana: analysis of the 2017/18 Multiple Indicator Cluster Survey. *BMC Womens Health*. 2022;22(1):92. doi:10.1186/s12905-022-01670-9

19. Hennegan J, Zimmerman L, Shannon AK, et al. The Relationship between Household Sanitation and Women's Experience of Menstrual Hygiene: Findings from a Cross-Sectional Survey in Kaduna State, Nigeria. *Int J Environ Res Public Health*. 2018;15(5). doi:10.3390/ijerph15050905

20. Dorgbetor G. Mainstreaming menstrual hygiene management in schools through the play-based approach: lessons learned from Ghana. *Waterlines*. 2015;34(1):41-50. doi:10.3362/1756-3488.2015.005

21. Ajong AB, Tankala NN, Yakum MN, Azenoi IS, Kenfack B. Knowledge of peri-menarcheal changes and a comparative analysis of the age at menarche among young adolescent school girls in urban and rural Cameroon. *BMC Public Health*. 2020;20(1):1661. doi:10.1186/s12889-020-09787-y

22. Anikwe CC, Mamah JE, Okorochukwu BC, Nnadozie UU, Obarezi CH, Ekwedigwe KC. Age at menarche, menstrual characteristics, and its associated

morbidities among secondary school students in Abakaliki, southeast Nigeria. *Heliyon*. 2020;6(5):e04018. doi:10.1016/j.heliyon.2020.e04018

23. Nwokocha ARC, Chinawa JM, Ubesie AC, Onukwuli VI, Manyike PC. Pattern of teen menstruation among secondary school girls in south east Nigeria. *J Pediatr Endocrinol Metab*. 2016;29(3):343-350. doi:10.1515/jpem-2015-0257

24. Ameade EPK, Amalba A, Mohammed BS. Prevalence of dysmenorrhea among University students in Northern Ghana; its impact and management strategies. *BMC Womens Health*. 2018;18(1):39. doi:10.1186/s12905-018-0532-1

25. Obasi M, Manortey S, Kyei KA, et al. Sexual and reproductive health of adolescents in schools for people with disabilities. *Pan Afr Med J*. 2019;33:299. doi:10.11604/pamj.2019.33.299.18546

26. Lawan UM, Yusuf NW, Musa AB. Menstruation and menstrual hygiene amongst adolescent school girls in Kano, Northwestern Nigeria. *Afr J Reprod Health*. 2010;14(3):201-207.

27. Oche MO, Umar AS, Gana GJ, Ango JT. Menstrual health: the unmet needs of adolescent girls' in Sokoto, Nigeria. *Scientific Research and Essays*. 2012;7(3):410-418.

28. Boakye-Yiadom A, Aladago D, Beweleyir J, Mohammed H, Salifu M, Asaarik M. Assessing the Knowledge, Attitude and Practice of Menstrual Hygiene Management Among Junior High Schools Adolescent Females in the Yendi Municipality in the Northern Region of Ghana. *European Scientific Journal ESJ*. 2018;14. doi:10.19044/esj.2018.v14n36p467

29. M Oche O. Menstrual health: the unmet needs of adolescent girls' in Sokoto, Nigeria. Published online January 1, 2012. doi:10.5897/SRE11.1842

30. Ssewanyana D, Bitanihirwe BKY. Menstrual hygiene management among adolescent girls in sub-Saharan Africa. *Glob Health Promot*. 2019;26(1):105-108. doi:10.1177/1757975917694597

31. Amu EO, Bamidele JO. Prevalence of menstrual disorders among adolescent girls in Osogbo, South Western Nigeria. *Int J Adolesc Med Health*. 2014;26(1):101-106. doi:10.1515/ijamh-2013-0500

32. Adegbayi A. Blood, joy and tears: menarche narratives of undergraduate females in a selected in Nigeria Private University. *Int J Adolesc Med Health*. 2017;31(4). doi:10.1515/ijamh-2017-0023

33. Iliyasu Z, Aliyu MH, Abubakar IS, Galadanci HS. Sexual and reproductive health communication between mothers and their adolescent daughters in northern Nigeria. *Health Care Women Int*. 2012;33(2):138-152. doi:10.1080/07399332.2011.562996

34. Gumanga SK, Kwame-Aryee RA. Menstrual characteristics in some adolescent girls in Accra, Ghana. *Ghana Medical Journal*. 2012;46(1). doi:10.4314/gmj.v46i1.

35. Ghararo L. Menstrual Hygiene Practices among Junior Secondary School Students in Benin City. *Journal of Educational and Social Research*. 2013;3(8):129-135.

36. Rheinländer T, Gyapong M, Akpakli DE, Konradsen F. Secrets, shame and discipline: School girls' experiences of sanitation and menstrual hygiene management in a peri-urban community in Ghana. *Health Care Women Int*. 2019;40(1):13-32. doi:10.1080/07399332.2018.1444041

37. Gyan SE. Exploring the Causes of Change in Adolescent Girls' Sexual Behaviour in Begoro, Ghana. *Afr J Reprod Health*. 2017;21(2):55-63. doi:10.29063/ajrh2017/v21i2.7

38. Aziato L, Dedey F, Clegg-Lamptey JNA. The experience of dysmenorrhoea among Ghanaian senior high and university students: pain characteristics and effects. *Reprod Health*. 2014;11:58. doi:10.1186/1742-4755-11-58

39. Acheampong K, Baffour-Awuah D, Ganu D, et al. Prevalence and Predictors of Dysmenorrhea, Its Effect, and Coping Mechanisms among Adolescents in Shai Osudoku District, Ghana. *Obstet Gynecol Int*. 2019;2019:5834159. doi:10.1155/2019/5834159

40. Kaur R, Kaur K, Kaur R. Menstrual Hygiene, Management, and Waste Disposal: Practices and Challenges Faced by Girls/Women of Developing Countries. *Journal of Environmental and Public Health*. 2018;2018:e1730964. doi:10.1155/2018/1730964

41. Chandra-Mouli V, Patel SV. Mapping the knowledge and understanding of menarche, menstrual hygiene and menstrual health among adolescent girls in low- and middle-income countries. *Reproductive Health*. 2017;14(1):30. doi:10.1186/s12978-017-0293-6

42. Ameade EPK, Garti HA. Relationship between Female University Students' Knowledge on Menstruation and Their Menstrual Hygiene Practices: A Study in Tamale, Ghana. *Adv Prev Med*. 2016;2016:1056235. doi:10.1155/2016/1056235

43. Mohammed S, Larsen-Reindorf RE, Awal I. Menstrual Hygiene Management and School Absenteeism among Adolescents in Ghana: Results from a School-Based Cross-Sectional Study in a Rural Community. *International Journal of Reproductive Medicine*. 2020;2020:e6872491. doi:10.1155/2020/6872491

