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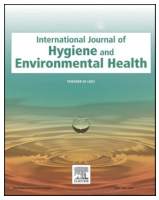

Perceived difficulties in maintaining menstrual hygiene practices among indigenous adolescents during seasonal water scarcity periods in Bandarban hill district of Bangladesh: A cross-sectional study☆

Imdadul Haque Talukdar [a,*], M.A. Rifat [b], Plabon Sarkar [c], Nobonita Saha [d], Mesfin Kassaye Tessma [a], Md. Ibrahim Miah [e]

[a] Department of Learning, Informatics, Management and Ethics (LIME), Karolinska Institutet, 17165, Stockholm, Sweden
[b] Department of Global Public Health, Karolinska Institutet, 17176, Stockholm, Sweden
[c] Caritas Bangladesh, 2, Outer Circular Road, Shantibagh, Dhaka, 1217, Bangladesh
[d] Institute of Nutrition and Food Science, University of Dhaka, Dhaka, 1000, Bangladesh
[e] Department of Microbiology, University of Dhaka, Bangladesh

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ABSTRACT

Background: Access to clean water is important for menstrual hygiene practices, an important aspect of health for adolescent girls. In Bangladesh, adolescent girls represent poor menstrual hygiene practices, whereas the practice is worse among vulnerable population groups living in areas experiencing seasonal water scarcity. This study portrays perceived difficulties in menstrual hygiene practices among indigenous adolescent girls during the period of seasonal water scarcity in Bandarban Hill District, Bangladesh.

Method: Data was collected from 242 indigenous adolescent girls through interviews during the period of water scarcity. Backward stepwise regression model was used to identify factors associated with perceived difficulty in maintaining menstrual hygiene (PD) practices.

Result: The study participants, mainly living in hard-to-reach areas, reported difficulty in getting adequate water during the water scarcity period, and the quality of water was reported to be poor. PD due to water scarcity was found to be significantly associated with water source degradation ($\beta = 0.247$, < 0.001), the need for boiling/purifying water before use for menstrual hygiene ($\beta = 0.203$, $p = 0.005$), and experience of water availability when it was necessary to maintain their optimal menstrual hygiene practice ($\beta = 0.449$, $p < 0.001$), time required to collect water ($\beta = 0.209$, $p < 0.001$), taking a bath every day ($\beta = -0.228$, $p < 0.001$), and frequency of washing genitals per day ($\beta = -0.094$, $p = 0.040$).

Conclusion: Indigenous adolescents perceive difficulty in menstrual hygiene practices during the period of water scarcity. Further research could be carried out to observe to what extent the seasonal water scarcity could be attributable to worsen the menstrual hygiene practices and to identify the need for addressing the problems.

1. Introduction

Water availability is essential for hygiene practices, including menstrual hygiene (Hussein et al., 2022). Water scarcity increases women's vulnerability regarding their menstrual health (Rossouw and Ross, 2021). Particularly in lower-middle-income countries (LMICs), studies showed that water scarcity significantly affects women's menstrual hygiene practices (Dr Shamima Yasmin, 2013; Van Eijk et al., 2016; Wali et al., 2020). Poor menstrual hygiene practices were found to be associated with urogenital infections such as bacterial vaginosis among reproductive-age women (Das et al., 2015; Torondel et al., 2018). School absenteeism among adolescent girls was also attributed to poor

Abbreviations: **LMIC**, Low- and middle-income countries; **CHT**, Chittagong Hill Tract; **MHP**, Menstrual hygiene practices; **PD**, Perceived difficulty in maintaining menstrual hygiene; **WASH**, Water, Sanitation and Hygiene.

☆ Present Address: Office of the Deputy Commissioner, Cumilla, Bangladesh. Postal code: 3500 Phone number: +8801622881927

* Corresponding author.
E-mail addresses: imdadul.haque.talukdar@stud.ki.se, haque.talukdar@gmail.com (I.H. Talukdar), rifatahmed011@gmail.com, m.a.rifat@ki.se (M.A. Rifat), sarkarplabon@gmail.com (P. Sarkar), nobonitasahaqueen@gmail.com (N. Saha), mesfin.kassaye.tessma@ki.se (M.K. Tessma), ibrahim@du.ac.bd (Md.I. Miah).

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menstrual hygiene due to inadequate access to water, sanitation and hygiene (WASH) facilities (Shumie and Mengie, 2022; Tegegne and Sisay, 2014). In consequence, it increases the overall burden of disease, especially in the domain of women's reproductive health (Mills and Cumming, 2016). Studies conducted in LMICs demonstrated that water scarcity highly affected women's menstrual hygiene practices (Dr Shamima Yasmin, 2013; Van Eijk et al., 2016; Wali et al., 2020). For instance, a study in West Bengal, India, found that adequate water supply was significantly associated with quality menstrual hygiene practices among adolescents (Dr Shamima Yasmin, 2013).

In Bangladesh, many women face challenges maintaining menstrual hygiene regarding water quantity and quality. Although 98% of people have access to water, the overall water quality is poor in Bangladesh (World Bank, 2018). For instance, it was found that *E. coli* bacteria was present in 80% of private piped water taps and most of the pond water (World Bank, 2018). National hygiene survey 2018 reported that 8% of adolescents and 12% of women of reproductive age used unprotected water sources for drying and storing menstrual clothes (Government of the People's Republic of Bangladesh, 2018), incurring 41% of school absenteeism among adolescent girls (Alam et al., 2017).

Chittagong Hill Tracts (CHT) of Bangladesh are considered one of the most vulnerable areas that suffer from water scarcity all over the year, and the situation becomes worse during the dry seasons (Alam, 2022; Hossen et al., 2016). As the area is steep with high latitude compared to the mainland and the infrastructures are poor, people experience hardship in getting and reserving water for their daily use during dry season. A study found that 50% of dwellers of CHT districts, namely Bandarban, Rangamati and Khagrachari, suffer from severe water crises during the winter and summer when they collect water from the nearby springs, streams, and other natural sources (Hossen et al., 2016).However, this rate was 41% in Bandarban district (Hossen et al., 2016). It was reported that only 15.4% of adolescent girls in CHTs clean vagina during menstruation with clean water (Borua et al., 2019). A recent study shows 59.4% of indigenous people in Bandarban use spring water, 36% use surface water, and 10.8% use tube-well water for drinking (Mahmud et al., 2020). However, this may vary due to seasonal water availability changes in these sources. More than half of the indigenous populations in Bandarban district were found to have poor WASH practices which could be attributed to water scarcity (Mahmud et al., 2020). Evidence represents that this severe water scarcity heavily obstructs the menstrual hygiene management of the women of reproductive age in this region (Ahmed et al., 2017; Muhit and Chowdhury, 2013). The study by Muhit and Chowdhury (2013) showed that adolescent schoolgirls of the CHT are more vulnerable to water supply and sanitation conditions compared to those in other parts of Bangladesh, contributing to 39% school absenteeism.

