




RESEARCH ARTICLE

# Unveiling disparities: a non-linear decomposition analysis of the gap in menstrual hygiene material use between adolescent women in Aspirational and the remaining districts of India

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## Abstract

This study aimed to investigate the factors contributing to the gap in the use of hygienic materials during menstruation to collect blood among adolescent women between Aspirational and the remaining districts of India. The study sample consisted of 114805 adolescent women (20835 women from 112 Aspirational districts and 93970 women from 595 remaining districts) from the National Family Health Survey-5. Fairlie decomposition was used to identify and measure the factors contributing to the gap in the use of hygienic materials between Aspirational and the remaining districts of India. This study determined that the use of hygienic materials during menstruation varied significantly between Aspirational and the remaining districts. While only 37% of adolescent women used hygienic materials in Aspirational districts, almost 52% did so in the remaining districts. Seventy-five per cent of Aspirational districts (84 of 112 districts) reported less than 50% use of hygienic materials, which is lower than the national average and the average of the remaining districts. It was revealed that nearly 90% of the total explained gap between the two groups was accounted for by household wealth, place of residence, exposure to mass media, and education level. Wealth was the main contributor to the gap, explaining about 46% of the difference in hygienic materials use between Aspirational and the remaining districts, followed by the place of residence (18%), exposure to mass media (15%), and education level (11%). Findings suggest that targeted interventions to improve access to hygienic materials among adolescent women in Aspirational districts, particularly those in the northern states of Uttar Pradesh, Bihar, and Chhattisgarh, are necessary. Policy efforts should focus on women from poor households, improving access to education, and expanding mass media exposure in Aspirational districts to reduce the gap in menstrual hygiene practices among adolescent women in India.

**Keywords:** menstrual hygiene practices; non-linear decomposition; hygienic materials use; menstrual hygiene; Fairlie decomposition; sanitary napkins

## Introduction

Menstrual hygiene is crucial for women's health, encompassing practices and facilities that ensure menstruation is managed in a clean, hygienic, and dignified manner (Gibson *et al.*, 2019). Access to hygienic materials such as sanitary pads, tampons, and menstrual cups is essential to maintain proper menstrual hygiene and prevent adverse health outcomes (Roeckel *et al.*, 2019). However, globally, many women and girls, especially in low- and middle-income countries, lack access to

these materials, leading to various health risks and hindrances to education and economic participation (Ademas *et al.*, 2020; Elledge *et al.*, 2018; Pandit *et al.*, 2014; Torondel *et al.*, 2018).

Low usage of hygienic materials during menstruation is a global issue, particularly in low- and middle-income countries. According to a study by UNICEF, over 500 million women and girls worldwide lack access to adequate menstrual hygiene materials, which can lead to a range of adverse health outcomes (Roeckel *et al.*, 2019; The World Bank, 2022). In addition, the issue of Menstrual Hygiene Management (MHM) is also linked to gender inequality, as a lack of access to menstrual hygiene materials can prevent women and girls from attending school or work, leading to missed opportunities and reduced economic participation (van Eijk *et al.*, 2016; Sivakami *et al.*, 2019; Sumpter and Torondel, 2013).

In recent years, there has been a concerted effort to address the pressing concerns surrounding MHM. Both governmental bodies and non-governmental organizations have implemented various programmes aimed at improving access to menstrual hygiene materials and disseminating essential menstrual hygiene education (Ram *et al.*, 2020; Singh *et al.*, 2022b; UNICEF, 2018). Despite these initiatives, a significant disparity persists in both the availability and utilization of hygienic materials during menstruation, particularly prevalent in low-income countries with constrained resources (Chakravarthy *et al.*, 2019; Singh *et al.*, 2022c). In such settings, the use of hygienic materials during menstruation assumes paramount importance, as it directly impacts women's reproductive and sexual health, overall well-being, and fundamental human rights (Elledge *et al.*, 2018; Kaur *et al.*, 2018; Ministry of Health: Republic of Kenya, 2020; McCammon *et al.*, 2020).