44. Salau OR, Ogunfowokan AA. Pubertal Communication Between School Nurses and Adolescent Girls in Ile-Ife, Nigeria. *J Sch Nurs*. 2019;35(2):147-156. doi:10.1177/1059840517727831

45. Iliyasu Z, Galadanci HS, Abubakar IS, Ismail AO, Aliyu MH. Menstrual patterns and gynecologic morbidity among university students in Kano, Nigeria. *J Pediatr Adolesc Gynecol*. 2012;25(6):401-406. doi:10.1016/j.jpag.2012.08.006

46. Chandra-Mouli V, Patel SV. Mapping the knowledge and understanding of menarche, menstrual hygiene and menstrual health among adolescent girls in low-

and middle-income countries. *Reprod Health*. 2017;14(1):30. doi:10.1186/s12978-017-0293-6

47. Creswell JW, Clark VLP. *Designing and Conducting Mixed Methods Research*. SAGE; 2011.

48. Nalugya R, Tanton C, Hytti L, et al. Assessing the effectiveness of a comprehensive menstrual health intervention program in Ugandan schools (MENISCUS): process evaluation of a pilot intervention study. *Pilot and Feasibility Studies*. 2020;6(1):51. doi:10.1186/s40814-020-00585-2

49. Tools-and-Resources-for-Task-Teams.pdf. Accessed August 14, 2022. https://documents1.worldbank.org/curated/en/497961622035770181/pdf/Tools-and-Resources-for-Task-Teams.pdf

50. Friese S, Soratto J, Pires D. Carrying out a computer-aided thematic content analysis with ATLAS.ti. *IWMI Working Papers*. 2018;18.

51. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101. doi:10.1191/1478088706qp063oa

52. Miiro G, Rutakumwa R, Nakiyingi-Miiro J, et al. Menstrual health and school absenteeism among adolescent girls in Uganda (MENISCUS): a feasibility study. *BMC Women's Health*. 2018;18(1):4. doi:10.1186/s12905-017-0502-z

53. Kansiime C, Hytti L, Nalugya R, et al. Menstrual health intervention and school attendance in Uganda (MENISCUS-2): a pilot intervention study. *BMJ Open*. 2020;10(2):e031182. doi:10.1136/bmjopen-2019-031182

54. Thakre SB, Thakre SS, Reddy M, Rathi N, Pathak K, Ughade S. Menstrual Hygiene: Knowledge and Practice among Adolescent School Girls of Saoner, Nagpur District. *Journal of Clinical and Diagnostic Research*. 2011;5:7.

55. Sommer M. Where the education system and women's bodies collide: The social and health impact of girls' experiences of menstruation and schooling in Tanzania. *Journal of Adolescence*. 2010;33(4):521-529. doi:10.1016/j.adolescence.2009.03.008

56. Mason L, Nyothach E, Alexander K, et al. 'We Keep It Secret So No One Should Know' – A Qualitative Study to Explore Young Schoolgirls Attitudes and Experiences with Menstruation in Rural Western Kenya. *PLOS ONE*. 2013;8(11):e79132. doi:10.1371/journal.pone.0079132

57. Cronk R, Guo A, Fleming L, Bartram J. Factors associated with water quality, sanitation, and hygiene in rural schools in 14 low- and middle-income countries. *Sci Total Environ*. 2020;761:144226. doi:10.1016/j.scitotenv.2020.144226

58. Oster E, Thornton R. Menstruation, Sanitary Products, and School Attendance: Evidence from a Randomized Evaluation. *American Economic Journal: Applied Economics*. 2011;3(1):91-100. doi:10.1257/app.3.1.91

59. A Time for Global Action: Addressing Girls' Menstrual Hygiene Management Needs in Schools | PLOS Medicine. Accessed October 5, 2022. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001962

60. Fetters MD, Curry LA, Creswell JW. Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Serv Res*. 2013;48(6 Pt 2):2134-2156. doi:10.1111/1475-6773.12117

61. Cargo M, Mercer SL. The value and challenges of participatory research: strengthening its practice. *Annu Rev Public Health*. 2008;29:325-350. doi:10.1146/annurev.publhealth.29.091307.083824

62. Israel BA, Parker EA, Rowe Z, et al. Community-based participatory research: lessons learned from the Centers for Children's Environmental Health and Disease Prevention Research. *Environ Health Perspect*. 2005;113(10):1463-1471. doi:10.1289/ehp.7675

63. Composite Indicator of Poverty | SpringerLink. Accessed August 15, 2022. https://link.springer.com/chapter/10.1007/978-1-4419-0843-8_3

64. SAS ® Reference. Published online 2013.

65. Tegegne TK, Sisay MM. Menstrual hygiene management and school absenteeism among female adolescent students in Northeast Ethiopia. *BMC Public Health*. 2014;14:1118. doi:10.1186/1471-2458-14-1118

66. Wateraid_menstrual-hygiene-school-adolesencegirls-Nepal_2009.pdf. Accessed October 6, 2022. https://menstrualhygieneday.org/wp-content/uploads/2016/12/Wateraid_menstrual-hygiene-school-adolesencegirls-Nepal_2009.pdf

67. El-Gilany AH, Badawi K, El-Fedawy S. Menstrual Hygiene among Adolescent Schoolgirls in Mansoura, Egypt. *Reproductive Health Matters*. 2005;13(26):147-152. doi:10.1016/S0968-8080(05)26191-8

68. Aluko OO, Oluya OM, Olaleye OA, Olajuyin AA, Olabintan TF, Oloruntoba-Oju OI. Knowledge and menstrual hygiene practices among adolescents in senior secondary schools in Ile Ife, south-western Nigeria. *Journal of Water, Sanitation and Hygiene for Development*. 2014;4(2):248-256. doi:10.2166/washdev.2014.084

69. Garba I, Rabiu A, Abubakar IS. Menstrual hygiene among adolescent school girls in Kano. *Tropical Journal of Obstetrics and Gynaecology*. 2018;35(2):153-157. doi:10.4314/tjog.v35i2

70. 2014_Annual_Results_Report_WASH.pdf. Accessed October 6, 2022. https://www.unicef.org/media/50741/file/2014_Annual_Results_Report_WASH.pdf

71. Sommer M, Hirsch JS, Nathanson C, Parker RG. Comfortably, Safely, and Without Shame: Defining Menstrual Hygiene Management as a Public Health

Issue. *Am J Public Health*. 2015;105(7):1302-1311. doi:10.2105/AJPH.2014.302525

72. Alam MU, Luby SP, Halder AK, et al. Menstrual hygiene management among Bangladeshi adolescent schoolgirls and risk factors affecting school absence: results from a cross-sectional survey. *BMJ Open*. 2017;7(7):e015508. doi:10.1136/bmjopen-2016-015508