Although studies were conducted on the water scarcity situation and its impact on the population health in CHT districts, there is no study exploring if the seasonal water scarcity has any association in maintaining adolescent girls' menstrual hygiene. To fill out this research gap, the present study aims at exploring the impact of water scarcity and its associated factors on the perception of difficulty faced by the adolescent ethnic minorities inhabiting the Bandarban district of CHT in maintaining their menstrual hygiene during the dry seasons.

2. Methods

2.1. Settings

Bandarban is in the south-eastern region under the Chattogram administrative division and is the remotest and least populated district in Bangladesh. Bandarban has some of the highest peaks in the country, and 11 different indigenous communities living along with mainstream Bengali people (Debnath et al., 2022). The indigenous communities have distinct languages, cultures, traditions, and religions. However, they experience discrimination, land extortion, ethnic prejudice, and poor health and nutritional status (Roy, 2012).

The total population of Bandarban is 436,950, and the total under-eighteen population is 173,351 (BBS, 2011a). Among them, 142,401 (44.39%) are from indigenous communities (BBS, 2011b). The population density in Bandarban is 87 per square km (BBS, 2011a), which is lower than the national average of 976 per square km (BBS, 2011a). It has seven sub-districts, called upazilas (the second smallest unit of local government/administration), and 29 unions (the smallest unit of local government). Most of the indigenous people live in rural small villages, called para (regarded as the smallest social institution administered by a local representative called Headman), near to hills, springs, rivers, and plains/valleys. For this study, the district of Bandarban was chosen for having higher water scarcity than the other two districts in the Chattrogram Hill Tracts (Chakma et al., 2021).

2.2. Study design, sampling, and sample size

A cross-sectional design was employed to collect information from 242 conveniently selected indigenous adolescent girls living in the water scarcity areas in Bandarban Hill District of Bangladesh. Water scarcity areas were identified with the help of local indigenous people during the planning phase of the study. There was no available data regarding what proportion of indigenous adolescent girls had access to quality water and sun drying the menstrual absorbent properly for menstrual hygiene practices. Therefore, population proportion was considered based on National Hygiene Survey 2018, indicating that 12% of the adolescents in Bangladesh had improved water source and adequate sundry of menstrual absorbent for menstrual hygiene practices (Government of the People's Republic of Bangladesh, 2018). The estimated population size was calculated as 10,295, considering a total of 76,036 adolescents, 44.39% indigenous population, and 61% people living in hilly areas (BBS, 2011b). Finally, sample size was determined considering a population proportion (p) of 0.12, 95% confidence level, and 5% margin of error, and 20% non-response (Kasiulevičius et al., 2006). The calculation provided at least 195 adolescents to be interviewed. In this study, 242 indigenous adolescents were interviewed, providing a representative sample of 10,295 indigenous adolescent girls.

2.3. Data collection and management

Data collection was conducted in 38 paras from 11 unions under the six upazilas from Bandarban district (Fig. 1). Data was collected between the period of February to May 2022. A total of 242 adolescent girls were interviewed using a pre-tested questionnaire. The questionnaire was translated from English to both Bengali and Marma languages (the most common indigenous language in the study area). Female interviewers were recruited from indigenous communities, including Marma, Tripura, and Tanchangya and were trained in data collection. The data collectors were able to speak both Bengali and indigenous. The purpose of the study, data privacy, potential impact was described, and verbal consents were taken before the interviews.

After interviewing, the questionnaire was transcribed into an SPSS datasheet. Each respondent was designated with an identity number (ID number) for anonymization during analysis and to maintain privacy of the respondent. Both versions of the dataset such as completed questionnaire and soft copy were stored securely.

2.4. Variables and covariates

Literature search was performed to understand how menstrual hygiene practices are associated with socioeconomic factors and water availability. Bangladesh National Hygiene survey 2018 and researches conducted in water scarcity settings were reviewed to select variables for formulating the questionnaire. Resource scarcity affects menstrual hygiene practice, knowledge, and awareness of different reproductive-aged women in crisis and resource-poor settings (Kuhlmann et al.,

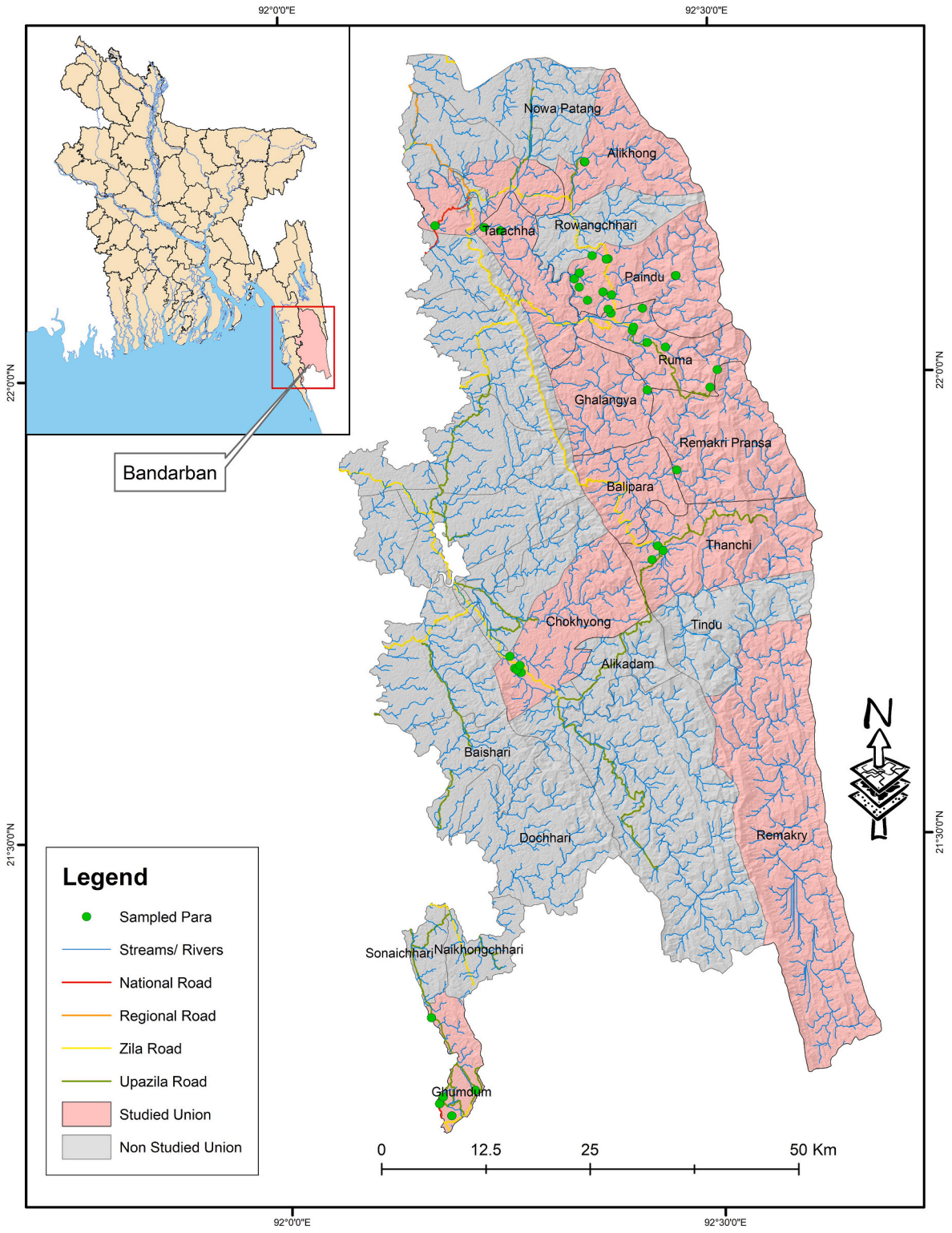

Fig. 1. Study area and data collection sites.

