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Menstrual Hygiene and Waste Disposal Practices among Reproductive-age Women in Rural and Urban Tamil Nadu, Southern India: A Cross-sectional Study

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ABSTRACT

Introduction: Despite menstruation affecting women for approximately 2,100 days throughout their lifetime, menstrual waste disposal remains an under-researched "double invisibility" issue with significant public health and environmental implications.

Aim: To assess the menstrual hygiene practices, the different menstrual waste disposal methods practised among rural and urban populations, and to study the various demographic variables associated with the menstrual hygiene and menstrual waste disposal practices.

Materials and Methods: The present analytical cross-sectional study was conducted among the field practice area of Dhanalakshmi Srinivasan Medical College, Siruvachur, Perambalur, Tamil Nadu, South India from September 2024 to November 2024. Reproductive-age women (15-49 years) from rural and urban areas of Perambalur district, Tamil Nadu were included. A multi stage sampling methodology was employed, randomly selecting 5 villages and 5 urban wards, followed by population proportion to size sampling and convenience sampling within households to achieve representative participant selection. Data was collected through structured face-to-face interviews using a pretested questionnaire covering sociodemographic characteristics, menstrual hygiene practices, and waste disposal patterns. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 26, employing Chi-square tests, Fisher's exact test, and independent t-tests to examine associations between sociodemographic factors and disposal practices, with significance set at $p < 0.05$.

Results: Among 505 participants (mean age 30.09±7.45 years), 303 (60%) practised safe disposal through dustbins while 202 (40%) used unsafe methods, primarily burning 181 (35.8%). Safe disposal practices were significantly associated with residence {urban (100%) vs rural (29.1%), $p<0.001$}, marital status {unmarried (100%) vs married (37.7%), $p<0.001$}, educational attainment {graduates (64.7%) vs basic schooling (50.0%), $p=0.006$}, family type {nuclear (65.9%) vs joint (35.1%), $p<0.001$}, housing infrastructure {pucca (71.0%) vs kutcha (0%), $p<0.001$}, toilet facilities {in-house (71.8%) vs open space (0%), $p<0.001$}, water supply {piped/stored (100%) vs borewell (2.9%), $p<0.001$], and monthly expenditure {>Rs.100 (100%) vs <Rs.100 (35.3%), $p<0.001$}.

Conclusion: Menstrual waste disposal practices are significantly influenced by sociodemographic factors, with urban residence, higher education, and better socioeconomic status strongly associated with safe disposal methods, highlighting the need for targeted interventions in rural and marginalised communities.

Keywords: Environmental sanitation, Health behaviour, Menstrual health management, Solid waste disposal

INTRODUCTION

The onset of menarche represents a pivotal developmental milestone, signalling the biological transition from adolescence to reproductive maturity- a transformative experience that profoundly shapes women's health trajectories throughout their lives [1]. This reproductive milestone initiates a journey spanning approximately 2,100 menstrual days over a woman's lifetime, equivalent to nearly six years of active menstruation which has a substantial role in her quality of life [2]. Menstrual health or hygiene encompasses a multidimensional area that extends far beyond basic biological processes. Optimal menstrual hygiene management requires the fulfilment of several critical components: reliable access to safe, absorbent menstrual products; adequate private facilities for hygienic product changes; consistent availability of clean water and soap for personal hygiene maintenance; and crucially, environmentally sustainable and health-conscious disposal mechanisms for used menstrual materials [3,4].

Women's choice of sanitary protection materials is determined by a complex interplay of factors. Geographic location significantly impacts product choices, with distinct variation patterns observed between rural and urban populations [5]. In India, readymade absorbents and ecofriendly sanitary napkins are commonly used in both urban and rural populations [6]. Traditional methods, such as the use of cloth and its reuse, are still practised, while the use of modern menstrual products like menstrual cups and tampons remains limited [7]. The complete menstrual hygiene management cycle is not limited to product usage alone but must also address the downstream challenge of menstrual waste disposal practices.