73. Asselin LM. Composite Indicator of Poverty. In: Asselin LM, ed. *Analysis of Multidimensional Poverty: Theory and Case Studies*. Economic Studies in Inequality, Social Exclusion and Well-Being. Springer; 2009:19-51. doi:10.1007/978-1-4419-0843-8_3

74. Phillips-Howard PA, Caruso B, Torondel B, Zulaika G, Sahin M, Sommer M. Menstrual hygiene management among adolescent schoolgirls in low- and middle-income countries: research priorities. *Glob Health Action*. 2016;9:33032. doi:10.3402/gha.v9.33032

75. Wilson E, Reeve J, Pitt A. Education. Period. Developing an acceptable and replicable menstrual hygiene intervention. *Development in Practice*. 2014;24(1):63-80. doi:10.1080/09614524.2014.867305

76. Hennegan J, Montgomery P. Do Menstrual Hygiene Management Interventions Improve Education and Psychosocial Outcomes for Women and Girls in Low and Middle Income Countries? A Systematic Review. *PLoS One*. 2016;11(2):e0146985. doi:10.1371/journal.pone.0146985

77. Coast E, Lattof SR, Strong J. Puberty and menstruation knowledge among young adolescents in low- and middle-income countries: a scoping review. *Int J Public Health*. 2019;64(2):293-304. doi:10.1007/s00038-019-01209-0

78. Phillips-Howard PA, Nyothach E, Kuile FO ter, et al. Menstrual cups and sanitary pads to reduce school attrition, and sexually transmitted and reproductive tract infections: a cluster randomised controlled feasibility study in rural Western Kenya. *BMJ Open*. 2016;6(11):e013229. doi:10.1136/bmjopen-2016-013229

APPENDIX 1 (QUESTIONNAIRE)

Questionnaire on Menstrual Hygiene Management for Female Students Aged <19 years old ONLY

Screen	Question	Response
QX001	School name:	
QX002	Date of survey:	D D M M Y Y Y Y

Screen	Question	
CONSENT: Check consent and assent forms are complete and complete below *For participants aged 11-17 yrs., this questionnaire requires verbal assent.*		
QX003	Age of student in completed years:	years
QX004	Assent obtained from students aged 11-17 yrs. old?	Yes ___ No ___ Not applicable ___

SECTION A: STUDENT IDENTIFIER/DEMOGRAPHICS

Screen	Question Response			
Q01	Student's initials (***Write the beginning letter for each of your first name, middle name and <u>surname</u>***)			|___|___|___|
Q02	What is your student unique study number? (***Write this number on the top of every page***)			|___|___|___|___|___|___|
Q03	Are you a boarding or day student? (***Circle one response***)			Day 1 Boarding 2
Q04	How old are you now? (***Write age in completed years***)			|___|___|
Q05	What is your date of birth?	DD	MM	Y Y Y Y
Q06	Does your household own or have the following?	Electricity		Yes 1 No 2
		Running water		Yes 1 No 2
		Flush toilet		Yes 1 No 2
		Land		Yes 1 No 2
		Car		Yes 1 No 2

		Television	Yes No	1 2
		Livestock	Yes No	1 2
QO7	How many members live in your household?	people		
Q08	What is your father's/male guardian's educational level?	No education Basic education (primary school) Secondary education (secondary school) Tertiary education (university) N/A		1 2 3 4 5
Q09	What is your mother's/female guardian's educational level?	No education Basic education (primary school) Secondary education (secondary school) Tertiary education (university) N/A		1 2 3 4 5

SECTION B: SCHOOL ATTENDANCE

It can often be difficult to get to school every day, even when you are trying your best. We now want to find out how regularly you attend school and which factors affect your school attendance.

Screen	Question	Response	
Q010	How many days of school have you missed in the past 30 days? (***Write 00 if none)***	|__|__|	
Q011	Give the number of days you missed school in the past 30 days for each reason given on the right. At the bottom, add any additional reasons you have missed school.	**Reasons for missing school**	**DAYS**
		Sick at home (not menstruating)	|__|__|
		Menstruating	|__|__|
		Sick in clinic/hospital	|__|__|
		Lost a relative	|__|__|
		Not paying school fees	|__|__|
		Not having school requirements	|__|__|
		Sent home from school, discipline	|__|__|
		Care-taking at home	|__|__|
		Caretaking in hospital	|__|__|
		Other reasons	|__|__|
		Specify other reasons:	
		Total days missed	|__|__|

Q08	Of the reasons given above, what is the main reason that you missed school? (***Circle one***)	Sick at home (not menstruating) 1 Menstruating 2 Sick in clinic/hospital 3 Lost a relative 4 Not paying school fees 5 Not having school requirements 6 Sent home from school, discipline 7 Caretaking at home 8 Caretaking in hospital 9 Other reasons 10

SECTION C: MENSTRUATION / PERIODS

Menstruation is an important process when girls come into womanhood. We are interested in finding out more about girls' attitudes towards having their menstruation or periods.

Screen	Question	Response
Q013	Have you started menstruating (having your periods)?	Yes 1 No 2 Don't know 3
Q014	How old were you when you had your first menstruation period?	|___|___|
Q015	About how many days does each of your menstruation periods last?	|___|___| days
Q016	On average, how many <u>weeks</u> are there between the start of one period, and the start of the next one?	|___|___| weeks
Q017	How many menstruation periods have you had in the past 3 months?	|___|___|
Q018	Which of the following issues (if any) did you experience during your last menstruation period? **(*Circle Yes/No for each question*)**	
	Skin irritation/rash/itching in the genital parts	Yes1 No 2
	Knickers/panties were stained with blood	Yes1 No 2
	Outside garments were stained with blood	Yes1 No 2
	Sticky or wet feeling in the genital parts	Yes1 No 2

Unpleasant smell	Yes1 No 2
Headache	Yes1 No 2
Stomach pains, cramps, or bloating	Yes1 No 2
Back pain	Yes1 No 2
Irritability or moodiness	Yes1 No 2
Other discomforts that you felt which are not mentioned here? Please specify: _____	Yes1 No 2

Screen	Question	Response
SHARING INFORMATION ON MENSTRUATION		
Q019	Who was the main person from whom you learnt about menstruation periods? (***Circle ALL that apply***)	**Circle ALL that apply** 1 My mother 2 Paternal aunt (Senga) 3 Grandmother 4 Maternal aunt/stepmother 5 My sister 6 Other aunties – not related 7 My father 8 My brother 9 My friend 10 A health worker 11 A teacher 12 No-one 13 Specify if another person: _____
Q020	When did you learn about menstruation periods?	Before my first menstruation 1 When the first menstruation started 2 After my first menstruation ended 3 I have never learnt about periods 4