2017; Michael et al., 2020; Raina and Balodi, 2014; Thakre et al., 2011; VanLeeuwen and Torondel, 2018). Then, we narrowed our search to the associated factors of water scarcity and menstrual hygiene in similar socioeconomic and geographic contexts (Das et al., 2015; Garg et al., 2022; Ha and Alam, 2022).

Socio-demographic information included age, marital status, educational status, number of family members, place of residence, and ethnicity. Variables related to hardship in getting water included sources of water for family use and menstrual hygiene practices, the time required to collect water from these sources, degradation of water sources during the dry seasons, quality of water used in the last menstrual period, the hardship of getting sufficient water during the last menstrual period, if they need to boil or purify water before use, and event of family relocation due to water scarcity in last three years. Menstrual hygiene practices were assessed considering the frequency of taking baths and washing genitals in a day during the last menstrual period.

2.5. Psychometric toll development: outcome measurement

To address our research question, we needed a validated and reliable instrument to measure the perception of the indigenous adolescent girls. However, no pre-tested or validated scale or questionnaire was available in previous studies that could measure the perception of the adolescents who experiences the hardship of water scarcity in maintaining their menstrual hygiene. Thus, we endeavoured to construct a new validated instrument to measure adolescents' perceptions named as perceived difficulty in maintaining menstrual hygiene due to water scarcity (PD). In the initial stage of scale development, we performed a literature search and created an item pool which was used for measuring the different perceptions of the women who face difficulties in maintaining menstrual hygiene due to water scarcity (Dr Shamima Yasmin, 2013; Ellis et al., 2016; Michael et al., 2020; Patel et al., 2022; Van Eijk et al., 2016). Followed by that, the items were discussed with three women of reproductive age and three indigenous adolescents to get their feedback on it. Finally, a self-reported five-point Likert scale with five items was finalized considering that these were well structured, clear, comprehensive, and could sufficiently measure the adolescents' PD by the authors- IHT, MAR, and PS. To ensure content validity, all the disagreements were discussed and resolved by the other authors. The items of the scale are provided in Table 1.

Both classical and modern psychometric tests were performed to examine the reliability and validity of the newly constructed scale.

In classical item analysis, Cronbach's Alpha value was found 0.91 which is higher than widely accepted cut-off value 0.70 (Bolarinwa, 2015) that denotes high inter-item consistency. Exploratory factor analysis found one component determined by Eigenvalue greater than 1 which denotes that the five items combinedly create a common factor what we named PD. Moreover, Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (0.88) denotes that the sample size of our study was enough to perform the factor analysis, whereas Bartlett's test of Sphericity (815.17) found significant ($p < 0.01$) which denotes that the items were correlated to each other to make a common factor or construct. The component matrix of each item was found to be more than the accepted cutoff value of 0.7 (Table 2), which means there were enough variabilities (not repetitive) among the items.

Rasch analysis was performed to evaluate the psychometric properties of the 5-item questionnaire that was aimed to measure a single construct named PD. Data of respondents in that questionnaire was tested for their fit to the Rasch model following the Joint Maximum Likelihood Estimation (JMLE) (Linacre, 2017) method in WINSTEP, version 5.4.1. The result of Rasch analysis shows that the questionnaire has accepted values of separation index (1.62) and reliability (0.72) and a high item separation index (4.51) and reliability (0.95) (Souza et al., 2017). Explanation of getting lower person separation index and reliability values might be homogeneity of the participants from all demographic perspectives. On the other hand, the item reliability index and value are higher than the accepted cutoff point of 3 and 0.90, which denotes that the items have a reasonably different range of variability.

Mean square values of infit and outfit for the person and item were within the cutoff range of 0.5–1.5, as recommended by Linacre (2017) (Table 2). Only one value of the MNSQ outfit for the person in item D1 was found to be 1.70, slightly higher than the recommended cutoff value. It indicates that the questionnaire is a reliable construct and statistically fit.

The structural validity of the questionnaire was examined by unidimensionality and local independence assumptions of the Rasch model. The assumption of unidimensionality was held according to three criteria. Firstly, 44.5% of the variance was explained by the Rasch measurement, which is more than the 40% recommended cutoff point (Linacre, 2017; McCreary et al., 2013). Secondly, Eigenvalue was found to be 1.49 for the first construct, which is less than 2, and denotes that the questionnaire expresses a single construct combinedly. Thirdly, all disattenuated correlation values were found to be 1 except one value of 0.89 (PCS contrast 3 item clusters 2–3: 0.89), which denotes that the items are highly concentrated to a common construct. Local independence assumption was also held considering standardized residual item correlation values were found to be all negative as negative or zero standardized residual item correlation coefficient values suggest that the items have local independence (Marais and Andrich, 2008).

Considering these psychometric properties of the constructed scale, the questionnaire's composite values were considered continuous numeric in the statistical analysis of the paper (Leung, 2011; Wu and Leung, 2017).

2.6. Statistical analysis

The study chose a backward elimination linear regression method to figure out the most relevant factors and their joint predictive ability from a wide range of factors presupposed in the study (Chowdhury and Turin, 2020). To avoid the possibility of including irrationally too many numbers of variables, *the 'one in ten rule'* (Harrell et al., 1984; Peduzzi et al., 1996), the role of including each variable for every 10 observations, for determining the total number of variables in the prediction model was strictly followed. Before performing stepwise multiple regression, a univariate analysis was performed to examine the association of each factor with the predicted variable PD. To avoid any possibility of exclusion of any important factor, we considered all the candidate variables in our backward stepwise multiple regression.

Statistical analyses were performed with Statistical Packages for Social Science (SPSS) version 28. Descriptive statistics were used to observe the distribution of demographic characteristics of the participants, their menstrual hygiene practice, and perceived difficulties. Regression analysis was performed to observe the variables associated with PD of menstrual hygiene practices, which is a major objective of the study. Backward stepwise multiple linear regression was performed to observe the variables associated with PD of the adolescents adjusted for age, number of family members, education level, place of residence, and ethnic identity. Quality of the regression model was assessed using R^2 value, variance inflation factors (VIF) of the independent variables and observing the heteroscedasticity of the model.

Table 1
Perceived difficulty in maintaining menstrual hygiene due to water scarcity questionnaire.

