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Unmet menstrual needs and psychosocial well-being among schoolgirls in Northern Tanzania: baseline results from the PASS MHW study

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Abstract

Introduction Improving menstrual health among schoolgirls is essential to meeting the Sustainable Development Goals (SDGs) of good health and wellbeing (SDG 03), quality education (SDG 04), and gender equality (SDG 05). School participation and wellbeing among girls in low and middle-income countries are impacted by inadequate access to quality menstrual materials and WASH facilities, taboos around menstruation, and poor knowledge. Comprehensive evidence is needed to address these challenges and guide policy and practice.

Methods An assisted self-completed questionnaire was used to collect socio-demographic information, menstrual-related data, and school climate data from 486 girls in four mixed-gender government secondary schools in Mwanza, Tanzania. The mean (SD) of three Menstrual Practices and Needs Scale (MPNS-36) sub-scores were calculated. Specifically, the extent to which girls perceived needs for carrying and changing menstrual material in school (transport and school environment); washing and drying menstrual material (reuse needs); and privacy and drying menstrual material in school (reuse insecurity) were met. An ANOVA test compared MPNS scores for groups, and logistic regression examined the association between menstrual health and wellbeing outcomes (self-efficacy, menstrual anxiety, school attendance, and participation) and MPNS subscale scores.

Results The mean age of the 486 participants was 15.6 years (SD 1.3); 87% had started menstruating; the mean age at menarche was 14.2 years (SD 1.15). The majority (75%) of girls experienced pain during the last menstrual period, 39% had menstrual-related anxiety, and 16% missed at least one day of school due to menstruation. The mean MPNS subscale score (out of 3) for the reuse needs ranged from 1.0 to 2.1 across schools; 1.6 to 2.1 for reuse insecurity; and 0.9 to 1.8 for transport and school environment needs. The MPNS subscales had sufficient reliability (Cronbach alpha = 0.74 to 0.9). The subscales also had good construct validity with menstrual-related self-efficacy: higher scores for transport and school environment were associated with confidence to seek menstrual support, participate in class, and predict when periods were about to start.

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Conclusions Schoolgirls have unmet needs related to transporting and using menstrual material in school, and these needs differed across schools in northern Tanzania. Menstrual-related pain remains a major reason for poor school attendance and participation. Interventions to address menstrual practice needs in schools are required and should include a strong pain management component.

Keywords Menstrual health, Menstrual anxiety, Menstrual pain, Schoolgirls, Tanzania

Introduction

Menstrual health (MH), defined as a state of complete physical, mental, and social well-being in relation to the menstrual cycle [1], remains a critical public health issue for adolescent girls in school settings in low- and middle-income countries [2–10]. Research conducted in these settings highlights the multifaceted nature of the problem, including, lack of access to safe, clean, reliable menstrual products, menstrual pain, and a lack of the necessary WASH facility infrastructure [1, 11–15]. Inadequate water, sanitation, and hygiene facilities in schools and poor access to menstrual products force girls to use unhygienic products, which increases the risk of urogenital symptoms and infections [16–21].

Beyond the practical challenges, menstruation is often viewed as a taboo or shameful topic, which restricts open dialogue. This, coupled with inadequate or inaccurate information about menstruation and limited support, leaves girls unprepared for and unable to effectively manage their menstruation [3, 4, 22–26]. Lack of menstruation knowledge, stigma, and taboos drive bullying and teasing of menstruating girls [25, 27] and are associated with fear, shame, low self-efficacy, menstrual-related anxiety, and poor school and social participation [28–31]. Improving MH is essential to meeting the Sustainable Development Goals (SDGs) of good health and wellbeing (SDG 03), quality education (SDG 04), and gender equality (SDG 05) [32].

In response to these challenges, various efforts have emerged to address menstrual health challenges in school settings within low- and middle-income countries. These interventions have focused on improving access to menstrual hygiene products, providing education and awareness-raising about menstruation, and ensuring the availability of safe, clean, and private water, sanitation, and disposal facilities, as well as reducing menstrual-related shame, embarrassment, and taboos to improve school attendance and participation [27, 33–36]. Studies in Eastern and Southern Africa have shown the potential of multi-component school-based menstrual health interventions to improve MH and the associated mental health and educational outcomes among girls in schools in LMICs [21, 37–40].

In Tanzania, there have been increased efforts, such as an active MH Coalition and the development of school WASH guidelines, however, efforts to improve adolescent girls' MH are disjointed, and rigorous evidence remains sparse [41–43]. A few studies conducted in Tanzania, including the recent large-scale national school menstrual health and hygiene assessment, highlighted poor WASH infrastructure, low MH knowledge, high levels of pain, limited access to emergency pads and painkillers in school, and stigma related to the social construction of menstruation as "dirty and shameful" and a "woman's thing" [15, 44]. In terms of types of menstrual products used by students, the study revealed that on average, about half of the girls (52%) reported regular use of commercial disposable sanitary pads, while 45.2% reported regular use of pieces of cloth. However, the prevalence varied significantly between private and government-owned schools with 81% of girls in private schools reporting the regular use of commercial disposable pads compared to only 48% of girls in government-owned schools [44].