Q021	From whom do you get **the most useful** information about menstruation periods?	**Circle only one response**	
		My mother	1
		Paternal aunt (Senga)	2
		Grandmother	3
		Maternal aunt/stepmother	4
		My sister	5
		Other aunties – not related	6
		My father	7
		My brother	8
		My friend	9
		A health worker	10
		A teacher	11
		Radio, TV or newspapers	12
		Other means/person	13
		Specify if other: _____	
Q022	Who do you **NOT** talk about menstruation periods with? (***Please circle all that applies***)	My mother	1
		Paternal aunt (Senga)	2
		Grandmother	3
		Maternal aunt/stepmother	4
		My sister	5
		Other aunties – not related	6
		My father	7
		My brother	8
		My friend	9
		A health worker	10
		A teacher	11
		Radio, TV or newspapers	12
		Other means/person	13
		Specify if other: _____	

MANAGEMENT OF MENSTRUATION PERIODS

*A **menstrual absorbent is a material used to hold blood during a menstruation period**. Examples of menstrual absorbents include sanitary pads, sanitary towels, old clothes, homemade materials, and cotton wool.*

Menstrual absorbents include:

- *re-usable (materials that are used during several periods after washing).*
- *disposable (materials that are thrown away after a single use e.g. Always sanitary pads).*

The next questions are about which menstrual absorbents you know and which of these absorbents you have used or are currently using during your periods.

Screen	Question	Response
Q023	Do you know that the following materials are used to take care of the menstrual blood? (**Please circle Yes or No for the following)**	
	Newspapers	Yes 1 No 2
	Leaves	Yes 1 No 2
	Old clothes	Yes 1 No 2
	Toilet paper	Yes 1 No 2
	Cotton wool	Yes 1 No 2
	Knickers only	Yes 1 No 2
	Locally made disposable pads made of local materials i.e. *banana fibres*	Yes 1 No 2
	Locally made re-usable pads	Yes 1 No 2
	Disposable manufactured pads i.e. *Always*	Yes 1 No 2
	Manufactured tampons	Yes 1 No 2
	New clothes i.e. face towels, hankies, socks	Yes 1 No 2
	Other, specify _____	Yes 1 No 2
Q024	Have you **ever** used the following materials during your periods? **(Please circle Yes or No for the following)**	
	Newspapers	Yes 1 No 2
	Leaves	Yes 1 No 2

	Old clothes	Yes 1 No 2
	Toilet paper	Yes 1 No 2
	Cotton wool	Yes 1 No 2
	Knickers only	Yes 1 No 2
	Locally made disposable pads made of local materials i.e. *banana fibres*	Yes 1 No 2
	Locally made re-usable pads	Yes 1 No 2
	Disposable manufactured pads i.e. *Always*	Yes 1 No 2
	Manufactured tampons	Yes 1 No 2
	New clothes i.e. face towels, hankies, socks	Yes 1 No 2
	Other, specify _____	Yes 1 No 2

Q025	What did you use **during your last menstruation period**? **Please circle Yes or No for the following:**	
l)	Newspapers	Yes 1 No 2
	Leaves	Yes 1 No 2
	Old clothes	Yes 1 No 2
	Toilet paper	Yes 1 No 2
	Cotton wool	Yes 1 No 2
	Knickers only	Yes 1 No 2

	Locally made disposable pads made of local materials i.e. *banana fibre's*	Yes 1 No 2
	Locally made re-usable pads	Yes 1 No 2
	Disposable manufactured pads i.e. *Always*	Yes 1 No 2
	Manufactured tampons	Yes 1 No 2
	New clothes i.e. face towels, hankies, socks	Yes 1 No 2
	Other, specify _____	Yes 1 No 2
Q026	If you currently use disposable manufactured pads (e.g. Always), would you be interested in trying a sanitary pad made locally in Nigeria?	Yes 1 No 2 Not applicable (don't use pads) 3
Q027	Why would you be interested in trying a sanitary pad made locally in Nigeria?	It is cheaper 1 If it is disposable 2 If it is re-usable 3 Other, specify: 9 _____

Screen	**Question**	**Response**
Q028	Where would you most likely buy disposable pads i.e. *Always* or locally made? **Please circle Yes or No for the following:**	
	Local Pharmacy	Yes1 No 2
	Local shop	Yes1 No 2
	Market	Yes1 No 2
	School	Yes1 No 2
	NGO	Yes1 No 2
	Hospital or clinic	Yes1 No 2

	Other Specify: _____	Yes 1 No 2
Q029	How much blood do you lose on the day of the heaviest blood flow of your period?	Very much 1 Average 2 Little 3
Q030	During your last period, how many times did you change your menstrual absorbent in 24 hours (1 day and 1 night) on the day of heaviest flow?	|___|___|
Q031	In the past 3 months, have you bought any sanitary pads, or had them bought for you?	Yes 1 No 2
Q032	Have you ever had a menstrual blood accident, when blood leaked through your clothes?	Yes 1 No 2 Don't know 3
Q033	While at school (from when class starts to when it ends), where do you change your menstrual absorbents?	**Select Yes/Agree or No/Disagree for each below**
	I don't attend school when I have my menstrual period?	Agree 1 Disagree 2 Don't know 3
	Inside the latrine booth	Agree 1 Disagree 2 Don't know 3
	At the back of the classroom	Agree 1 Disagree 2 Don't know 3

	(D) Go back home (during break) and change	Agree 1 Disagree 2 Don't know 3
	(E) Outside behind a bush	Agree 1 Disagree 2 Don't know 3
	(F) Another private room in the school	Agree 1 Disagree 2 Don't know 3

	(G) Another way, please specify _____	Agree 1 Disagree 2 Don't know 3
Q034	What do you do with your used menstrual absorbents when you are **at school**?	**Select Yes/Agree or No/Disagree for each below**
	Throw into a pit latrine	Agree1 Disagree 2 Don't know 3
	Throw into a dustbin	Agree1 Disagree 2 Don't know 3
	Throw into a bin that will be taken to incinerators	Agree1 Disagree 2 Don't know 3
	Take it home or to dormitory	Agree1 Disagree 2 Don't know 3
	I don't change my menstrual absorbent at school	Agree1 Disagree 2 Don't know 3
	Another way, please specify _____	Agree1 Disagree 2 Don't know 3
Q035	What do you do with your used menstrual absorbents when you are **at home**?	**Select Yes/Agree or No/Disagree for each below**
	Throw into a pit latrine	Agree 1 Disagree 2 Don't know 3
	Throw into a dustbin	Agree 1 Disagree 2 Don't know 3

	Throw into a bin that will be taken to incinerators	Agree 1 Disagree 2 Don't know 3
	Another way, please specify _____	Agree 1 Disagree 2 Don't know 3