Women and girls employ a diverse array of disposal methods for used menstrual absorbents, each carrying distinct environmental and health implications. Current disposal practices include throwing used materials in open spaces, disposing them in latrines and toilets, burning through open incineration, burying, and utilising routine waste disposal systems. These practices are deeply influenced by embedded sociocultural norms and taboos surrounding menstruation and menstrual blood [8]. A systematic review and meta-analysis conducted in India [9] revealed that unsafe disposal practices, particularly throwing absorbents in open spaces and

burning, were significantly more prevalent in community-based studies, especially in rural and slum settings, compared to school-based studies. The study further demonstrated that reliable solid waste disposal systems were more accessible in urban areas than rural settings, highlighting geographic disparities in waste management infrastructure. The disposal method often depends on the type of absorbent material used, as evidenced by research in a South Indian city where 76% of female students burned used cloth materials [10], which has been a routine practice reported by another study done in North India [11]. The absence of appropriate disposal facilities creates considerable challenges, forcing women to resort to suboptimal practices such as storing used materials under beds for extended periods until suitable disposal opportunities arise [8].

The societal silence surrounding menstruation creates a "double invisibility" where menstrual waste disposal becomes an ultra-hidden aspect of women's health, receiving minimal research attention despite its significant implications. Although systematic reviews have documented unsafe menstrual waste disposal practices in India, most studies focus on school-based populations or single geographic settings [12-14]. Community-based research examining the full spectrum of reproductive-age women across both rural and urban areas, with comprehensive assessment of housing infrastructure, sanitation facilities, and economic factors as determinants of disposal behaviour, remains inadequate. The study aimed to assess the menstrual hygiene practices, the different menstrual waste disposal methods practised among rural and urban populations, and to study the various demographic variables associated with the menstrual hygiene and menstrual waste disposal practices.

MATERIALS AND METHODS

The present analytical cross-sectional study was conducted among the field practice area of Dhanalakshmi Srinivasan Medical College, Siruvachur, Perambalur, Tamil Nadu, South India from September 2024 to November 2024. Ethics committee approval was taken from the institution ethics committee (IECHS/IRCHS/No.558, 06.08.2024) and informed consent was obtained before the start of the study.

Inclusion and Exclusion criteria: The study population selected was from the reproductive age group, women aged 15-49 years permanently residing (≥6 months) in the selected study areas, currently menstruating or having menstruated within the past three months, and willing to provide informed consent for participation in structured interviews on menstrual hygiene and waste disposal practices were included. women who were pregnant, postpartum (within six months), menopausal, or experiencing medically induced amenorrhea were excluded.

Sample size and sampling technique: The sample size for this study was calculated using the standard formula for cross-sectional studies: $n=Z^2pq/d^2$, where n represents the required sample size, Z^2 equals 1.96 (corresponding to the statistical value for 95% confidence interval), p denotes the expected proportion, q represents (100-p), and d indicates the desired absolute precision. Based on findings from Gupta R et al., the prevalence of burning as the predominant method of menstrual waste disposal was used as the reference proportion, with p=72.10% and consequently q=27.90% [11]. With an absolute precision (d) set at 4%, the calculated minimum sample size was determined to be 482.78, which was rounded up to 483. To account for potential non-response and incomplete data, the total sample size collected for this study was 505 participants.

A multi stage sampling methodology was employed to ensure a representative selection of participants from both rural and urban areas. Initially, the sampling frame was established using the line list of households from the field practice area of a tertiary care hospital, which encompassed 17 villages in rural areas and 16 wards in urban areas. In the second stage, due to time constraints and investigator availability, five villages from the rural areas and five wards from the urban areas were randomly selected through a simple random sampling technique. The third stage involved determining the number of households to be sampled from each selected village and ward using population proportion to size (PPS) sampling, based on the calculated sample size and the assumption that each household contained at least one woman of reproductive age. Finally, convenience sampling was employed within the selected households to recruit participants until the predetermined sample size was achieved. While convenience sampling at the household level was necessitated by the sensitive nature of menstrual health topics and field practicalities, standardised selection criteria were applied, with the eldest eligible woman selected in households containing multiple eligible participants to minimise selection bias.

Study Procedure

Data collection was conducted using a pretested, structured questionnaire. A draft questionnaire was developed and a pilot study involving 20 participants was conducted to assess the clarity, comprehensiveness, and feasibility of the instrument. These 20 participants were subsequently excluded from the primary data analysis. Based on the feedback from the pilot study, necessary modifications were incorporated into the final version of the questionnaire. To ensure the internal consistency of the study tool (section 2 and 3), Cronbach's alpha coefficient was calculated, yielding a satisfactory score of 0.72, indicating an acceptable degree of internal consistency among the items within the questionnaire.