This paper aims to extend the limited contextual evidence by describing key individual-level menstrual factors (products and practices, pain management, menstrual anxiety, participation) alongside broader, school-level factors (WASH facilities, school climate, and bullying), assessing the reliability and construct validity of MPNS [45] subscale and its association with menstrual self-efficacy. In this study, school climate is defined as the quality of interpersonal relationships between and among students and teachers and how this impacts support for menstruating schoolgirls [46].

Methods

Study setting

The Mwanza region lies in the northern part of Tanzania, on the shores of Lake Victoria. The region's population is approximately 3.7 million. The region has poor reproductive health indicators, including high child marriage prevalence rates, high adolescent fertility rates, and low contraceptive prevalence rates. It is also among the regions with the highest pregnancy-related school dropout rates in the country and one of the lowest secondary school completion rates [47].

Study design and participants

This paper presents baseline data collected as part of a longitudinal mixed methods study known as 'Partnering to Support Schools to Promote Good Menstrual Health and Well-Being (PASS MHW) Project" [48]. The baseline data were collected in January and February 2022 before

the implementation of a pilot menstrual, sexual, and reproductive health (MSRH) intervention that involved four schools drawn from medium-sized, gender-mixed government secondary schools in Misungwi and Nyamagana districts, Mwanza region. To capture maximum variation in experiences, both rural and urban secondary schools were selected. Participants were 486 girls in Forms 2 and 3 (2nd and 3rd years of secondary school), with an age range of 13 to 19 years.

Measures

An assisted, self-completed [49] questionnaire was designed to capture relevant socio-demographic information (age, religion, school location, age of menarche); knowledge of puberty and menstruation; pain and pain management practices; menstrual-related anxiety; and menstrual management self-efficacy (confidence to seek menstrual-related help from peers or teachers, predict periods, and stand up in class during menstruation). Data on self-reported urinary tract infection/reproductive tract infection (UTI/RTI) symptoms, school participation, and perceptions of WASH facilities were also collected. Each of these variables was assessed using a set of questions drawn from standard tools or tools that had been used in similar settings. Further details about the tools have been published in a protocol paper [48]. The school climate was measured using eight items adopted from the Beyond Blue School Climate questionnaire [46], focussing on the quality of interpersonal relationships between and among students, and teachers and additional questions to assess the prevalence of bullying and teasing during menstruation, reasons, and perpetrators of bullying. The questionnaire also assessed girls' menstrual practices and perceptions using the menstrual practices and needs scale (MPNS)-36 [50]. The MPNS scale is a set of 36 self-reported questions assessing perceptions of comfort, satisfaction, adequacy, reliability, worries, and concerns about menstrual products and the menstruation management environment, focussing on the last menstrual period [45]. In the current analysis, we used questions from three subscales with a total of 13 questions relevant to the school context. The subscales were (i) *Transport and school environment needs*, a 5-item subscale to assess if girls' needs for transporting and changing menstrual material at school were met; (ii) *Re-use need*, 5-item assessing if needs for washing and drying menstrual materials were met; and (iii) *Re-use insecurity*, a 3-item subscale to assess if needs for privacy and drying time for menstrual materials were met by the school environment.

Data collection

Data were collected using a paper questionnaire. The questionnaire was pilot-tested and modified based on feedback from 40 girls in May 2021. The questionnaire was assisted and self-completed with supervision by two female social scientists with training in research ethics and extensive experience of working with adolescents. The questionnaire took an average 90 min to complete for each student.

Statistical analysis

The primary sample size calculation was powered to detect an intervention effect in the endline survey and has previously been reported in the protocol paper [48]. For this analysis, the sample of 486 schoolgirls provides adequate precision to report the prevalence of different menstrual practices and needs, including menstrual product use and appropriate pain management, with a precision of 5% around an estimated prevalence of 50%. Descriptive analysis was conducted by calculating frequencies and percentages for categorical data and means and standard deviations for continuous data. The key individual-level menstrual indicators were summarised in frequency tables. The MPNS score for each scale ranged from 0 to 3 and was calculated as the average answer across all the relevant items answered; ANOVA was used to compare scores across groups based on the MPNS user guide recommendation [50]. The construct validity of MPNS was assessed by examining the ability of MPNS sub scales to predict menstrual-related self-efficacy measured through participants' self-report. We hypothesised that higher MPNS subscale scores would predict higher menstrual-related self-efficacy among participants. Menstrual-related self-efficacy was assessed using four different binary outcomes that required the participants to report whether or not they were confident to: (i) ask female friends for menstrual material; (ii) stand up to answer questions in class during menstrual period without worrying that they had stained clothes; (iii) roughly predict when periods are about to start; and (iv) ask for help from a female teacher if the participant was faced with a menstrual-related problem at school. We performed three separate logistic regressions for each menstrual related self-efficacy outcome. The three models were distinguished by the covariate used to predict the outcome, with one of the three MPNS subscales being entered as a continuous covariate to predict the respective self-efficacy outcome. We plotted predicted probabilities for each menstrual-related self-efficacy outcome across levels of MPNS (ranging from 0 to 3).