Screen	Question	Response
The next questions are for students who have been assisted by teachers/nurses during menstruation		
Q036	Have teachers ever provided any help during your menstruation?	Never asked a teacher for help 1 Provided spare clothes 2 Provided menstrual absorbent 3 Allowed more bathroom breaks 4 Provided remedial classes/tests 5 Other, specify: _____ 6
Q037	How often is water available in your school for you to use while you are menstruating?	Always 1 Most of the time 2 Sometimes 3 Never 4
Q038	How often is soap available in your school for you to use while you are menstruating?	Always 1 Most of the time 2 Sometimes 3 Never 4
These questions are for students who have ever used washable goods (i.e. Clothes, Reusable sanitary pads, or knickers only		
Q039	Do you use reusable/washable menstrual absorbents?	Yes 1 No 2
Q040	How do you wash your reusable menstrual absorbents when you are **at home**?	Water alone 1 Water and soap, I don't wash it 2 3

Q041	How do you wash your reusable menstrual absorbents when you are **at school**?	Water alone Water and soap, I don't wash it	1 2 3

Screen	Question	Response	
Q042	Where do you dry your menstrual absorbents?	**Select 'Yes' or 'No' for each option below**	
	Outside on a drying line	Yes No	1 2
	Inside the bathroom/shelter	Yes	1
		No	2
	Inside the house/under the bed	Yes No	1 2
	Inside the dormitory room	Yes No	1 2
	Others, specify _____	Yes No	1 2
Q043	Do you share the washable menstrual absorbents with other people i.e. sister, mother, friends, relatives?	Yes, always Yes, sometimes Never	1 2 3

These next questions are for students who have ever used disposable menstrual absorbents (i.e. Always, tampons, cotton wool)

Screen	Question	Response	
Q044	Who buys the disposable menstrual absorbents that you use? (**please circle all that apply**)	**Select 'Yes' or 'No' for each option below**	
	Yourself	Yes No	1 2
	Father	Yes No	1 2
	Mother	Yes No	1 2

	Boyfriend	Yes 1 No 2
	Sister	Yes 1 No 2
	Aunt	Yes 1 No 2
	Other, please specify _____	Yes 1 No 2
Q045	What was the cost per packet of the menstrual absorbents you used last month? (***Don't know=8888***)	Naira |__|__|__|__|__|__|

Q046	How often can you afford to use disposable menstrual absorbents?	Every period for all the days of menstruation Every period but only for the heaviest days At least 3 times a year but not every period Once or twice a year Never	1 2 3 4 5
Q047	Why do you choose disposal menstrual absorbents? (Please circle all that apply)	**Select 'Yes' or 'No' for each option below.**	
	Less worry about leaks	Yes 1 No 2	
	More comfortable	Yes 1 No 2	
	Disposal is easier	Yes 1 No 2	
	No need to wash and dry	Yes 1 No 2	

	Cloths ae viewed as traditional and for people of low income	Yes 1 No 2
	Others, specify: _____	Yes 1 No 2

PERCEPTIONS ABOUT MENSTRUATION PERIODS		
Screen	**Question**	**Response**
Q048	How much do agree/disagree with the following statements? **(Please circle the best option)**	
	Period days are like any other day (I do not feel any difference)	Strongly disagree 1 Somewhat disagree 2 Neither agree nor disagree 3 Somewhat agree 4 Strongly agree 5
	I prefer staying at home during my period rather than going to school	Strongly disagree 1 Somewhat disagree 2 Neither agree nor disagree 3 Somewhat agree 4 Strongly agree 5
	During my period I feel less self-confident than during other days	Strongly disagree 1 2 Somewhat disagree 3 Neither agree nor disagree 4 Somewhat agree 5 Strongly agree
	During my period I avoid physical activity (e.g. walking, running)	Strongly disagree 1 2 Somewhat disagree Neither agree nor disagree 3 Somewhat agree 4 Strongly agree 5

	I feel anxious about having my next menstrual period	Strongly disagree 1 2 Somewhat disagree 3 Neither agree nor disagree 4 Somewhat agree 5 Strongly agree
	I wish I would know more information about my menstrual period	Strongly disagree 1 2 Somewhat disagree 3 Neither agree nor disagree 4 Somewhat agree 5 Strongly agree
	Boys tease me about my menstrual period	Strongly disagree 1 2 Somewhat disagree 3 Neither agree nor disagree 4 Somewhat agree 5 Strongly agree
Q049	How important are the following for you in a menstrual absorbent? **(Please circle the best option)**	
	Washable sanitary absorbents	Not important 1 Of little importance 2 3 Moderately important 4 Important 5 Very important
	Disposable sanitary absorbents (e.g. Always, LadyCare)	Not important 1 Of little importance 2 3 Moderately important 4 Important 5 Very important

	Environmentally Friendly sanitary pads	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5

	Sanitary absorbents made from local products	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5
	Leak Free sanitary absorbents	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5
	Comfortable sanitary absorbents	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5
	Discrete sanitary absorbents	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5
	Low cost sanitary absorbents	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5
	Sanitary absorbents which are sold at convenient locations	Not important 1 Of little importance 2 Moderately important 3 Important 4 Very important 5

MENSTRUATION KNOWLEDGE		
Screen	**Question**	**Response**

Q050	**Answer True or False to the following statements to the best of your current knowledge.**	
	Adolescence is the time between puberty and adulthood.	True 1 False 2
	Changes in the body happen during puberty because of hormones.	True 1 False 2
	Menstrual blood comes from the stomach where food is digested.	True 1 False 2
	Women stop menstruating around the age of 45-50 years old.	True 1 False 2
	Menstruation in girls and women is normal.	True 1 False 2
	Pregnant women menstruate.	True 1 False 2
	During her period, a girl can get pregnant.	True 1 False 2
	When a girl first gets her period, her body is ready to have a baby.	True 1 False 2
	Painkillers can be used to manage period pains.	True 1 False 2
	When a girl has her period, she is unclean.	True 1 False 2
	It is important to hide used sanitary products because of money rituals.	True 1 False 2
	Period blood comes from the uterus in response to hormones.	True 1 False 2
	Periods happen on a cycle every 28 days approximately.	True 1 False 2

SECTION E: MENSTRUATION AND SCHOOL ATTENDANCE

Screen	Question	Response
Q051	Have you ever missed school in the past 3 months because of menstruation periods?	Yes 1 No 2