Data collection was conducted through structured face-to-face interviews using a comprehensive questionnaire specifically designed for this study. The questionnaire was systematically organised into three distinct sections to capture comprehensive information on menstrual health management practices. The first section comprised sociodemographic characteristics including age, education, place of residence, along with socioeconomic indicators such as modified BG Prasad socioeconomic classification, type of family structure, housing type (pucca, semi-pucca, kutcha), and toilet facility availability and location (inside home, outside home, open space).

The second section focused on menstrual-related details and hygiene practices, encompassing menstrual history including menarche age, frequency of menstrual material changes per day, monthly expenditure on sanitary materials, sources of menstrual hygiene information, and awareness and utilisation of both conventional and non-conventional menstrual hygiene products such as tampons and menstrual cups.

The third section specifically addressed menstrual waste disposal patterns, including various disposal methods practised (burning, wrapping and throwing in dustbins, throwing in fields). For this study, menstrual waste disposal practices were operationally defined based on guidelines from the Central Pollution Control Board of India [15]. 'Safe disposal' was defined as disposal methods that minimise human contact with used menstrual materials and reduce environmental pollution, specifically disposal in designated dustbins/waste bins with the assumption of proper municipal waste management infrastructure for subsequent handling. 'Unsafe disposal' included practices that expose others to decaying material or cause environmental contamination, specifically: burning (which releases toxic pollutants), throwing used materials in open fields or water bodies (ponds/rivers), flushing in toilets (which can cause sewage system blockages), and burial in inappropriate locations.

STATISTICAL ANALYSIS

The data collected was entered in Microsoft Excel (Microsoft Corporation, Redmond, WA) and analysed using SPSS trial version 26 {IBM Corp. Released 2019. IBM SPSS Statistics for Windows,

Version 26.0. Armonk, NY: IBM Corp} software. Descriptive statistics were calculated for sociodemographic variables, with results presented as means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Inferential statistics were employed to analyse relationships between sociodemographic factors and menstrual hygiene practices and waste disposal methods. Chi-square tests and Fisher's exact test were conducted to examine associations between categorical variables Independent t-tests were used to compare mean differences in age and age at menarche between groups practising safe versus unsafe disposal methods. Statistical significance was established at $p<0.05$.

RESULTS

The analysis was done with the categorisation of occupation as nil/stable (salaried and retired with pension)/unstable (agriculture, business and daily wager). The details of demographic features and other details are put up in [Table/Fig-1]. The mean monthly expenditure on sanitary products among participants was Rs. 115.79±73.034. A significant majority of participants 312 (61.8%) spent less than Rs.100 per month on sanitary materials, while 193 (38.2%) incurred expenses exceeding Rs.100 monthly for menstrual hygiene products.

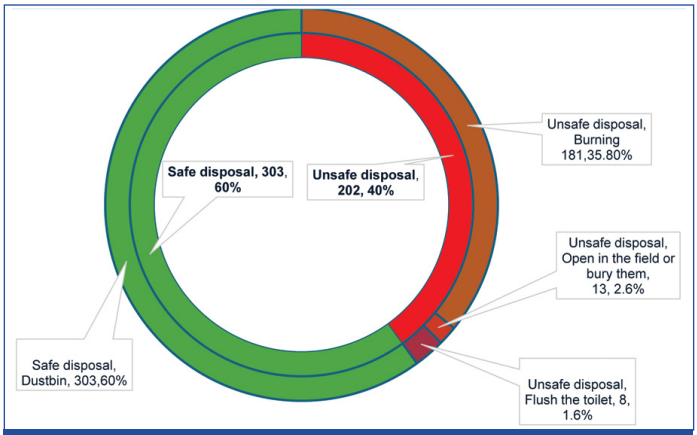
Parameters		Mean±Standard deviation
Age (years)		30.09±7.45
Menarche age (years)		13.76±1.248
Variables		**Frequency (%)**
Religion	Hindu	459 (90.9%)
	Christian	23 (4.6%)
	Muslim	23 (4.6%)
Education	Illiterate	11 (2.2%)
	Done Schooling	148 (29.3%)
	Graduate	346 (68.5%)
Occupation	Stable	248 (49.1%)
	Unstable	257 (50.9%)
Modified BG Prasad SES	I	161 (31.9%)
	II	192 (38.0%)
	III	81 (16.0%)
	IV	57 (11.3%)
	V	14 (2.8%)
Type of family	Joint family	97 (19.2%)
	Nuclear family	408 (80.8%)
Residence	Rural	285 (56.4%)
	Urban	220 (43.6%)
Marital status	Married	324 (64.2%)
	Unmarried	181 (35.8%)
Housing structure	Pucca house	427(84.6%)
	Kutcha house	78(15.4%)
Sanitation facilities	Toilet facilities within their premises	422(83.6%)
	Common toilet	54(10.7%)
	Open space outside	29(5.7%)
Household water supply	Water stored	42(8.3%)
	Borewell	208(41.2%)
	Piped supply at home	255(50.5%)