Item Number	Item Description
D1	The distance of the water source made it difficult to collect enough water for cleanliness during my last menstrual period.
D2	I did not get sufficient water to wash my genitals during my last menstruation period.
D3	I did not get sufficient water to bathe during my last menstruation period.
D4	Washing my absorbents and other menstruation-related materials was difficult due to sufficient water.
D 5	Felt difficulty in washing hand before and after changing absorber and clothes due to scarcity of safe water in the last menstrual period

Response options: 0 = completely disagree, 1 = disagree, 2 = neither agree nor disagree, 3 = agree, 4 = strongly agree.

Table 2
Item statistics of the perceived difficulty questionnaire.

Item	Exploratory Factor Analysis			Rasch Analysis			
	Component Matrix	% of variance explained	Cumulative % of variance explained	Item Endorsability (difficulty) *	Standard Error	MNSQ Infit	MNSQ Outfit
D1	0.86	72.95	72.95	−0.08	0.13	1.23	1.70
D2	0.87	11.50	84.44	−0.04	0.13	1.11	1.09
D3	0.91	6.212	90.65	−0.51	0.14	1.00	0.96
D4	0.90	5.99	96.64	−0.53	0.14	0.84	0.80
D5	0.72	3.37	100	1.17	0.12	0.74	0.69

2.7. Ethical issues

Ethical clearance was obtained from the ethical review committee of the Faculty of Biological Sciences of the University of Dhaka, Bangladesh with reference number: 176/Biol.Scs (Supplementary file 01). Before conducting data collection, informed consent was received from all the participants and from their guardians/legal guardians.

3. Result

3.1. Characteristics of the participants

Characteristics of the participants are presented in Table 3. The participants (n = 242) of the study belonged to Tripura (33.1%), Marma (32.2%), and other (34.7%) ethnic groups in the Bandarban hill district, and their mean age of the participants was 15.67 (SD = 2.07) years. 15.3% of adolescents were illiterate or had no formal education, 15.7% were educated until primary level, and 68.2% had more than primary level education. The mean number of family members was 5.87 (SD = 1.74). The Sources of water of their families were spring/fall (47.9%) and surface water (36.8%), while a minimal number of the families used underground water (12.8%) and multiple sources (2.5%). Similarly, sources of water for maintaining their menstrual hygiene were spring/waterfall (45.9%), surface water (36.4%), underground water (16.1%), and multiple sources (1.7%). Most adolescents reported using disposable sanitary pads (50%), while a significant proportion (27.3%) reported using cloth or towels for their menstrual secretion. On the other hand, 27.3% used multiple types of materials, while 2.9% reported that they did not use any material for menstrual secretion. Common coping strategies for maintaining menstrual hygiene were reported to be reducing their cleaning frequency (6.6%), using tissues or clothes rather than washing with water (1.2%), reducing the amount of water used for cleaning genitals (19%), and suboptimal use of water while bathing (26.9%). 45.9% reported that they did not need to cope with this situation at all. Average reported time to collect water was 19.24 (±14.85) minutes and 75.2% respondents reported that the quality of these sources of water degrades during the dry seasons and 69.8% reported that the quality of these water was not good as 75.2% reported that their sources of water degrade during the dry seasons. 67.2% reported that their place of residence was in hard-to-reach areas. 44.2% reported that they needed to boil or purify that water before use. 4.5% adolescents reported that their family has been relocated from their previous place of residence to another place due to water scarcity.

Table 3
Characteristics of participants.

Variable	Frequency (%)
Age (mean ± SD)	15.67 ± 2.07
Number of family members (mean ± SD)	5.87 ± 1.74
Marital status	
Unmarried	230 (95.5)
Married	11 (4.5)
Ethnicity	
Tripura	80 (33.1)
Marma	78 (32.2)
Others	84 (34.7)
Education level	
No formal education	37 (15.3)
Less than primary	38 (15.7)
More than primary	165 (68.2)
Source of water of the family	
Underground	31 (12.8)
Surface water	89 (36.8)
Spring/waterfall	116 (47.9)
Multiple sources	
Source of water for menstrual hygiene	
Underground	39 (16.1)
Surface water	88 (36.4)
Spring/waterfall	111 (45.9)
Multiple sources	4 (1.7)
Material used for menstrual secretion	
Disposable sanitary pad	121 (50)
Cloth/towel	41 (16.9)
More than one	66 (27.3)
Nothing	7 (2.9)
Methods of disposing absorbents	
Burning	99 (40.9)
Throwing away	33 (13.6)
Under soil	49 (20.2)
Toilet	10 (14)
Did not dispose	34 (14)
More than one method	3 (1.2)
Other ways than the abovementioned	7 (2.9)
Not applicable	5 (2.1)
Coping strategy during water scarcity	
Reduced the cleaning frequency	16 (6.6)
Used tissue or cloths for cleaning genitals	3 (1.2)
Reduced amount of water used for cleaning genitals	46 (19)
Suboptimal use of water while bathing	65 (26.9)
Not applicable	111 (45.9)

3.2. Factors associated with PD

3.2.1. Testing of assumptions in linear regression analysis

Before conducting multiple linear regression, the assumptions were tested. Normal PP plot showed normality of the outcome variable while residual plot showed no heteroscedasticity. No multicollinearity was found among the explanatory variables as the values of tolerance (>0.1) and variable inflation factor (VIF <10) were found within generally accepted values (Alin, 2010). No heteroscedasticity was found diagnosed with residual plot and standardized residuals in the scatterplot where the range of residual values were found between 1.01 and 2.15 (Supplementary file 02).

3.2.2. Univariate analysis

Univariate linear regression (Table 4) shows that number of family member, place of residence, time required to collect water, water source degradation, perceived water quality, took a bath every day, and experience of water scarcity in last menstruation period were positively and significantly associated with perceived difficulty while needed to boil or purify water and having of Marma ethnicity were negatively and significantly associated with perceived difficulty. On the other hand, other covariates were not found to have any significant association with the outcome variable.

Table 4
Association between predictor variable and perceived difficulty.

Factor	Coefficient (95% CI)	*p* value
Age	−0.042 (−0.094 to 0.010)	0.112
Number of family member	0.093 (0.032–0.154)	0.003
Education level (no formal Education as reference)		
Primary education	0.177 (.367 to −.209)	0.904
Above primary	0.086 (0.579 to −0.218)	0.555
Ethnic identity (other ethnic group as reference)		
Marma	−0.744 (−0.979 to −0.509)	<0.001
Tripura	0.106 (−0.128 to 0.339)	0.374
Living hard to reach area	0.318 (0.091–0.544)	0.006
Time required to collect water	0.032 (0.026–0.038)	<.001
Water source degradation	1.156 (0.903–1.409)	<.001
Family relocation due to water scarcity	−0.148 (−0.662 to 0.366)	0.571
Bad water quality during last menstruation	0.384 (0.155–0.612)	0.001
Need boil or purify water (no need to boil or purify as reference)	−0.522 (−0.727 to −0.316)	<.001
Frequency of washing genitals	0.011 (−0.056 to 0.078)	0.748
Took a bath everyday (not taking a batch as reference)	1.108 (0.636–1.581)	<.001
Experience of water scarcity in last menstrual period	1.123 (0.963–1.284)	<.001

3.2.3. Multivariable analysis

In the backward multiple linear regression model, cut-off p-value 0.01 was used to exclude the variables in each stage.