Ethics statement

All participants provided written informed consent/assent. Head teachers provided overall consent on behalf of adolescents aged below the age of 18 years before they assented. Participants were given the opportunity to ask questions and seek clarification before they were asked to

sign the informed consent/assent and were free to withdraw from the study without justification or consequence at any time. Each respondent was assured of confidentiality and privacy during data collection, management, and analysis. Personal data were anonymised using ID numbers, and stored data were de-identified. The study protocol, tools, and consent/assent forms were reviewed and approved by the independent Tanzanian national ethics committee (Ref: NIMR/HQ/R.8a/Vol.IX/3647) and LSHTM ethics committee (LSHTM Ethics Ref: 22854). Permissions to conduct the study were obtained from the Mwanza Regional Administrative Secretary, the regional and district education offices, and school administrations.

Results

The baseline survey included a total of 486 schoolgirls with a mean age of 15.6 years (SD 1.3). Out of the 486, 261 (54%) were in the second year of study in secondary school (Table 1). The majority (81%) of the participants were Christians, while 19% were Muslims.

A total of 424 out of 486 (87%) girls reported that they had started menstruating. The mean age of participants at menarche was 14.2 years (SD 1.15). At least half (53%) of the girls responded correctly to six or more of the 10 questions that were used to assess knowledge on puberty and menstruation (Table 1).

Table 1 Socio-demographic characteristics, menarche and menstrual knowledge among school girls participating in a school-based menstrual health study in Mwanza

	n **(%)**
School, *n* = 486	
S01	133 (27%)
S02	97 (20%)
S03	78 (16%)
S04	178 (37%)
Location,*n* = 486	
Urban	311 (64%)
Rural	175 (36%)
Mean age of girls (SD),*n* = 485	15.6 (1.3)
Current study year,*n* = 486	
Second year of secondary education (Form two)	261 (54%)
Third year of secondary education (Form three)	223 (46%)
Religion,*n* = 484	
Christian	390 (81%)
Muslim	93 (19%)
Other religion	1 (0.2%)
Started menstruating,*n* = 485	
Yes	424 (87%)
No	55 (11%)
Not sure	6 (1%)
Mean age at menarche in years (SD),*n* = 373	14.2 (1.15)
Participants' knowledge of puberty / menstruation,*n* = 486*	
Poor (Correct response for 5 or fewer questions out of 10)	228 (47%)
Good (Responded correctly to least 6 out of 10 questions)	258 (53%)

*We used ten questions assessing knowledge of puberty and menstruation (5 questions for knowledge of menstruation and 5 questions for puberty)

Individual-level menstrual related indicators

Among the 424 menstruating girls, 243 (57%) reported using more than one type of menstrual material during their last period; 166 (39%) used a single type of material; and 15 (3.5%) reported using no materials (Table 2). The most commonly used menstrual materials were commercially produced disposable pads (59%), fabric (53%), and reusable pads (40%), as shown in Table 2. Twenty-seven (6%) girls reported that blood visibly leaked through their clothes during their last period. More than one-third (34%) did not feel confident enough to stand up in class during menstruation.

A total of 310 out of 411 (75%) menstruating girls reported pain during their last period (Table 2). The median score for menstrual pain based on a scale from 0 (no pain) to 10 (severe pain) was 3 (interquartile range 1 to 7). Most participants (60%) did nothing to manage pain during periods; the rest reported using at least one pain management strategy. Pain management strategies were reported by 218 girls and included relaxing (32%), taking painkillers (27%), and drinking lots of clean water (14%). Sixty-three (16%) out of 388 girls missed at least one day of school during their last period, while 17% girls left school early on at least one day during their last period. Reasons for absence or leaving school early commonly included pain or cramping and feeling unwell or uncomfortable (Table 2). In total, 59% missed two or more social activities as a result of their menstruation.

Of the 424 menstruating girls, 165 (39%) experienced menstrual anxiety in their last menstrual period. The menstrual experience was assessed using three sub-scales in MPNS-36, with each subscale ranging from 0 (negative experience) to 3 (positive experience). The mean scores were 1.4 (SD 1.0) for transport and school environment needs, 1.7 (SD 1.1) for reuse needs, and 1.8 (SD 1.0) for reuse insecurity. There was evidence that MPNS varied across the four schools - the mean MPNS subscale score (out of 3) for the reuse needs ranged from 1.0 to 2.1 across schools; 1.6 to 2.1 for reuse insecurity; and 0.9 to 1.8 for transport and school environment needs (Fig. 1).