Furthermore, the promotion of menstrual hygiene is intricately intertwined with various Sustainable Development Goals (SDGs) (Ministry of Human Resource Development Government of India, 2014; Sommer *et al.*, 2021). Specifically, it serves as a catalyst for advancing multiple dimensions of sustainable development. For instance, by ensuring adequate menstrual hygiene practices, it contributes to the promotion of good health (SDG 3), facilitates access to education (SDG 4), fosters gender equality (SDG 5), and promotes responsible consumption and production patterns (SDG 12) (United Nations, 2015). Thus, the promotion of menstrual health emerges as a pivotal component of global development endeavours.

The Government of India has undertaken several initiatives to promote MHM among women, including the Menstrual Hygiene Scheme and the Swachh Bharat Abhiyan (Ministry of Jal Shakti, 2022; Shah, 2016). Despite these endeavours, there exists a notable oversight in addressing menstrual health within certain programmes, such as the 'Aspirational District Programme'. Launched in 2018, the Aspirational District Programme aims to ameliorate developmental gaps in 112 identified districts across the nation, categorized as 'Aspirational' based on various socioeconomic indicators (Khasnobis *et al.*, 2020). These districts were singled out for their lagging development indices. Despite the programme's concerted efforts to bolster critical sectors such as health, education, nutrition, agriculture, water resources, and basic infrastructure, there remains a significant lacuna in addressing menstrual health and hygiene. Moreover, there is a paucity of available data on the state of menstrual hygiene within these districts (Khasnobis *et al.*, 2020). Given the adverse health effects and reduced work productivity associated with the use of non-hygienic menstrual materials, it becomes imperative to prioritize MHM in Aspirational districts, not only to foster gender equality but also to empower women (McCammon *et al.*, 2020; Vishwakarma *et al.*, 2020). Understanding the current landscape of hygienic material usage and identifying potential strategies for enhancement is paramount. However, the prevailing information gap poses a significant hurdle in addressing this issue, underscoring the exigency for further research to delineate and tackle the challenges in promoting menstrual hygiene within these districts.

Research conducted by MHM in India has seen a surge in attention in recent years, particularly focusing on the adoption of hygienic menstrual materials among women. Recent studies have also conducted thorough examinations of the usage patterns of hygienic menstrual materials among

adolescent girls in India (Chauhan *et al.*, 2021; Majeed *et al.*, 2022). These investigations have revealed the persistence of traditional menstrual practices, notably the use of cloth and communal laundering, among women in rural regions of India (Singh *et al.*, 2022a). Such practices have been linked to an elevated susceptibility to reproductive tract infections (Anand *et al.*, 2015; Das *et al.*, 2015; Das *et al.*, 2021). Furthermore, research has highlighted the urgency of addressing MHM issues across India, with reports indicating that over 50% of adolescent girls in Delhi miss school during their periods due to inadequate water and sanitation facilities (Sharma *et al.*, 2017). Multiple studies have underscored the need for improved MHM practices among women in India (Bhusal, 2020; Sonowal and Talukdar, 2019; Yaliwal *et al.*, 2020).

Several recent inquiries have delved into the utilization of hygienic menstrual materials among Indian women (Goli *et al.*, 2020; Ram *et al.*, 2020). Some studies have found that women who opt for reusable menstrual cups report heightened levels of comfort and convenience compared to their counterparts using disposable sanitary pads, while also exhibiting a lower risk of vaginal infections in comparison to alternative absorbents such as pads and cloth (van Eijk *et al.*, 2016; MacRae *et al.*, 2019; Singh *et al.*, 2022a). Previous studies have ascertained menstrual cups to be a cost-effective and environmentally sustainable substitute for disposable sanitary pads (Mahajan, 2019; Roeckel *et al.*, 2019; Singh *et al.*, 2022c). Nevertheless, a recent study conducted by van Eijk *et al.* (2019) has highlighted the potential risks of vaginal wounds and toxic shock syndrome associated with the use of menstrual cups.