In the full model including all the candidate variables, multiple linear regression was statistically significant (R square: 0.632), F (13, 198) = 26.152, $p < 0.01$) (Table 5).

In the full model, all the variables related to hardship of getting water were significantly associated with PD (time required to collect everyday water: β = 0.013, $p = 0.003$; family relocation due to water scarcity: β = −0.485, $p = 0.006$; water source degradation (β = 0.541, $p < 0.01$), quality of used water: β = −0.335, $p = 0.004$), water source degradation (β = 0.541, $p < 0.001$), need to boil or purify water (β = 0.287, $p = 0.044$), and experience of facing hardship in getting water in last menstruation: β = 0.772, $p < 0.001$) except living hard to reach area (β = 0.048, $p = 0.623$) (Table 5).

Similarly, both variables related to menstrual hygiene practice were significantly and negatively associated with PD (frequency of washing genitals: β = −0.051, $p = 0.038$) whether took a bath every day during menstrual period: β = −0.975, $p < 0.001$) (Table 5, Full Model).

In the final model (Table 5), Marma (β = −0.116, $p = 0.028$) and Tripura (β = −0.192, $p = 0.009$) ethnic groups of peoples were found to be negatively associated with PD compared to the other ethnic group of peoples. The factors related to hardship of getting water-water source degradation (β = 0.247, p <0.001), whether needed to boil or purify water (β = 0.203, $p = 0.005$), and experience of difficult in getting water during the last menstrual period (β = 0.449, $p < 0.001$) were found negatively and significantly associated with PD, while time required to collect water (β = 0.209, $p < 0.001$) was found to be negatively associated with PD. Both variables related to menstrual hygiene practice-frequency of washing genitals (β = - 0.094, $p = 0.040$) and whether took a bath every day (β = −0.228, $p < 0.001$) were found to be negatively and significantly associated with PD, while the factor living hard to reach area was not found to be significant association with PD (β = 0.048, $p = 0.623$.

4. Discussion

4.1. Findings

To our best knowledge, this is the first study that investigated the status of PD by the indigenous adolescents in the Bandarban Hill District of Bangladesh. The major finding shows that indigenous adolescent girls

Table 5
Adjusted models of the association of predictor variable with perceived difficulty in maintaining menstrual hygiene due to water scarcity (N = 242).

	Full Adjusted Multiple Regression Model		Final Reduced Multiple Regression Model with Backward Stepwise Elimination	
Variable	Coefficient (95% CI)[a]	p-value	Coefficient (95% CI)[b]	p-value
Age	0.026 (−0.014 to 0.066)	0.206	–	–
Number of family member	0.010 (−0.032 to 0.052)	0.635	–	–
Education level (no formal education as reference)				
Primary education	0.079 (−.227 to .385)	.610	–	–
Above primary	−0.091-(.335 .153)	.463	–	–
Ethnic identity (other ethnic group as reference)				
Marma	−.206 (−.429 to .016)	.069	−0.116 (−0.403 to −0.023)	0.028
Tripura	−.311 (−.609 to −.012)	.041	−0.192 (−0.623 to −0.090)	0.009
Living hard to reach area	0.048 (−.145 to .241)	0.623		
Time required to collect water	0.013 (.004–.021)	0.003	0.209 (0.005–0.019)	<.001
Water source degradation	0.541 (.317–.766)	<.001	0.247 (0.323–0.756)	<.001
Family relocation due to water scarcity	−0.485 (−0.827 to −0.142)	0.006	−0.125 (−0.819 to −0.142)	0.006
Perceived water quality during last menstruation	−0.335 (−0.559 to −0.112)	0.004	−0.187 (−0.569 to −0.146)	0.001
Need boil or purify water	0.287 (0.008–0.565)	0.044	0.203 (0.108–0.596)	0.005
Frequency of washing genitals	−0.051 (−0.099 to −0.003)	.038	−0.094 (−0.097 to −0.002)	0.040
Whether took a bath everyday	−0.975 (−1.374 to −0.576)	<.001	−0.228 (−1.358 to −0.578)	<.001
Experience of water scarcity in last menstrual period	0.772 (0.567–0.977)	<.001	0.449 (0.571–0.970)	<.001
Model Fit Statistics	R square: 0.632, Adjusted R square: 0.608, F (13, 198) = 26.152, $p < 0.01$.		R square: 0.628, Adjusted R square: 0.608, F (13, 198) = 47.690, $p < 0.01$.	

[a] Unstandardised Beta.
[b] Standardised Beta.

of the study area faced difficulty in menstrual hygiene practices during water scarcity period, causing more than half of the respondents to undergo various coping strategies to maintain menstrual hygiene practices. Therefore, the finding complies with the fact that water inadequacy leads to poor menstrual hygiene practices (Blair et al., 2022; Chatterjee, 2020; Downing et al., 2021; Ellis et al., 2016; Michael et al., 2020; Van Eijk et al., 2016). However, on the other hand, 45.9% of respondents were found to maintain their usual menstrual hygiene practices, regardless of seasonal water scarcity in the study area. This could be due to the fact that seasonal water scarcity is geographical as a whole, whereas some families might still have access to water throughout the year. Furthermore, convenient sampling caused the exclusion of potential participants from some remotest and hard-to-reach areas where water scarcity is perceived as extreme.

Though studies have been conducted on the perception of menstruation (Parle and Khatoon, 2019) and menstrual hygiene (Hennegan and Sol, 2020, p. 20192019; Parle and Khatoon, 2019), no study was found on the perception of the difficulty of maintaining menstrual hygiene due to water scarcity, specifically, faced by menstruating women. However, Caruso et al., 2020 found that less access to water sources significantly increased menstrual insecurity among menstruating women in Odisha, India, where they included access to water as a component of menstrual security (Caruso et al., 2020).

In our study, PD was associated with a few factors of the hardship of getting water and menstrual hygiene practices. Among the factors related to the hardship of getting water, we found that water scarcity caused displacement, and the association of PD with that displacement was inversely related. This inverse association might be explained by the fact that families who changed their residences due to water scarcity already had their water situations resolved. Studies have reported forced displacement due to the adverse effects of climate change and water scarcity over the decades globally (Palattiyil et al., 2022). Another hardship factor, the need for purification or boiling the water, was also found to be positively and significantly associated with PD in our study. According to the National Hygiene Survey 2018 (Government of the People's Republic of Bangladesh, 2018), 14% of households in Bangladesh were found to purify water at household level (boiling, chemical, or filtered treatment) (Debnath et al., 2022), whereas, the frequency of boiling or purifying water was found to be comparatively high (44.2%) in our study. In previous studies, boiling or purifying water implied poor water quality (Debnath et al., 2022) posing a serious obstacle to maintaining menstrual hygiene (Elledge et al., 2018; Krishnan and Twigg, 2016; VanLeeuwen and Torondel, 2018). Time required to collect water, water source degradation, and water quality were also found to be associated with PD in our study, which is similar to the findings of previous studies in different water scarcity settings. For instance, a systematic review (Patel et al., 2022) found that access to water adversely affects menstrual hygiene management in humanitarian crisis settings. Our study also found poor menstrual hygiene practices to be associated with higher PD. Previous studies found poor menstrual hygiene practices to be associated with water access and availability. For instance, a study in the Sub-Saharan region found that inadequate water and sanitation facilities were associated with poor menstrual hygiene practices (Kuhlmann et al., 2017).