School related menstrual indicators

Girls' reports of the school environment varied between schools (Table 3). Nearly all girls (98% or more) in two schools reported the availability of toilets with working locks. However, in the remaining two schools, only 38% and 57% of girls reported toilets with working locks. The proportion of participants reporting that they had access to a clean changing space for menstruation at school

Table 2 Prevalence of key menstrual practices at last menstrual period among 424 school girls aged 13 to 20 years in Mwanza

	***n* (%)**
Menstrual product use during last menstrual period, *n* = 424	
Single type of menstrual product	243 (57%)
Two or more menstrual products	166 (39%)
Did not use menstrual product	15 (3.5%)
Type of menstrual product used by participants during last menstrual period	
Reusable menstrual material	305 (72%)
Fabric/ Clothes (e.g. face towels, handkerchiefs, socks)	226 (53%)
Commercial reusable pads or other reusable pads	170 (40%)
Ruby cup or other menstrual cup	9 (2%)
Disposable pads (commercial and locally-made pads)	263 (62%)
Commercial disposable pads	252 (59%)
Locally-made disposable pads	43 (10%)
Other material/ menstrual products	
Knickers only	44 (11%)
Toilet paper/ newspaper	5 (1%)
Cotton wool	4 (1%)
Tampons	3 (1%)
Blood visibly leaked through clothes	
Yes	27(6%)
No	392(92%)
Can't remember	5(1%)
Menstrual pain,*n* = 411	
Any pain (score of 1 or above out of 10)*	310(75%)
Pain management practices,*n* = 218	
Relaxing	70 (32%)
Painkiller	58 (27%)
Drinking lots of clean water	30 (14%)
Exercising and stretching	21 (10%)
Taking antibiotics	16 (7%)
Eating foods containing lots of water	13 (6%)
MPNS-36 subscales**	
Transport and school environment needs, mean (SD)	1.4 (1.0)
Reuse needs, mean (SD)	1.6 (1.2)
Reuse insecurity, mean (SD)	1.1 (1.0)
Menstrual anxiety†	165 (39%)
Proportion of girls missing at least a day of school during last period because of the period,*n* = 388	63(16%)
Reasons for missing school,*n* = 63	
Pain or cramping	51 (81%)
No menstrual product to use	31 (51%)
Felt unwell or uncomfortable	29 (46%)
Scared of leaking	25 (40%)
Ashamed or embarrassed	17 (27%)
No place to wash or change	16 (25%)
I was not allowed to go to school	5 (8%)
Don't remember	7 (11%)
Proportion leaving early on at least one day of school during periods because of period,*n* = 390	68 (17%)
Reasons for leaving early during periods,*n* = 68	
Reasons for missing school or leaving early	
Pain or cramping	42 (67%)
Felt unwell or uncomfortable	25 (40%)
No menstrual product to use	24 (38%)
Scared of leaking	22 (35%)
Ashamed or embarrassed	16 (25%)

Table 2 (continued)

	***n* (%)**
Not allowed	14 (22%)
No place to wash or change	13 (21%)
Don't remember	8 (13%)
Missed out on 2 or more social activities during the last period because of period	252(59%)
Confident to stand up in class during your period without worrying that you have stained your clothing	
Never/ less than half of the time	261(62%)
More than half the time/ always	157(37%)

* The median score for pain among the 411 girls reporting menstrual related pain was 3 (interquartile range 1–7). ** MPNS-36 scale has 36 items; of these data were collected for 28 items and complete data were available for 3 out of 6 subscales. (The overall MPNS-36 score and score for the scales with incomplete data were not calculated because of the missing items)

†Menstrual related anxiety was assessed using the seven questions from generalised anxiety disorder questionnaire (GAD-7) focusing only on the events during the last period