It is worth noting despite the growing focus on the utilization of hygienic materials in India, there exists a notable gap in research regarding the current status of their usage among adolescent women, particularly in Aspirational districts. The government has identified these districts as lagging in various health indicators, yet there is a dearth of research on menstrual hygiene practices in these districts (Khasnobis *et al.*, 2020). Given the potential impact of menstrual hygiene on women's health and overall well-being, this absence of attention is concerning. There is a need for further research to understand the challenges and opportunities for improving the proportion of use of hygienic materials during menstruation in Aspirational districts. By addressing the menstrual hygiene needs of women in these areas, we can help to improve their health outcomes and contribute to the broader goal of reducing health inequalities in India. Therefore, this paper aims to examine the disparities in the use of hygienic materials between Aspirational districts and the remaining districts of India, while also uncovering the factors contributing to the gap in the use of hygienic materials among adolescent women in these districts.

## Methods

### Data source

The data for this study come from the fifth round of the National Family Health Survey (NFHS-5), which was conducted during 2019–2021. It is a multi-round, large-scale survey with a nationally representative sample of Indian households. The NFHS collects information on various demographic, socioeconomic, maternal and child health outcomes, morbidity and healthcare, reproductive health, and family planning issues (International Institute for Population Sciences (IIPS) & ICF, 2021). The Government of India's Ministry of Health and Family Welfare approved the NFHS-5 survey conducted by the International Institute of Population Sciences, Mumbai, India. The NFHS-5 sample is a stratified two-stage sample. The study has been designed as a nationally representative cross-sectional study. In the survey, a uniform multistage sampling technique has been adopted with separate sampling in urban and rural areas. Detailed information about the sampling used in this survey can be obtained from the national report of NFHS-5 (International Institute for Population Sciences (IIPS) & ICF, 2021).

In NFHS-5, 724,115 women aged between 15 and 49 years were interviewed from 636,699 households, covering 28 states, 8 union territories, and 707 districts of India. For women, the

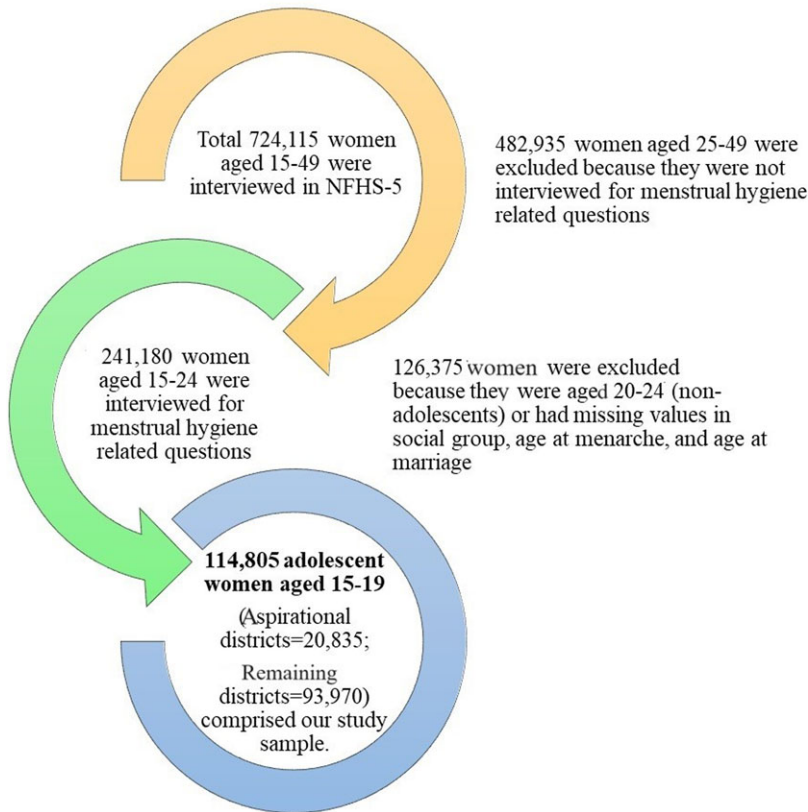


Figure 1. Sample size selection for the current study.