4.2. Methodological discussion

The study tried to objectively define the PD based on in-depth literature review, expert opinions, and developing a new measurement tool of PD in this context by piloting and testing the reliability and validity of that instrument. Both classical and modern methods of reliability and validity determination were used to confirm that the newly developed tool is competent enough to objectively measure the PD as a single construct. As its explorative nature, the study considered a considerable number of factors as independent variables and applied backward stepwise linear regression analysis to ensure all candidate variables to be included into the mode. That is likely to avoid the possibility of occurring omission bias. For having robust measurement of association, both univariate and multiple regression models were used. All possible demographic variables, assumed as potential confounders, were adjusted for each regression model.

No funding was received to conduct this study that provided the researchers scope of being objective and unbiased in the entire process of the study. Additionally, an ethical clearance has been taken from an authorized ethical committee and informed consent form was used prior to data collection. In every stage of the study, including data collection, data handling, and analyzing, highest personal secrecy and privacy of the participants was maintained.

Due to lack of previous theoretical ground and empirical evidence, it was difficult to scope out the possible phenomena of the PD and its associated factors. Thus, this study is not a conclusive one that could claim that the domain of interest has been scooped in the best way. Thus, generalizability of the study should be drawn carefully. Advanced statistical tools and methods could have been used, for instance, Structural Equation Modeling (SEM), Path Analysis, to draw more confirmed causal relationships.

4.3. Strengths and limitations of the study

Data was collected by volunteers from local indigenous communities which might help to reduce information bias arising from language barrier and cultural reservedness of the participants to talk about sensitive menstrual health issues.

Several limitations of the study could also be worth mentioning. Cross-sectional nature of the data doesn't imply any causal association between the variables of interest. Convenient sampling might lead to either underestimation or overestimation of both the PD score and the water scarcity situation because some of the remotest areas were not considered for data collection. Use of more advanced statistical methods, for instance, structural equation model, path analysis, or analysis of commonality, could have been applied to get a more robust and clearer picture of the associations of the considered variables. But due to lack of time and resources, further analysis was not possible to perform. Thus, the findings cannot be generalized with the same population groups in other areas of Bangladesh.

Exposing the frequency of washing genitals is sensitive personal information. Similarly, daily bathing represents a standard hygienic behavior in Bangladesh (Sultana, 2011), and the menstruation period is considered a social, cultural, and religious taboo (Mohammed and Larsen-Reindorf, 2020). Thus, daily bathing (94.6%) has been a regular cultural norm of the menstruating women of Bangladesh. These findings reflect the cognitive dissonance theory that claims that individuals tend to protect their positive self-image and feel uncomfortable while facing image-threatening events (Alicke and Sedikides, 2009). It is the self-protective behavior of the adolescent girls, as the indigenous communities of Bandarban district highly value hygiene and sanitation (Hussain et al., 2015). Thus, a great chance of over and under estimation considering self-image protecting tendency as a potential confounder can be attributable to the association of taking baths and washing genitals with PD of menstrual hygiene due to water scarcity of the participating adolescent girls.

5. Conclusion

This study shed light on how the PD was associated with the demographic factors, practical hardship of getting water, and menstrual hygiene practices of the indigenous adolescent girls in Bandarban Hill District, providing evidence that PD increases with poor menstrual hygiene practices and practical hardship of getting water. The further analytical study could be carried out to investigate, with more methodological rigor, if the seasonal water scarcity is attributable to the PD.

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Availability of data

Complete data set and analyzed files are available in "sav" format and accessible to all. Any further use of these data is subjected to have prior permission of the corresponding author.

Authorship contribution statement

IHT: Study design, analysis, writing and editing; MAR: Study design, writing and editing; PS: Conceptualization, study design, data collection, and writing and editing; NP: Data collection, manuscript editing; MKT: Data analysis; IM: Project administration, writing and editing. All authors carefully read and provided consensus to the submitted version of the manuscript.

Declaration of competing interest

No conflict of interest is declared. The contents of this manuscript are free of copyright and submitted nowhere for publication.

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Appendix A. Supplementary data

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References

Ahmed, S., Tarique, K.M., Arif, I., 2017. Service quality, patient satisfaction and loyalty in the Bangladesh healthcare sector. Int. J. Health Care Qual. Assur. 30 (5), 477–488. https://doi.org/10.1108/IJHCQA-01-2017-0004.

Alam, M.Z., 2022. Ethnic inequalities in access to WASH in Bangladesh. Lancet Global Health 10 (8), e1086–e1087. https://doi.org/10.1016/S2214-109X(22)00232-7.

Alam, M.-U., Luby, S.P., Halder, A.K., Islam, K., Opel, A., Shoab, A.K., Ghosh, P.K., Rahman, M., Mahon, T., Unicomb, L., 2017. Menstrual hygiene management among Bangladeshi adolescent schoolgirls and risk factors affecting school absence: results from a cross-sectional survey. BMJ Open 7 (7), e015508. https://doi.org/10.1136/bmjopen-2016-015508.

Alicke, M.D., Sedikides, C., 2009. Self-enhancement and self-protection: what they are and what they do. Eur. Rev. Soc. Psychol. 20 (1), 1–48. https://doi.org/10.1080/10463280802613866.

Alin, A., 2010. Multicollinearity: multicollinearity. Wiley Interdisciplinary Reviews: Comput. Stat. 2 (3), 370–374. https://doi.org/10.1002/wics.84.

BBS, 2011b. Bangladesh Population and Housing Census 2011 Zila Report: *Bandarban*. Bangladesh Bureau of Statistics (BBS). https://www.bbs.gov.bd/site/page/47856ad0-7e1c-4aab-bd78-892733bc06eb/Population-and-Housing-Census.

BBS, 2011a. Population and Housing Census-2011 *National Volume-2: Union Statistics*. Bangladesh Bureau of Statistics (BBS). http://203.112.218.65:8008/WebTestApplication/userfiles/Image/National%20Reports/Union%20Statistics.pdf.

Blair, L.A.G., Bajón -Fernández, Y., Villa, R., 2022. An exploratory study of the impact and potential of menstrual hygiene management waste in the UK. Clean.Eng. Technol. 7, 100435 https://doi.org/10.1016/j.clet.2022.100435.

Bolarinwa, O., 2015. Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. Niger. Postgrad. Med. J. 22 (4), 195. https://doi.org/10.4103/1117-1936.173959.

Borua, G.R., Islam, S.M.S., Faisel, A.J., 2019. Menstrual hygiene: knowledge and practices among adolescent girls in a selected district of Bangladesh. Police Hospital J.Med.Sci. 87. https://cph.police.gov.bd/images/Others/CPH-Journal-2019.pdf.