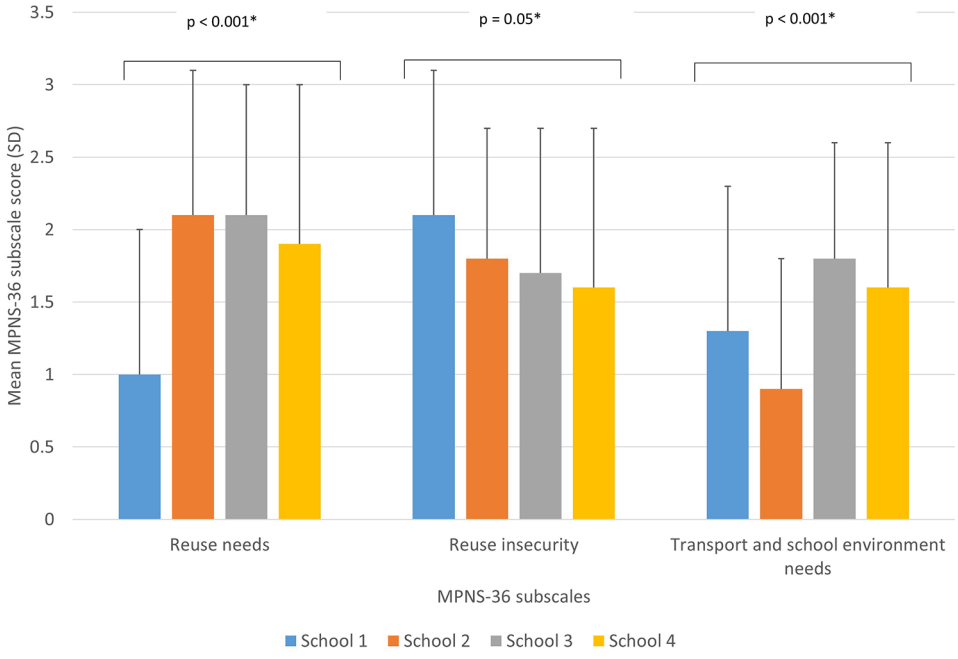

Fig. 1 Mean scores for reuse needs, reuse insecurity, and transport and school environment subscales of MPNS-36 among schoolgirls in Mwanza

varied between 17% and 80% by school. More than 80% of girls reported that water for handwashing was available more than half the time in three schools. Over 90% of girls reported that soap was never available in two schools. The school climate score ranged between 5.6 and 7.1 (Table 3). The schools with poor WASH facilities based on participant reports also had lower mean school environment scores (mean=5.6 and 5.7 in schools one and four) compared to those with better participant-reported WASH facilities (mean=6.9 and 7.1 in schools two and three), Table 3. Teasing related to menstruation was reported by 6–9% of girls, depending on the school. All MPNS sub-scales had means lower than 3 (range 0.9–2.1). There was evidence of differences in MPNS subscale scores across schools (Fig. 1).

Reliability and validity of MPNS subscales

Table 4 summarises the reliability and internal consistency of the three MPNS scales: transport and school environment, reuse needs, and reuse insecurity. The items in each of the three MPNS subscales were sufficiently consistent (Cronbach alpha=0.74 to 0.90), indicating that the MPNS was reliable for measuring menstrual perceptions and needs among participants in the study. The MPNS showed good construct validity based on the hypothesised associations between MPNS scores and menstrual-related self-efficacy (Figs. 2 and 3). High MPNS scores for the transport and school environment needs subscale predicted higher probability for all the four menstrual related self-efficacy outcomes: confidence to ask female friends for menstrual material if in need; confidence to ask for help from female teachers; roughly predicting when periods would start; and standing up in

Table 3 School girls' report of school-level menstruation-related factors during a school-based menstrual health survey in Mwanza

	School			
	S01	**S02**	**S03**	**S04**
WASH facilities				
Availability of water for washing hands at school				
Less than half the time	13 (10%)	62 (64%)	15 (19%)	11 (6%)
At least half the time	120 (90%)	35 (36%)	63 (81%)	167 (94%)
Availability of soap for washing hands at school				
Never	132 (99%)	71 (73%)	38 (49%)	166 (93%)
At least sometimes	1 (1%)	26 (27%)	40 (51%)	12 (7%)
Availability of toilet paper at school				
Never	133 (100%)	91 (94%)	44 (57%)	174 (98%)
Sometimes or more	0 (0)	6 (6%)	33 (43%)	3 (2%)
Any toilets with working locks within the school	74 (57%)	96 (99%)	30 (38%)	174 (98%)
Clean changing space for menstruating girls in the school (*n* = 424) *				
Never	56(50%)	66(80%)	12(17%)	71(46%)
At least sometimes	56(50%)	16(20%)	56(80%)	77(49%)
School climate				
Mean school climate score (SD), range 0 to 8†	5.6 (1.8)	6.9 (1.8)	7.1 (1.4)	5.7 (1.8)
Girls reporting that they had ever been teased at school because of menstruation				
Yes	9 (7%)	7 (7%)	5 (6%)	14 (8%)
No	119 (93%)	88 (93%)	73 (94%)	164 (92%)

*Includes only girls who had started menstruating

†Higher scores represent positive school climate and lower scores negative school climate

class to answer questions during periods without worrying about stained clothing. For reuse needs, high MPNS scores predicted a higher probability of asking for help from female teachers (Fig. 2) and standing up in class to answer questions during periods without worrying about stained clothing (Fig. 3). The reuse insecurity subscale only predicted the probability of participant confidence in asking for help from a female teacher in case of menstrual-related problem at school (Fig. 2).