response rate was 97% in the survey. The study sample comprised 114,805 adolescents aged 15–19 years (20,835 from the Aspirational districts and 93,970 from the remaining districts) who were asked questions regarding the materials they use during menstruation (for a detailed list of Aspirational districts, see **supplementary table 1**). The detailed process of sample selection for this study is shown in Figure 1.

### Outcome variable

In NFHS-5, adolescent women were asked about the materials they use to prevent bloodstains during their menstruation. Women were offered seven possible responses to choose from, including clothes, sanitary napkins, locally prepared napkins, tampons, menstrual cups, and nothing. The responses were recoded into two categories. The first category included sanitary napkins, locally made napkins, tampons, and menstrual cups, and the second category included cloth, nothing, and others. Based on these categories, a binary outcome variable was created. Women who exclusively used materials from the first category (exclusive users of sanitary napkins, locally made napkins, tampons, and menstrual cups) were categorized as ‘exclusive users of hygienic materials’ and assigned the code ‘1’. Women who used materials from the second category or materials from a combination of both the first and second categories were labelled as ‘non-exclusive users of hygienic materials’ and coded as ‘0’.

Throughout the text, the phrase ‘use of hygienic materials’ was used to denote exclusive usage of hygienic materials. This choice was made to maintain clarity and ease of understanding for the reader.

### **Independent variables**

The current research investigated several socioeconomic and demographic factors potentially relevant to the use of hygienic materials (Chauhan *et al.*, 2021; Ram *et al.*, 2020; Roy *et al.*, 2021; Singh *et al.*, 2022a, 2022b, 2022c; Sivakami *et al.*, 2019; Vishwakarma *et al.*, 2020). These factors include the respondent's current age, age at menarche, marital status, education, employment status, religion, place of residence, social group, household wealth, exposure to mass media, interaction with community healthcare workers, and barriers such as distance, transportation, or permission issues encountered while seeking medical assistance. The selection of these variables was informed by a review of existing literature on menstrual hygiene practices, as documented in various sources. A detailed description of the independent variables is provided in **Supplementary Table 2**.

### **Statistical analysis**

In this study, various methods were used to compare the use of hygienic materials among adolescent women in Aspirational districts and the rest of the Indian districts. Firstly, a bivariate analysis was conducted to examine these differences. This involved looking at how the categorical independent variables relate to the outcome variable of interest. The chi-squared test was used to determine the statistical significance of these associations. Further to enhance the visualization of results, QGIS software was used to prepare a map that depicted the distribution of the use of hygienic materials among adolescent women in Aspirational and the remaining districts. Given the complex survey design of NFHS-5, the 'svyset' command in Stata 16 was used to account for sampling weights, design effects, and clustering.

Given that the study's outcome variable was binary, the Fairlie decomposition method was utilized to identify the factors contributing to the average outcome disparities between groups. This method aids in decomposing the gap between hygienic materials use between Aspirational districts and the remaining districts of India. To perform this analysis, the 'Fairlie' package in Stata 16 was used. For a detailed discussion of this decomposition method, please refer to Appendix A.

### **Results**

Table 1 provides the background characteristics of individuals from Aspirational and the remaining districts. Almost 80% of adolescent women from Aspirational and the remaining districts had experienced the onset of their menarche between 13 and 15 years. In terms of marital status, a higher percentage of individuals in Aspirational districts are married before the legal age of 18 years than in the remaining districts (10% vs 6%). The proportion of Hindus is higher in both Aspirational districts and the other districts compared to their respective counterparts. Only 6.3% of the adolescent women from Aspirational districts belonged to the richest wealth quintile compared to 17% of the adolescent women from the remaining districts.