These next questions are for the students who missed school because of menstruation periods			
Q052	If yes, how many days of school have you missed in the last menstrual period?		|__|__| days
Q053	Which of the following challenges have you faced during your menstruation/period?		**Select 'Yes' or 'No' for each option below**
	a) Stomach or back pain:		Yes 1 No 2
	b) Feeling generally unwell:		Yes 1 No 2
	c) Fear of leaking blood on clothes		Yes 1 No 2
	d) Unable to afford menstrual absorbents:		Yes 1 No 2
	e) Lack of knickers:		Yes 1 No 2
	f) Embarrassment that others may find out that I am menstruating:		Yes 1 No 2
	g) Lack of access to water at school for washing hands if they are blood-stained:		Yes 1 No 2
	h) Lack of access to water at school for washing menstrual absorbents:		Yes 1 No 2
	i) Not being able to change menstrual absorbents at school:		Yes 1 No 2
	j) School latrines/toilets do not have enough privacy:		Yes 1 No 2
	k) School latrines are not clean:		Yes 1 No 2
	l) School latrines/toilets are congested and difficult to use:		Yes 1 No 2
	m) Household members telling me not to go school during menstruation periods:		Yes 1 No 2
Q054	Of all the reasons mentioned above in Q053, which one is the main reason for missing school?	**Select from list (a) to (m) above**	|__|

Screen	Question	Response
These next questions are for all students including those who have not started having their menstrual periods		
Q055	If you were the head teacher of your school, which, from the following list, would you give priority to, in order to reduce school absenteeism due to menstruation periods, or for girls who miss school to catch up with schoolwork? **(Rank in a table below with 1 having the highest priority and 9 being the least priority, ensuring that no number is repeated.)**	
	Stocking sanitary towels in the school	|___|
	Allow girls to answer questions while seated to avoid embarrassment in case of staining one's dress	|___|
	Ensure plenty of water to allow girls to clean themselves	|___|
	Ensure that the girls' toilets are far from the boys' areas to allow for privacy	|___|
	Ensure that there are disposal bins and incinerators for disposing used sanitary towels	|___|
	Stocking pain killers in the school for reducing menstrual pains and discomfort	|___|
	Ensure that there are remedial classes for the girls who miss class because of menstruation	|___|
	Ensure that girls who are menstruating do not receive corporal punishment	|___|
	Other, specify: _____	

PSYCHOLOGICAL WELL-BEING IN RELATION TO MENSTRUATION (adapted from SDQ-25)

Screen	Question	Response
Q056	**Answer True or False to the following statements.**	
	I worry about my period/menstruation	True 1 False 2
	I get very angry and often lose my temper during my period.	True 1 False 2
	I am often unhappy, depressed, or tearful during my period.	True 1 False 2
	I find it difficult to concentrate during my period.	True 1 False 2
	I do not like it when my period arrives each month.	True 1 False 2

ADDITIONAL COMMENTS

Q057	Add any other comments you might have about this study	
QX01	Time of ending survey:	H H : M M

Thank you! The student initials will be removed from the database after data checking and cleaning so that no identifying information remains on the database.

APPENDIX 2: LIST OF ABBREVIATIONS

BMI	Body Mass Index
C.I.	Confidence Interval
LMIC	Lower- Middle-Income Countries
MHM	Menstrual Hygiene Management
OR	Odds Ratio
SD	Standard Deviation
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund
WHO	World Health Organization

APPENDIX 3: DEFINITIONS

Menstrual Hygiene Management (MHM)

Defined by the WHO as women and adolescent girls using a clean menstrual management material to absorb or collect menstrual blood, that can be changed in privacy as often as necessary for the duration of a menstrual period, using soap and water for washing the body as required, and having access to safe and convenient facilities to dispose used menstrual management materials.

Menstruation/Period

The process in a woman of discharging blood and other materials from the lining of the uterus at intervals of about one month from puberty until menopause, except during pregnancy.

Menarche

The first period.

CURRICULUM VITAE

Madeline M Tomlinson

EDUCATION

University of Louisville, School of Public Health and Information Sciences, Department of Epidemiology and Population Health, Louisville, Kentucky
Ph.D. Epidemiology | December 2022 (expected)
Cumulative GPA: 4.0
Dissertation: "A Mixed Methods Assessment of Menstrual Hygiene Management and School Attendance in Edo State, Nigeria"
Chair: Anne Baber Wallis, MHS, Ph.D., Associate Professor of Epidemiology

MPH Maternal and Child Health and Global Health | 2020
Practicum Experience: An assessment of vaccination hesitancy across southeastern Europe with a research team based in Zagreb, Croatia.
Cumulative GPA: 4.0
Advisor: Anne Baber Wallis, MHS, Ph.D., Associate Professor of Epidemiology

Yale University, College of Arts and Sciences, New Haven, Connecticut
B.A. History of Science, Medicine, and Public Health | 2017
Cumulative GPA: 3.76

AWARDS AND GRANTS

Doctoral Dissertation Completion Award | August 2022
Pre-dissertation research grant (Centre of Reproductive Health Innovation) | May 2021

RELATED EXPERIENCE

Co-Instructor| January 2022 – Present | 20 hours/week
University of Louisville, Department of Epidemiology and Population Health
Dr. Anne Baber Wallis
Co-instructor experience description: Designed and compiled lectures, exams, and other class material, managed class logistics, and taught classes and lectures using many formats of discussion, lecture, and activities. Classes include *Introduction to Global Health* (50-100 undergraduate student lecture) and *Maternal and Child Health* seminar (10-20 graduate student seminar).

Co-Instructor| January 2021 - June 2021| 10 hours/week
University of Babes-Boylai, Romania with Dr. Anne Baber Wallis
Co-instructor description: Led and assisted class design, management, and teaching for graduate school *Introduction to Global Health* graduate class.

Graduate Teaching/Research Assistant| August 2017 – January 2022| 20 hours/week
University of Louisville, Department of Epidemiology and Population Health
Dr. Anne Baber Wallis, Dr. Natalie DuPre, Dr. Kira Taylor

GTA experience description: Led and assisted class design, management, and teaching for undergraduate and graduate school classes. Classes include *Introduction to Global Health* (100 student lecture), *Perinatal and Reproductive Epidemiology* seminar, *Maternal and Child Health* seminar (10-20 student seminar), *Epidemiology for Public Health* (50 student lecture), *Epidemiology Methods I and II* (20 student lecture).
GRA experience: Compiled public facing data reports of Head Start and Healthy Start programs in Iowa, designed website pages for University of Louisville School of Public Health Office of Diversity, edited manuscripts, conducted data analysis, compiled literature reviews.

Graduate Research Volunteer | June 2021 – August 2021 | 40 hours/week
The Centre of Excellence in Reproductive Health Innovation (CERHI), Women's Health Action Research Centre (WHARC), University of Benin, Benin City, Edo State, Nigeria
Professor Friday Okonofua
CERHI description: The Centre of Excellence in Reproductive Health Innovation (CERHI) at the University of Benin was established in 2014 under the African Centers of Excellence (ACE) Project 1, with funding from the World Bank. The project was designed to build capacity within the west and Central African regions to address the challenges related to inadequate policies and programming on population and reproductive health in the regions. Assisting in grant writing, research proposals, data collection, and manuscript editing and presentations. Currently assisting with a paper about
WHARC Description: A non-profit organization that consists of a multi-disciplinary team of health, social science and legal professionals and researchers working together to build the knowledge base and to improve the policy environment for advancing women's health in Africa. Leading a new, innovative research project assessing menstrual hygiene management among adolescents attending school in rural parts of Edo State, including training data collectors, building rapport with schools, leading in-depth interviews and community assessments, and planning for phase two quantitative data collection.