[Table/Fig-1]: Sociodemographic profile of the study participants (n=505).

Mothers emerged as the predominant source of menstrual health information for 370 participants (73.3%), followed by sisters (65, 12.9%) and healthcare workers (51, 10.1%). The utilisation of alternative menstrual hygiene products remained extremely limited, with only 18 participants (3.6%) having tried menstrual cups or tampons, compared to 487 (96.4%) who had not [Table/Fig-2]. The study revealed that 303 (60%) of participants practised safe disposal methods, primarily through proper disposal in dustbins [Table/Fig-3].

Questions	Values
Source of information	
Mother	370 (73.3%)
Sister	65 (12.9%)
Teacher	19 (3.8%)
Healthcare worker	51 (10.1%)
Knowledge questions	
The actual proper way of disposing of sanitary waste	
Using dustbin	278 (55.0%)
Burning	218 (43.2%)
Incinerator	9 (1.8%)
Practice	
Total number of times menstrual wastes are disposed of in a day	
≤ 2 times	177 (35.0%)
>3 times	328 (65.0%)
Are you able to change menstrual waste in public places?	
Yes	343 (67.9%)
No	162 (32.1%)
Other menstrual hygiene products used or feminine hygiene products used	
Have you tried using a menstrual cup or a tampon?	
Yes	18 (3.6%)
No	487 (96.4%)
If yes, using a menstrual cup - What is the method of sterilisation?	
Boiling	11 (2.2%)
Washing with tap water	7 (1.4%)

[Table/Fig-2]: Menstrual hygiene knowledge and practices among the population.



[Table/Fig-3]: Menstrual waste disposal practice among the subjects (n=505).

Age at menarche was significantly higher among those practicing unsafe disposal (13.98±1.49 vs 13.62±1.03 years, $p=0.002$). Safe disposal practices demonstrated significant associations with multiple sociodemographic and infrastructure variables (all $p<0.001$ unless specified): residence (urban 100% vs rural 29.1%), marital status (unmarried 100% vs married 37.7%), disposal frequency (<2 times/day 98.9% vs >3 times 39.0%), and monthly expenditure (>Rs.100: 100% vs <Rs.100: 35.3%) [Table/Fig-4].

DISCUSSION

The present study assessed various methods of menstrual waste disposal and their impact on menstrual hygiene among 505 women of reproductive age. In this study, 303 participants (60.0%) reported