### **Differences in the use of hygienic materials among adolescent women in Aspirational and the remaining districts of India by selected background characteristics**

Figure 2 shows that in India, the use of hygienic materials during menstruation stands at 50% among adolescent women. However, the use of hygienic materials is lower in Aspirational districts (38%) compared to the remaining districts (52%).

Table 2 shows the percentage of adolescent women who used hygienic materials for menstrual bloodstain prevention by selected background characteristics in Aspirational and the remaining districts of India. There is a positive correlation between the level of education and the use of hygienic materials in India's Aspirational and the remaining districts. This trend is consistently observed across various socioeconomic and religious subgroups.

**Table 1.** Background characteristics of sampled adolescent women in India, NFHS-5, 2019–2021

Background characteristics	Aspirational districts		Remaining districts	
	Frequency (20,835)	Weighted percentage	Frequency (93,970)	Weighted percentage
<b>Age at menarche (in years)</b>				
≤12	3,971	19.06	16,395	17.45
13–15	16,434	78.88	75,100	79.92
≥16	430	2.06	2,476	2.63
<b>Age at marriage (in years)</b>				
Not married	17,353	83.29	82,567	87.87
Married <18 years	2,099	10.08	6,392	6.80
Married ≥18 years	1,383	6.64	5,010	5.33
<b>Level of education</b>				
No education	1,767	8.48	3,488	3.71
Primary	1,596	7.66	4,466	4.75
Secondary	16,547	79.42	78,478	83.51
Higher	925	4.44	7,538	8.02
<b>Religion</b>				
Hindu	16,874	80.99	77,320	82.28
Muslim	2,978	14.29	12,604	13.41
Christian	427	2.05	1,896	2.02
Others	556	2.67	2,150	2.29
<b>Social group</b>				
SC	4,238	20.34	23,458	24.96
ST	3,823	18.35	8,102	8.62
OBC	9,789	46.98	43,437	46.22
Other	2,986	14.33	18,973	20.19
<b>Household wealth index</b>				
Poorest	7,952	38.17	18,007	19.16
Poorer	5,492	26.36	20,747	22.08
Middle	3,643	17.49	20,408	21.72
Richer	2,443	11.73	18,829	20.04
Richest	1,304	6.26	15,979	17.00
<b>Exposure to mass media</b>				
No exposure	6,074	29.15	16,555	17.62
Any one type of media exposure	14,761	70.85	77,415	82.38
<b>Discussed menstrual hygiene with healthcare workers in past three months</b>				
No	20,438	98.09	91,964	97.87
Yes	397	1.91	2,006	2.13

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Table 1. (Continued)

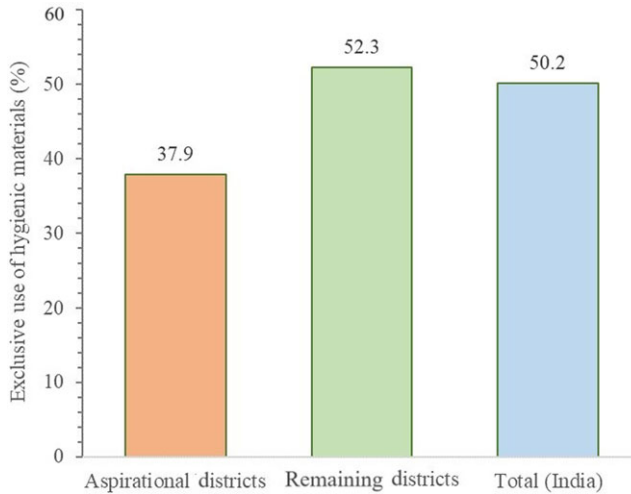
Background characteristics	Aspirational districts		Remaining districts	
	Frequency (20,835)	Weighted percentage	Frequency (93,970)	Weighted percentage
<b>Place of residence</b>				
Rural	17,465	83.82	65,650	69.86
Urban	3,370	16.18	28,320	30.14
<b>Problem regarding getting medical help for self: getting permission to go</b>				
No problem	11,124	53.39	57,143	60.81
Big problem	4,463	21.42	14,694	15.64
Not a big problem	5,248	25.19	22,133	23.55
<b>Problem regarding getting medical help for self: getting money needed for treatment</b>				
No problem	8,293	39.80	46,417	49.40
Big problem	5,876	28.20	19,532	20.79
Not a big problem	6,666	31.99	28,020	29.82
<b>Problem regarding getting medical help for self: distance of health facility</b>				
No problem	6,740	32.35	40,494	43.09
Big problem	6,579	31.58	21,346	22.72
Not a big problem	7,516	36.07	32,130	34.19
<b>Problem regarding getting medical help for self: transportation</b>				
No problem	7,168	34.40	42,230	44.94
Big problem	6,316	30.31	19,866	21.14
Not a big problem	7,351	35.28	31,874	33.92