Discussion

Our findings showed varied menstrual practices among schoolgirls, with a wide range of menstrual materials being used during menstruation. A significant proportion of girls experienced pain, and menstrual-related anxiety and missed at least one day of school due to menstruation during the last menstrual period. Participants reported moderate, positive scores on the reuse needs and reuse insecurity domains but lower for transport and school environment needs. The MPNS subscales had sufficient reliability (Cronbach alpha = 0.74 to 0.9). Equally the subscales had good construct validity with menstrual related self-efficacy: higher scores for transport and school environment were associated with confidence to seek menstrual support, participate in class, and predict when periods are about to start.

High prevalence of, and an absence of prompt and effective care for, menstrual-related pain has been reported previously in LMICs [37, 51], and our study, although conducted years later, documented comparable findings. This suggests minimal progress in addressing this issue, despite its high prevalence. Strategies to ensure optimal pain management during menstruation are urgently needed. That pain was highlighted so commonly as the reason for missing school and participation more broadly makes it important that any school-based MH interventions should have a component to address pain management [52].

Overall, the MPNS-36 tool had good validity and reliability in our study. The Cronbach alpha for all the three MPNS-36 subscales used was greater than 0.7, reflecting good internal reliability for items within each subscale. The reliability in our study was similar to that reported in the study that reported the development and validation of MPNS-36 [45]. We also confirmed the hypothesised associations between menstrual self-efficacy and MPNS-36. Using this approach, we determined that MPNS-36 had acceptable construct validity with MPNS scores for transport and school environment needs predicting all the four menstrual self-efficacy items we assessed. This finding confirms the construct validity reported in

Table 4 MPNS-36 subscales scores, reliability, internal consistency and correlation between subscales based on responses from school girls in Mwanza

	Mean (SD)	**Skew, Kurtosis**	**Cronbach alpha**	**Correlation between subscales (Pearson's rho)**		
				1	**2**	**3**
1.Transport and school environment needs (*n* = 423)	1.41(0.99)	-0.33, 1.58	0.77	1.00		
2. Reuse needs (*n* = 239)	1.70(1.14)	-0.33, 1.58	0.90	0.63	1.00	
3. Reuse insecurity (*n* = 238)	1.84(1.02)	-0.45, 1.97	0.74	0.16	-0.07	1.00

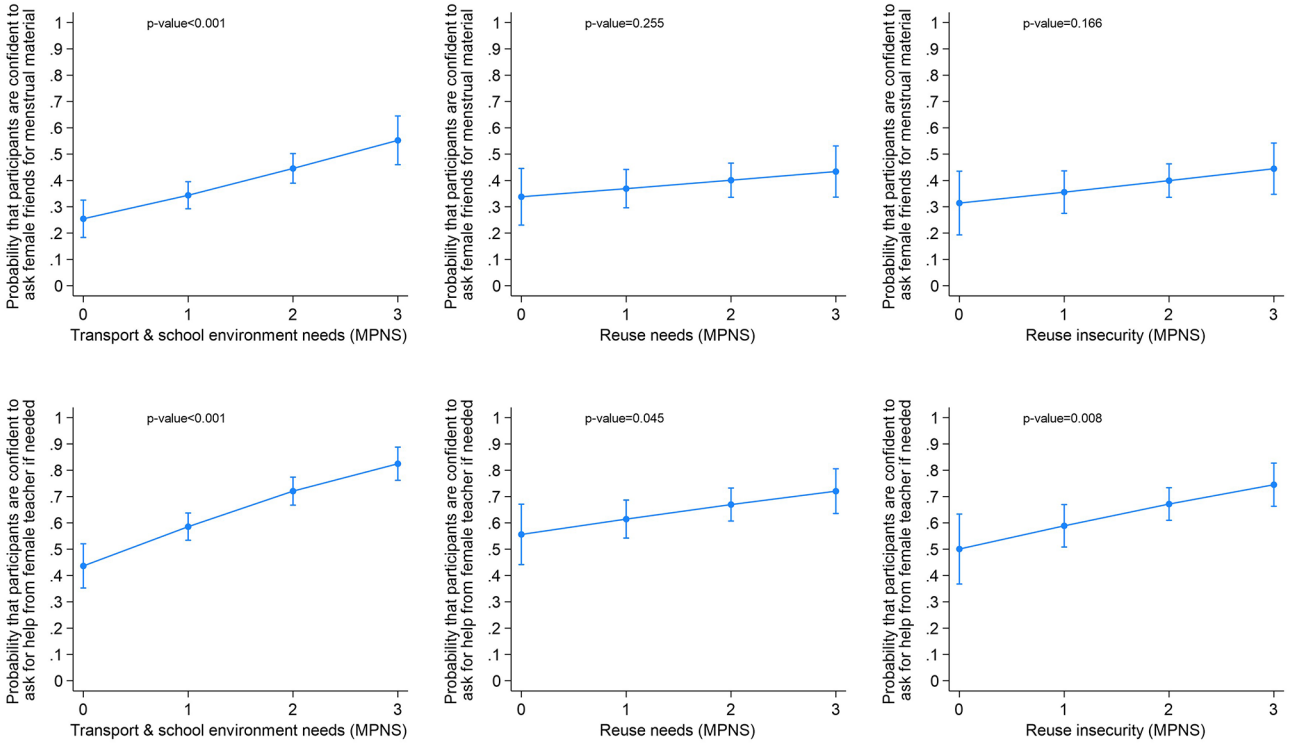

Fig. 2 MPNS-36 Subscales and confidence of schoolgirls to ask for menstrual-related assistance from teachers and female friends