Caruso, B.A., Portela, G., McManus, S., Clasen, T., 2020. Assessing women's menstruation concerns and experiences in rural India: development and validation of a menstrual insecurity measure. Int. J. Environ. Res. Publ. Health 17 (10), 3468. https://doi.org/10.3390/ijerph17103468.

Chakma, B., Dewan, J., Chakma, S.B., 2021. Water Scarcity Worsens Hill People's Woes | Prothom Alo. https://en.prothomalo.com/environment/water-scarcity-causes-hill-people-to-suffer.

Chatterjee, P., 2020. Improving menstrual hygiene among adolescent girls in India. Lancet Child Adolescent Health 4 (6), 422–423. https://doi.org/10.1016/S2352-4642(20)30142-5.

Chowdhury, M.Z.I., Turin, T.C., 2020. Variable selection strategies and its importance in clinical prediction modelling. Family Med. Commun. Health 8 (1), e000262. https://doi.org/10.1136/fmch-2019-000262.

Das, P., Baker, K.K., Dutta, A., Swain, T., Sahoo, S., Das, B.S., Panda, B., Nayak, A., Bara, M., Bilung, B., Mishra, P.R., Panigrahi, P., Cairncross, S., Torondel, B., 2015. Menstrual hygiene practices, WASH access and the risk of urogenital infection in women from Odisha, India. PLoS One 10 (6), e0130777. https://doi.org/10.1371/journal.pone.0130777.

Debnath, P., Mamun, M.M.A.A., Karmakar, S., Uddin, M.S., Nath, T.K., 2022. Drinking water quality of Chattogram city in Bangladesh: an analytical and residents' perception study. Heliyon 8 (12), e12247. https://doi.org/10.1016/j.heliyon.2022.e12247.

Downing, S., Benjimen, S., Natoli, L., Bell, V., 2021. Menstrual hygiene management in disasters: the concerns, needs, and preferences of women and girls in Vanuatu. Waterlines 40 (3), 144–159. https://doi.org/10.3362/1756-3488.21-00002.

Dr Shamima Yasmin, D.S.Y., 2013. Menstrual hygiene among adolescent school students: an indepth cross-sectional study in an urban community of WestBengal, India. IOSR J. Dent. Med. Sci. 5 (6), 22–26. https://doi.org/10.9790/0853-0562226.

Elledge, M., Muralidharan, A., Parker, A., Ravndal, K., Siddiqui, M., Toolaram, A., Woodward, K., 2018. Menstrual hygiene management and waste disposal in low and middle income countries—a review of the literature. Int. J. Environ. Res. Publ. Health 15 (11), 2562. https://doi.org/10.3390/ijerph15112562.

Ellis, A., Haver, J., Villasenor, J., Parawan, A., Venkatesh, M., Freeman, M.C., Caruso, B. A., 2016. WASH challenges to girls' menstrual hygiene management in metro manila, masbate, and south central mindanao, Philippines. Waterlines 35 (3), 306–323. https://doi.org/10.3362/1756-3488.2016.022.

Garg, S., Bhatnagar, N., Singh, M.M., Basu, S., Borle, A., Marimuthu, Y., Azmi, F., Dabi, Y., Bala, I., 2022. Menstrual hygiene management and its determinants among adolescent girls in low-income urban areas of Delhi, India: a community-based study. Osong Publ. Health Res. Perspect. 13 (4), 273–281. https://doi.org/10.24171/j.phrp.2022.0127.

Government of the People's Republic of Bangladesh, 2018. National Hygiene Survey 2018. Bangladesh Bureau of Statistics (BBS). https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b343a8b4_956b_45ca_872f_4cf9b2f1a6e0/2021-02-18-12-34-38806de91fa4ca8d9e70db96ecff4427.pdf.

Ha, Md A.T., Alam, Md Z., 2022. Menstrual hygiene management practice among adolescent girls: an urban–rural comparative study in Rajshahi division, Bangladesh. BMC Wom. Health 22 (1), 86. https://doi.org/10.1186/s12905-022-01665-6.

Harrell, F.E., Lee, K.L., Califf, R.M., Pryor, D.B., Rosati, R.A., 1984. Regression modelling strategies for improved prognostic prediction. Stat. Med. 3 (2), 143–152. https://doi.org/10.1002/sim.4780030207.

Hennegan, J., Sol, L., 2020. Confidence to manage menstruation at home and at school: findings from a cross-sectional survey of schoolgirls in rural Bangladesh. Cult. Health Sex. 22 (2), 146–165. https://doi.org/10.1080/13691058.2019.1580768.

Hossen, Md M., Muhibbullah, Md, Hasnat, M.A., Rahman, Md H., 2016. Water crisis, adaptation practices and management strategies in Chittagong hill Tracts (CHT) area: a case study on naniarchar upazila. Soc. Change 6 (1 & 2), 69–90.

Hussain, S., Ruano, A.L., Rahman, A., Rashid, S.F., Hill, P.S., 2015. From knowing our needs to enacting change: findings from community consultations with indigenous communities in Bangladesh. Int. J. Equity Health 14 (1), 126. https://doi.org/10.1186/s12939-015-0264-x.

Hussein, J., Gobena, T., Gashaw, T., 2022. The practice of menstrual hygiene management and associated factors among secondary school girls in eastern Ethiopia: the need for water, sanitation, and hygiene support. Women's Health 18, 174550572210878. https://doi.org/10.1177/17455057221087871.

Kasiulevičius, V., Šapoka, V., Filipavičiūtė, R., 2006. Sample size calculation in epidemiological studies. Vilnius Univ. Instit.Experiment. Clin. Med. Vilnius Univ. 7 (4). https://www.researchgate.net/publication/254847492_Sample_size_calculation_in_epidemiological_studies?enrichId=rgreq-fa0af9a02bd98e3a78a757b2d962148b-XXX&enrichSource=Y292ZXJQYWdlOzI1NDg0NzQ5MjtBUzoyMTgxNzcxNDY0OTQ5ODBAMTQyOTAyODg5MzUyMQ%3D%3D&el=1_x_2&_esc=publicationCoverPdf.

Krishnan, S., Twigg, J., 2016. Menstrual hygiene: a 'silent' need during disaster recovery. Waterlines 35 (3), 265–276. https://doi.org/10.3362/1756-3488.2016.020.

Kuhlmann, A.S., Henry, K., Wall, L.L., 2017. Menstrual hygiene management in resource-poor countries. Obstet. Gynecol. Surv. 72 (6), 356–376. https://doi.org/10.1097/OGX.0000000000000443.

Leung, S.-O., 2011. A comparison of psychometric properties and normality in 4-, 5-, 6-, and 11-point Likert scales. J. Soc. Serv. Res. 37 (4), 412–421. https://doi.org/10.1080/01488376.2011.580697.

Linacre, J.M., 2017. A User's Guide to FACETS. Rasch-Model Computer Programs. Program Manual 3.80. 0. Hentet, p. 25.

Mahmud, S., Amin, S.M.A., Rashed, A.W., Mahmud, R., 2020. Water, sanitation and hygiene practices among ethnic communities in Chittagong hill tracks, Bangladesh. Int.J. Curr. Res. 12.