Graduate Research Volunteer | August 2020 – Present | 5 hours/week
University of Louisville, American Heart Association VAPERACE Center
University of Louisville Department of Communication, Epidemiology, School of Medicine
Drs. Joy Hart and Kandi Walker
Grant: Hamburg, N., Wu, J., Blaha, M. (PIs), et al. Rapidly Advancing Discovery to Arrest the Outbreak of Youth Vaping (VAPERACE). (Hart and Walker, PIs, Community Engagement and Research Translation Core; Hart and Walker, Co-Is, Project 3—Cessation of Nicotine Vaping in Youth). American Heart Association; $6,650,000 for 2020-2022.
VAPERACE Description: A research center aiming to better understand the youth perspective on anti-vaping campaigns with a long-term goal of implementing anti-vaping initiatives led by the Youth Advisory Council (YAC). Participated in YAC engagement and research translation of the vaping epidemic among youth. Led discussions with the YAC and translated the youth perspective to leading researchers. Assisted the YAC in

building anti-vaping campaigns targeted towards youth. Managed and created content for all VAPERACE social media accounts.

Graduate Research Volunteer | August 2020 – Present | 5 hours/week
University of Louisville School of Public Health and Information Sciences, School of Medicine, School of Urban and Public Affairs
Drs. Natalie DuPre, Tyler C. Ellis, and Matthew Ruther
Grant: Ellis, C. T., DuPre N., Ruther M. (PIs), Identifying Geographic Clusters and Environmental Correlates of Colorectal Cancer (CRC) in Kentucky. University of Louisville Center for Integrated Health Sciences CIEHS P30 Interdisciplinary Award (P30 ES030283); $50,000 for 2020-2021.
CRC Project Description: A preliminary research study examining the role of environmental exposures correlated with colorectal cancer incidence in Kentucky, particularly for early-onset CRC for which risk factors are unclear. Participated in the data management, literature reviews, study design, and data analysis to assess relationships between heavy metal exposure, NDVI (greenness) exposure, and proximity to superfund sites and the risk of CRC incidence. Utilized geospatial techniques and ecological- and individual-level modelling with multiple data sources to determine associations between these exposures and CRC incidence.

Graduate Research Volunteer | August 2020 – Present | 2 hours/week
University of Louisville Department of Epidemiology, School of Medicine
Drs Kira Taylor and Aruni Bhatnagar
Tear Gas and Health Effects Description: The study objective is to determine whether tear gas exposure, estimated by the number of protests attended in the 2020-21 period and number of acute exposure symptoms, is associated with the cardiovascular, respiratory, and reproductive health effects. Participated in IRB protocols, preparation of data collection materials using RedCap, participant recruitment through various methods, data analysis and synthesis of reports.

Graduate Research Volunteer | January 2019 – Present |5 hours/week
University of Louisville, Envirome Institute Green Heart Louisville
University of Louisville Department of Communication, Epidemiology, School of Medicine
Drs. Joy Hart and Kandi Walker
Grant: Bhatnagar, A. (PI), Keith, R. (Co-I), DeFilippis, A. (Co-I), O'Toole, T. (Co-I), Hart, J. L. (Co-I), Walker, K. L. (Co-I), et al. Green Heart Louisville (Urban Greenness and Cardiovascular Health). National Institute of Environmental Health Sciences; $2,614,648 for 2018-2023.
Green Heart Louisville Description: An environmental community health study examining the relationships between community greenness, air quality and other environmental factors, and many facets of human health. Participated in all phases of community engagement, collaborated with project partners and research team leads, facilitated relationships with community members and organizations, built ongoing relationships for multiyear project, led community meetings and presentations recruited and retained study participants through several novel methods.

PUBLICATIONS

1. Wood, L. A., Agbonlahor, O., **Tomlinson, M. M.,** Kerstiens, S., Vincent, K., McLeish, A. C., Walker, K. L., & Hart, Joy L. (2021, November). *Readability of Online E-Cigarette Cessation Information.* Paper published in Tobacco Induced Diseases.
2. Wood, L. A., **Tomlinson, M. M.,** Pfeiffer, J. A., Walker, K. L., Keith, R. J., Smith, T. R., Yeager, R. A., Bhatnagar, A., Kerstiens, S., Gilkey, D., Gao, H., Srivastava, S., & Hart, J. L. (2021, March). *Time spent outdoors and sleep normality: A preliminary investigation.* Paper published in Population Medicine.
3. Pfeiffer, J. A., Hart, J. L., Wood, L. A., Bhatnagar, A., Keith, R. J., Yeager, R. A., Smith, T., **Tomlinson, M. M.**, Kerstiens, S., Gilkey, D., Gao, H., Srivastava, S., & Walker, K. L. (2021, July). *The importance of urban planning: Views of greenness and open space is reversely associated with self-reported views and depressive symptoms.* Paper published in Population Medicine.

MANUSCRIPTS IN SUBMISSION

1. Agbonlahor, O., Vincent, K., Wood, L. A., Tomlinson, M. M., Kerstiens, S., Clark, J., Alison C. McLeish, A. C., Walker, K. L., & Hart, J. L. (2022, May). *Readability of online information on nature and mental health*. Manuscript submitted for publication.

MANUSCRIPTS IN PREPARATION

1. **Tomlinson M. M.,** Pugh F, Newton J, Tamimi RM, Laden F, Iyer H, Ruther M, Ellis T, DuPre N. *Environmental Heavy Metal Exposure and Odds of Residing in a Breast or Colorectal Cancer Hotspot in Kentucky*.
2. **Tomlinson, M. M.,** Wallis A. B., Harris, M. J., DuPré, N. C., Baumgartner, R., Okonofua, F. A. Menstrual Hygiene Management in West Africa: A Systematic Literature Review from 2010-2022.
3. **Tomlinson, M. M**., Wallis A. B., Harris, M. J., DuPré, N. C., Baumgartner, R., Okonofua, F.. Knowledge attitudes, and practices of menstrual hygiene management among adolescent schoolgirls in peri-urban areas in Edo State, Nigeria.
4. **Tomlinson, M. M.,** Wallis A. B., Harris, M. J., DuPré, N. C., Baumgartner, R., Okonofua, F.. Menstrual Hygiene Management and School Attendance among adolescent schoolgirls in peri-urban areas in Edo State, Nigeria

PRESENTATIONS

Walker, K. L., Hart, J. L., McLeish, A. C., DeJarnett, N., Shuck, B., Agbonlahor, O., **Tomlinson, M. M.,** Vincent, K., Wood, L. A., Kerstiens, S., Clarke, J. E., Garfinkle Plymesser, E., & Keith, R. J. (2022, September). The race to embrace: Engaging youth, employees, and community members. Paper to be presented at the annual meeting of the Kentucky Communication Association, Louisville, Kentucky.