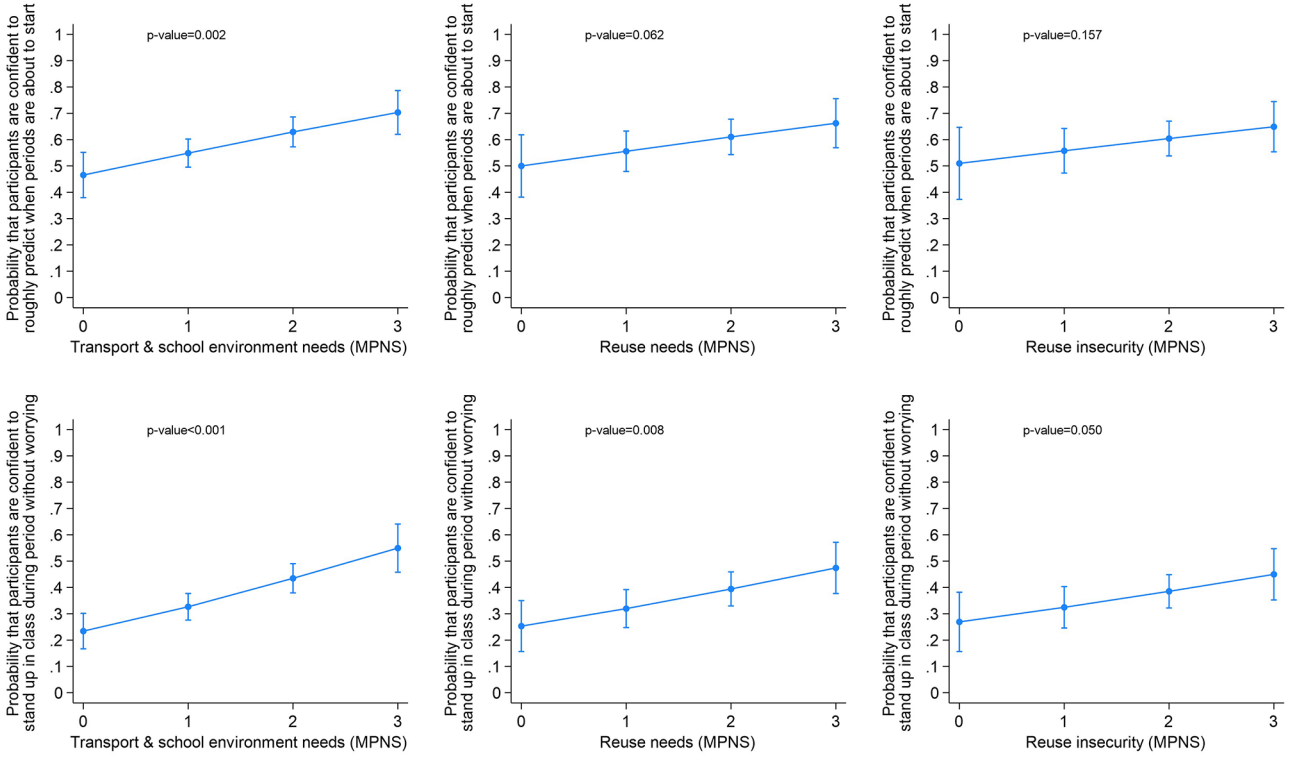

Fig. 3 MPNS-36 Subscales and confidence to predict next menstrual period or stand up in class during period without worrying

previous studies [45]. Separately, the menstrual experience of schoolgirls measured using domains of the MPNS-36 is comparable to those reported during tool development and validation in Uganda [45, 53]. In our study, schoolgirls reported moderate, positive scores on the reuse needs and reuse insecurity domains. This supports previous studies, which also showed that more positive menstrual experiences were associated with higher self-efficacy, lower menstrual anxiety, and greater participation in social activities [4]. This study was the first in Tanzania to apply this scale, and the alignment with other studies suggests that this tool is suitable for wider use in the Tanzania setting for future studies of this nature and supports its use as the main outcome measure for this study.

In line with previous studies [53], limited access to adequate menstrual products and satisfactory WASH facilities was a major challenge to good menstrual practices. While 60% of girls in our study used commercially available disposable pads, the use of multiple products was common, suggesting that girls switch to alternative materials when pads are inaccessible. A considerable proportion of girls reported using cloths and other materials, including face towels, handkerchiefs, socks, and toilet paper. Leaking during menstruation was commonly reported, implying that use of substandard menstrual products is common or that changing was too infrequent, possibly due to an inability to afford sufficient products, a lack of high-quality products or a lack of suitable facilities to enable girls to change with confidence.