Parameters		Safe disposal (n=303)	Unsafe disposal (n=202)	Table value	p-value
Age (years)		29.71±7.42	30.64±7.47	1.38[a]	0.170a
Age at menarche (years)		13.62±1.03	13.98±1.49	3.13[a]	0.002*
Religion	Hindu	272 (59.3%)	187 (40.7%)	1.97[c]	0.374
	Christian	17 (73.9%)	6 (26.1%)		
	Muslim	14 (60.9%)	9 (39.6%)		
Education	Illiterate	5 (45.5%)	6 (54.5%)	10.38[c]	0.006*
	Schooling	74 (50%)	74 (50%)		
	Graduate	224 (64.7%)	122 (35.3%)		
Occupation	Unstable	161 (62.6%)	96 (37.4%)	1.53[c]	0.217
	Stable	142 (57.3%)	106 (42.7%)		
Type of family	Nuclear family	269 (65.9%)	139 (34.1%)	31.14[c]	<0.001*
	Joint family	34 (35.1%)	63 (64.9%)		
Maternal education status	Illiterate	180 (59.6%)	122 (40.4%)	211.93[f]	<0.001*
	Schooling Done	107 (57.2%)	80 (42.8%)		
	Graduate	16 (100%)	0		
Residence	Rural	83 (29.1%)	202 (70.9%)	259.88[f]	<0.001*
	Urban	220 (100)	0		
Marital status	Married	122 (37.7%)	202 (62.3%)	188.08[f]	<0.001*
	Unmarried	181 (100%)	0		
Modified BG Prasad SES	I	124 (77%)	37 (23%)	70.70[f]	<0.001*
	II	128 (66.7%)	64 (33.3%)		
	III	32 (39.5%)	49 (60.5%)		
	IV	17 (29.8%)	40 (70.2%)		
	V	2 (14.3%)	12 (85.7%)		
Housing	Kutcha	0	78 (100%)	138.37[c]	<0.001*
	Pucca	303 (71%)	124 (29%)		
Toilet facility	Open space outside	0	29 (100%)	148.99[f]	<0.001*
	Common toilet	0	54 (100%)		
	Toilet in the house	303 (71.8%)	119 (28.2%)		
Household water supply	Water stored	42 (100%)	0	480.72[f]	<0.001*
	Borewell	6 (2.9%)	202 (97.1%)		
	Piped supply at home	255 (100%)	0		
No. of. times you change the menstrual waste in a day	≤2 times	175 (98.9%)	2 (1.1%)	171.56[f]	<0.001*
	>3 times	128 (39%)	200 (61%)		
Amount spent in a month for menstruation	≤100 Rs	110 (35.3%)	202 (64.7%)	208.26[f]	<0.001*
	>100 Rs	193 (100%)	0		

[Table/Fig-4]: Factors associated with unsafe and safe practices (Chi-square/Fisher's-exact).
*p-value < 0.05 is statistically significant; [a]Independent t-test expressed as mean + standard deviation; [c]Chi-square test expressed as frequency (%); [f]Fisher's exact test expressed as frequency (%)

using a dustbin for disposal, while 181 (35.8%) preferred burning their menstrual waste. The disposal practices observed in this study align with previous research conducted by Britto DR et al., which indicated that 98.48% of participants used sanitary pads exclusively, with the majority disposing of them in waste bins (62.48%) or by burning (34.43%) [7]. The percentage of tampon users in their study was 2.5%, which is lower than the study finding of 3.6%. This higher adoption of tampons in the present study likely reflects increased health education initiatives and greater exposure to diverse menstrual products in urban settings, where awareness campaigns and product availability have expanded access beyond traditional sanitary pads.

In a study done in Bangladesh and Egypt the menstrual waste disposal was done safely into dust bins [16,17]. But study done in Ethiopia showed that major subjects practice throwing in the latrine and burning as the disposal process [18]. In a study done by Thakre S et al., the urban rural difference was evident with safer disposal among urban subjects [19]. In a community-based study done in India [20] 54.8% were disposing safely in dustbins, whereas a study done in South Africa [21] showed the proportion to be 87.5%. The variations in disposal practices across studies can be attributed to differences in study population composition (rural versus urban), availability of waste management infrastructure, and varying socioeconomic conditions of the participants. Additionally, cultural norms, educational levels, and access to sanitation facilities in different geographic regions significantly influence the adoption of safe versus unsafe disposal methods.

The average age of menarche reported in this study was 13.76±1.248. Generally, the mean age at menarche in developed countries is lower than in developing countries, with reported ages of 13.05 years in France, 13.3 years in the United Kingdom, and 12.8 years in the United States, while it is 13.5 years in Sri Lanka, 15.8 years in Bangladesh, and 16.2 years in Nepal [22]. Regional variations in dietary patterns, particularly protein and micronutrient intake, play a crucial role, as adequate nutrition accelerates body fat accumulation necessary to trigger menarche. Genetic factors and environmental stressors such as altitude also contribute to these variations

Information sources showed interesting patterns when compared to other studies. The present finding that 73.3% received information from mothers was notably higher than Prajapati DJ et al., 54% and Jailkhani SMK 45.5% [23,24]. This higher proportion may reflect the specific cultural context of Tamil Nadu where maternal influence in health matters remains strong. The variation from Mitra A et al., findings in Gujarat, where teachers were the main source, suggest regional differences in information dissemination patterns, possibly due to varying levels of formal health education programs in schools and different cultural norms regarding discussing reproductive health within families versus educational institutions [25]. The contrast with the rural Varanasi study by Kansal S et al., where sisters (55%) and friends (46.75%) were primary sources, indicates that family dynamics and social structures vary significantly across different regions of India [26]. Most of the study participants belong to nuclear families, which is 404 (80.8%). This finding is comparable to a study conducted in Delhi by Kumar G et al., which reported that 71.3% of participants were from nuclear families [27].