Hart, J. L., Walker, K. L., McLeish, A. C., Vincent, K., Wood, L. A., Kerstiens, S., **Tomlinson, M. M.,** Clarke, J. E., Garfinkle Plymesser, E., Agbonlahor, O., &

Hamburg, N. M. (2022, September). Citizen science and youth vaping. Paper to be presented at the annual meeting of the Kentucky Communication Association, Louisville, Kentucky.

Tomlinson, M. M., Wallis, B. A., Maduako, K. T., Okonofua, F. A. (2022, March). *Menstrual Hygiene Management Among Adolescent Schoolgirl's in Rural Edo State.* Poster presented at the Consortium of Universities for Global Health, virtual due to pandemic.

Walker, K. L., McLeish, A. C., Wood, L. A., Agbonlahor, O., **Tomlinson, M. M.,** Vincent, K. A., Kerstiens, S., Hart, J. L. (2021, November). *An end to ENDS: Youth-led initiatives.* Poster presented at the 28th annual meeting of the Society for Research on Nicotine and Tobacco, Baltimore, MD.

Wood, L. A., Agbonlahor, O., **Tomlinson, M. M.,** Kerstiens, S., Vincent, K., McLeish, A. C., Walker, K. L., & Hart, Joy L. (2021, November). *Readability of vaping information on the web*. Poster presented at the 28th annual meeting of the Society for Research on Nicotine and Tobacco, Baltimore, MD.

Wood, L. A., Agbonlahor, O., **Tomlinson, M. M.,** Kerstiens, S., McLeish, A. C., Walker, K. L., & Hart, J. L. (2021, October). *Readability of online vaping information: Assessing messages to teens and parents.* Paper presented at the annual meeting of the NIH Tobacco Regulatory Science Conference, Bethesda, Maryland. Electronic conference due to COVID-19 pandemic.

Walker, K. L., Wood, L. A., Vincent, K., **Tomlinson, M. M.,** Werner, A., Kerstiens, S., Agbonlahor, O., & Hart, J. L. (2021, September). *Communication and Community Engagement: Green Heart Louisville's Youth Art and Literature Showcase (presentation of the 2020-2021 K-12 student work).* Paper presented at annual meeting of the Kentucky Communication Association, Highland Heights, KY.

Vincent, K., Werner, A., Agbonlahor, O., Wood, L. A., **Tomlinson, M. M.,** Kerstiens, S., Kramer, A., McLeish, A. C., Walker, K. L., & Hart, J. L. (2021, September). *Youth Vaping: Seeing through the Clouds.* Paper presented at annual meeting of the Kentucky Communication Association, Highland Heights, KY.

Reece E, Unseld M, **Tomlinson M. M.,** Kakar A, Wallis A, Corbitt C, Smith T, Bhatnagar A, Taylor K. C. *Tear Gas Exposure During the 2020 and 2021 Protests and Female Reproductive Health.* (2021, August). Poster presented at Research Louisville! University of Louisville, Louisville, KY.

Tomlinson M. M., Pugh F, Newton J, Tamimi RM, Laden F, Iyer H, Ruther M, Ellis T, DuPre N. *Environmental Cadmium Exposure and Odds of Residing in a Breast Cancer Hotspot in Kentucky*. August 2021. Poster presented at the International Society for Environmental Epidemiology (ISEE). Virtual due to COVID-19 pandemic.

Newton J, Pugh F, **Tomlinson M. M.,** Ruther M, DuPre N, Ellis T. *Greenness Exposure in Relation to Residing in Areas of High Colorectal Cancer in Kentucky*. August 2021. Poster presented at the International Society for Environmental Epidemiology (ISEE). Virtual due to COVID-19 pandemic.

Newton J, Pugh F, **Tomlinson M. M**., Ruther M, Ellis T, DuPre NC. *Socioeconomic Patterns and Environmental Greenness in Relation to Census Tract-Level Colorectal Cancer Rates in Kentucky*. Poster presented at the Society for Epidemiologic Research (SER) Annual Conference. June 2021. Virtual.

Wood, L. A., Gilkey, D., **Tomlinson, M. M.,** Pfeiffer, J., & Hart, J. L. (2021, April). *The color of hope: Evergreen (and deciduous).* Paper presented at the annual meeting of the Southern States Communication Association. Electronic conference due to COVID-19 pandemic.

Walker, K. L., McLeish, A. C., Agbonlahor, O., **Tomlinson, M. M.,** (2021, April). *Youth engagement to stop vaping: Hope in action.* Paper presented at the annual meeting of the Southern States Communication Association, virtual due to pandemic.

Newton J, **Tomlinson M. M.,** Pugh F, Ruther M, DuPre NC, Ellis T. *Greenness and Colorectal Cancer Case Rates in Kentucky from 2006-2014*. University of Louisville Graduate Student Regional Research Conference. March 11-12, 2021. Virtual due to COVID-19 pandemic.

Wood, L. A., **Tomlinson, M. M.,** Gilkey, D., Pfeiffer, J. A., Kerstiens, S. Hart, J. L. Walker, K. L., & Bhatnagar, A. (2020, December). *Pandemic Possibilities: The Heart of the Matter.* Paper presented at the Superfund Research Program annual meeting, College Station, Texas. Electronic conference due to COVID-19 pandemic.

Hart, J. L., Walker, K. L., Wood, L. A., Kerstiens, S., Gilkey, D., **Tomlinson, M. M.** & Pfeiffer, J. (2020, September). *Communication and Community Engagement: Green Heart Louisville's Youth Art and Literature Showcase.* Paper presented at the annual meeting of the Kentucky Communication Association. Conference cancelled due to COVID-19 pandemic.

VOLUNTEER EFFORTS

Volunteered during Green Heart Louisville's tree planting drive conducted by General Electric (GE) to help plant over 1000 trees in Louisville. November 2021.

Volunteered to review manuscript submissions for the African Journal of Reproductive Health in Benin City, Nigeria. June-August 2021.

RESEARCH SKILLS

- Quantitative data collection through survey design and dissemination: Microsoft Office, RedCAP
- Quantitative data analysis and modelling: R, SAS, SPSS, Microsoft Excel
- Qualitative interviewing and focus group leading
- Qualitative data analysis: thematic selection, AtlasTi
- Application of scientific theory to quantitative and qualitative data
- Written communication skills for professional writing, manuscript preparation, conference presentations