There are various strengths and limitations to this study that should be considered when interpreting the results. The study has a strong theoretical basis and applied a carefully designed MH framework and corresponding MPNS scale, allowing for the quantification of complex social constructs [4, 45, 48]. The findings of the study are consistent with other projects across the region, suggesting broader applicability. However, the baseline study was cross-sectional in nature, thereby limiting the ability to determine the temporal sequence between exposures of interest and menstrual outcomes. Secondly, the self-completed questionnaire relied on self-reports and could have resulted in some information bias; for example, participants may have had difficulties accurately remembering the experience of pain, which was measured in the study using a visual scale requiring reporting of pain severity. Additionally, validated tools for collecting information surrounding menstruation are few. As a result, we were required to adapt existing measures intended for other purposes; for example, the generalised anxiety disorder (GAD-7) tool was adapted for menstrual-related anxiety. Thirdly, questionnaires took long to complete, which may have affected the quality of the data collected. Efforts to reduce social desirability bias included the self-completed nature of the study and ensuring clarity over the study aims and procedures were made. The study team was trained to clearly emphasise the need to capture events during the time period stated in order to mitigate against recall bias. Our data were collected from four schools in the Mwanza region, the second largest city in Tanzania, and were not designed to be generalisable to the rest of the country. Nonetheless, our baseline data is largely comparable with two recent studies conducted in Tanzania [44, 53].

Schoolgirls have unmet menstrual practice needs related to transporting and using menstrual material in school, and menstrual-related pain remains a major reason for poor school attendance and participation. The results have several implications. Firstly, comprehensive interventions are needed to improve MH and school outcomes in order to address menstrual management nuances such as the convenience of carrying and changing the menstrual material while in school. Secondly, interventions must mitigate against menstrual-related pain, which was cited as a main driver for menstruation-related absenteeism and poor participation in the classroom. Future interventions should include improving schoolgirls' access to analgesics while in school and empowering them to use more accessible and acceptable alternative non-pharmacological pain-management techniques. Our study strengthens the available evidence to support more comprehensive investment in programs targeting menstrual health in schools, including improving access to menstrual products, ensuring sufficient safe and private toilet facilities with water for changing and washing, and providing pain relief to facilitate menstrual care in schools. Furthermore, broader structural interventions are needed to improve access to pain management options in school and to improve access to menstrual products for adolescent schoolgirls. The latter may include strengthening the current policy to provide emergency menstrual pads in schools, introducing well-tailored menstrual product subsidies and tax incentives, promotion, and quality monitoring local production and technologies for menstrual products.

Abbreviations

DHSC	Department of Health and Social Care
FCDO	Foreign Commonwealth and Development Office
MH	Menstrual Health
MPNS	Menstrual Practices and Needs Scale
MRC	Medical Research Council
MSRH	Menstrual, Sexual, and Reproductive Health (MSRH)
PASS MHW	Partnering to Support Schools to Promote Good Menstrual Health and Well being
RTI	Reproductive Tract Infection
SGDs	Sustainable Development Goals
UTI	Urinary Tract infection
WASH	Water Sanitation and Hygiene
CEREB	Cerebellum
DEG(s)	Differentially expressed gene(s)
HPA	hypothalamus-pituitary-adrenal axis

HPCS	Hippocampus
hpi	Hours post-injury
HYPT	Hypothalamus
IACUC	Institutional Animal Care and Use Committee
t-SNE	t-distributed stochastic neighbor embedding

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Author contributions
EO, PA, JR, JR, SK, GG, BT conceived the study idea and designed the study: EO, JR, JR, OM, SKS, JL implementated the studyPA, CT, KT conducted the statistical analysis; EO, PA drafted the manuscript; SK, CT, JR, BT, JR, GG, OM, SKS, and JL did critical revisions of the manuscript for important intellectual content; and all the authors read and approved the final manuscript for submission.

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Data availability
The datasets used/analysed for this manuscript are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate
The study protocol, tools, and consent/assent forms were reviewed and approved by the independent Tanzanian national ethics committee (Ref: NIMR/HQ/R.8a/Vol.IX/3647) and LSHTM ethics committee (LSHTM Ethics Ref: 22 854). Permissions to conduct the study were obtained from the Mwanza Regional Demonstrative Secretary, the regional and district education offices, and school administrations. All participants provided written informed consent/assent. Head teachers provided overall consent on behalf of adolescents aged below the age of 18 years before they assented. Participants were informed that study participation was voluntary and that they were free to withdraw, without justification, from the study at any time without consequences. Each respondent was assured of confidentiality and privacy during data collection, management, and analysis. Personal data were anonymised using ID numbers, and stored data were stripped of any identifiable information.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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