The frequency of changing soaked menstrual waste is reported to be less than twice a day for 175 (98.9%) of respondents, while only 128 (39%) change it more than three times a day, among safe disposal practices. This is significantly lower compared to a study conducted by Kumar G et al., which indicated that 93% of participants changed their absorbent materials at appropriate intervals [27]. The present study results are similar to the study done by Shah SF et al., in Pakistan, among school students, of 49.3% reported to change their absorbents twice a day [28]. This discrepancy may be attributed to inadequate awareness regarding optimal menstrual hygiene practices, limited access to private changing facilities, particularly in rural areas, and cultural taboos that discourage frequent changing in public or shared spaces.

Menstrual waste disposal practices are profoundly influenced by sociocultural constraints and inadequate infrastructure, as demonstrated in the present study and corroborated by Roxburgh H et al., in Malawi [29]. Roxburgh's qualitative research revealed that menstruation remains shrouded in secrecy due to perceptions of menstrual blood as 'dirty' and fears of its misuse in witchcraft, leading women to conceal their menstrual practices. Their findings emphasized that infrastructure requirements vary based on menstrual product type: reusable cloth users require private bathrooms with discreet drainage, while disposable pad users need convenient disposal systems. These sociocultural and infrastructure dimensions align with the present study quantitative findings, where housing type emerged as a critical determinant- all participants in kutcha houses (100%) practised unsafe disposal compared to 71.0% safe disposal among pucca house residents. Unsafe disposal practice is seen among inadequate toilet facilities and those who use open space and common toilets. In contrast, 303 (71.8%) of the participants who practice safe disposal methods have a toilet facility inside the house, which is similar to the study done on period products among young women done by Biswas S et al., which showed a lack of toilet facilities or open spaces, reported a lower percentage, 60.05% of hygienic period [30].

Water supply plays a major role in waste disposal, as safe disposal practices are consistently observed among all households with piped water supply, in comparison to those relying on borewells or stored water for daily use. In a systematic review conducted by Robinson HJ et al., out of 80 studies, 56 indicated that the methods used for disposal and washing during menstruation were directly related to the adequacy of facilities for menstrual management [31]. Household sanitation significantly impacts menstrual hygiene management and the disposal of menstrual waste; however, the importance of water in sanitation is often overlooked. The study by Bhakta A et al., emphasises that washing and cleaning during menstruation require substantial amounts of water [32].

The present study indicates that a higher level of education correlates with a greater likelihood of safe disposal practices. This finding supports the research by Biswas S et al., which found that higher education levels lead to increased awareness of menstrual health and hygiene, as well as improved access to affordable menstrual hygiene products [30].

Menstrual waste management should be urgently integrated into existing governmental frameworks, particularly the Swachh Bharat Mission and National Health Mission, leveraging local governance structures (Panchayati Raj Institutions) and frontline workers to establish feasible rural infrastructure solutions including community hygiene corners, color-coded sanitary waste bins integrated with door-to-door collection systems, and Self-help group-operated small-scale incinerators.

Limitation(s)

The sample size calculation did not account for design effect in multi stage sampling, potentially affecting precision estimates. Convenience sampling at the household level, despite standardised protocols, may have introduced selection bias limiting representativeness. The cross-sectional design limits the ability to establish causal relationships between demographic factors and disposal practices, as it captures associations at a single point in time rather than tracking changes over time. The reliance on self-reported data through questionnaires introduces potential recall bias and social desirability bias, particularly given the sensitive nature of menstrual health topics and cultural taboos surrounding menstruation. Participants may have provided responses they perceived as socially acceptable rather than their actual practices. The study instrument was not subjected to formal content validity assessment through expert review, though face validity and internal consistency were established.

CONCLUSION(S)

The present study reveals that dustbin disposal emerged as the most practised safe disposal method, while burning was the predominant unsafe disposal practice, with significant disparities observed between rural and urban populations. The research identifies strong associations between disposal behaviours and multiple sociodemographic factors, including educational status, family structure, housing conditions.

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