Marais, I., Andrich, D., 2008. Formalizing dimension and response violations of local independence in the unidimensional Rasch model. J. Appl. Meas. 9 (3), 200–215.

McCreary, L.L., Conrad, K.M., Conrad, K.J., Scott, C.K., Funk, R.R., Dennis, M.L., 2013. Using the Rasch measurement model in psychometric analysis of the family

effectiveness measure. Nurs. Res. 62 (3), 149–159. https://doi.org/10.1097/NNR.0b013e31828eafe6.
Michael, J., Iqbal, Q., Haider, S., Khalid, A., Haque, N., Ishaq, R., Saleem, F., Hassali, M. A., Bashaar, M., 2020. Knowledge and practice of adolescent females about menstruation and menstruation hygiene visiting a public healthcare institute of Quetta, Pakistan. BMC Wom. Health 20 (1), 4. https://doi.org/10.1186/s12905-019-0874-3.
Mills, J.E., Cumming, O., 2016. The Impact of Water, Sanitation and Hygiene on KeyHealth and Social Outcomes. UNICEF. https://www.researchgate.net/profile/Joanna-Esteves-Mills/publication/319503296_The_impact_of_water_sanitation_and_hygiene_on_key_health_and_social_outcomes_review_of_evidence/links/59afa924458515150e4b0a73/The-impact-of-water-sanitation-and-hygiene-on-key-health-and-social-outcomes-review-of-evidence.pdf.
Mohammed, S., Larsen-Reindorf, R.E., 2020. 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 15 (10), e0241106. https://doi.org/10.1371/journal.pone.0241106.
Muhit, I.B., Chowdhury, S.T., 2013. Menstrual Hygiene Condition Of Adolescent Schoolgirls At Chittagong Division In Bangladesh 2 (6).
Palattiyil, G., Sidhva, D., Seraphia Derr, A., Macgowan, M., 2022. Global trends in forced migration: policy, practice and research imperatives for social work. Int. Soc. Work 65 (6), 1111–1129. https://doi.org/10.1177/00208728211022791.
Parle, J., Khatoon, Z., 2019. Knowledge, attitude, practice and perception about menstruation and menstrual hygiene among adolescent school girls in rural areas of Raigad district. Int.J.Commun.Med.Publ.Health 6 (6), 2490. https://doi.org/10.18203/2394-6040.ijcmph20192310.
Patel, K., Panda, N., Sahoo, K.C., Saxena, S., Chouhan, N.S., Singh, P., Ghosh, U., Panda, B., 2022. A systematic review of menstrual hygiene management (MHM) during humanitarian crises and/or emergencies in low- and middle-income countries. Front. Public Health 10, 1018092. https://doi.org/10.3389/fpubh.2022.1018092.
Peduzzi, P., Concato, J., Kemper, E., Holford, T.R., Feinstein, A.R., 1996. A simulation study of the number of events per variable in logistic regression analysis. J. Clin. Epidemiol. 49 (12), 1373–1379. https://doi.org/10.1016/S0895-4356(96)00236-3.
Raina, D., Balodi, G., 2014. Menstrual hygiene: knowledge, practise and restrictions amongst girls of dehradun, uttarakhand, India. Glob.J. Interdisciplinary.Soc. Sci. 3 (4).
Rossouw, L., Ross, H., 2021. Understanding Period poverty: socio-economic inequalities in menstrual hygiene management in eight low- and middle-income countries. Int. J. Environ. Res. Publ. Health 18 (5), 2571. https://doi.org/10.3390/ijerph18052571.
Roy, R.D., 2012. Country technical notes on indigenous peoples' issues: people's republic of Bangladesh. Int. Fund Agric.Dev. (IFAD) Asia Indigenous Peoples Pact (AIPP). https://www.ifad.org/documents/38714170/40224860/bangladesh_ctn.pdf/ea8bae36-7450-447a-b0e9-4c010ba315bf.
Shumie, Z.S., Mengie, Z.A., 2022. Menstrual hygiene management knowledge, practice and associated factors Among School Girls, Northeast Ethiopia. PLoS One 17 (7), e0271275. https://doi.org/10.1371/journal.pone.0271275.
Souza, M.A.P., Coster, W.J., Mancini, M.C., Dutra, F.C.M.S., Kramer, J., Sampaio, R.F., 2017. Rasch analysis of the participation scale (P-scale): usefulness of the P-scale to a rehabilitation services network. BMC Publ. Health 17 (1), 934. https://doi.org/10.1186/s12889-017-4945-9.
Sultana, F., 2011. Water, culture, and gender: an analysis from Bangladesh. In: Johnston, B.R., Hiwasaki, L., Klaver, I.J., Ramos Castillo, A., Strang, V. (Eds.), Water, Cultural Diversity, and Global Environmental Change. Springer Netherlands, pp. 237–252. https://doi.org/10.1007/978-94-007-1774-9_18.
Tegegne, T.K., Sisay, M.M., 2014. Menstrual hygiene management and school absenteeism among female adolescent students in Northeast Ethiopia. BMC Publ. Health 14 (1), 1118. https://doi.org/10.1186/1471-2458-14-1118.
Thakre, S.B., Thakre, S.S., Reddy, M., Rathi, N., Pathak, K., Ughade, S., 2011. Menstrual hygiene: knowledge and practice among adolescent school girls of saoner, nagpur district. J. Clin. Diagn. Res. 5.
Torondel, B., Sinha, S., Mohanty, J.R., Swain, T., Sahoo, P., Panda, B., Nayak, A., Bara, M., Bilung, B., Cumming, O., Panigrahi, P., Das, P., 2018. Association between unhygienic menstrual management practices and prevalence of lower reproductive tract infections: a hospital-based cross-sectional study in Odisha, India. BMC Infect. Dis. 18 (1), 473. https://doi.org/10.1186/s12879-018-3384-2.
Van Eijk, A.M., Sivakami, M., Thakkar, M.B., Bauman, A., Laserson, K.F., Coates, S., Phillips-Howard, P.A., 2016. Menstrual hygiene management among adolescent girls in India: a systematic review and meta-analysis. BMJ Open 6 (3), e010290. https://doi.org/10.1136/bmjopen-2015-010290.
VanLeeuwen, C., Torondel, B., 2018. Improving menstrual hygiene management in emergency contexts: literature review of current perspectives. Int. J. Wom. Health 10, 169–186. https://doi.org/10.2147/IJWH.S135587.
Wali, N., Georgeou, N., Simmons, O., Gautam, M.S., Gurung, S., 2020. Women and WASH in Nepal: a scoping review of existing literature. Water Int. 45 (3), 222–245. https://doi.org/10.1080/02508060.2020.1754564.
World Bank, 2018. Bangladesh: Access to Clean Water Will Reduce Poverty Faster [Text/HTML]. World Bank, 10/11/bangladesh-access-to-clean-water-will-reduce-poverty-faster.
Wu, H., Leung, S.-O., 2017. Can Likert scales be treated as interval scales?—a simulation study. J. Soc. Serv. Res. 43 (4), 527–532. https://doi.org/10.1080/01488376.2017.1329775.