Note: SC = Scheduled Caste, ST = Scheduled Tribe, OBC = Other Backward Classes

In addition, the use of hygienic materials among those who discussed menstrual hygiene with health workers in the remaining districts is higher than such women in Aspirational districts (58% vs 39%). Interestingly, the general category women ('others') in both groups of districts are more likely to use hygienic materials as compared to women from the SC/ST group.

### **Geographical variation in the use of hygienic materials across the Aspirational and the remaining districts of India**

The limited adoption of hygienic materials within India's 112 Aspirational districts is a cause for concern, as highlighted in Figure 3. 84 of these districts have indicated a usage rate of less than 50%. The analysis reveals significant disparities in hygienic material usage even among these districts. Notably, districts in southern states such as Tamil Nadu and Telangana demonstrate better performance compared to those in Uttar Pradesh, Bihar, and Chhattisgarh. Specifically, the investigation identifies that among Uttar Pradesh's eight Aspirational districts, six – Balrampur, Chitrakoot, Shrawasti, Bahraich, Sonbhadra, and Fatehpur – recorded usage rates of <20%. In contrast, both the Aspirational districts in Tamil Nadu (Virudhunagar and Ramanathapuram) and the Mamit Aspirational district in Mizoram reported usage rates exceeding 80%.



**Figure 2.** Exclusive use of hygienic materials among adolescent women between Aspirational and the remaining districts in India, NFHS-5, 2019–2021.

### Results of the decomposition analysis

The results of the decomposition analysis are provided in Table 3. In the bivariate analysis (from the chi-squared test), an insignificant association was identified between women's current age and interaction with community health workers about menstrual hygiene and the hygienic materials used, so these variables were removed from further analysis. After controlling for other variables, the results showed that adolescent women from Aspirational districts were less likely to use hygienic materials than women in the remaining districts. For instance, among adolescent women in Aspirational and the remaining districts, the mean of using hygienic materials was 0.38 and 0.52, respectively. The findings revealed that the factors included in the decomposition analysis accounted for over 71% of the gap in the use of hygienic materials between Aspirational and the remaining districts of India.

Table 4 presents the decomposition analysis results of the use of hygienic materials gap between Aspirational and the remaining districts. The coefficient is provided in the form of a percentage to make the findings easy to interpret and understand. Of this total explained gap, nearly 90% of the gap is explained by household wealth, place of residence, exposure to mass media, and education level. Results indicate that wealth is the main contributing factor, explaining about 46% of the gap in hygienic materials use between Aspirational and the remaining districts. The place of residence is another significant contributing factor explaining about 18% of the gap. Notably, women's exposure to mass media explains about 15% of the gap in the use of hygienic materials between Aspirational and the remaining districts. About 13% of the gap is explained by women's group differences in the level of education. Besides, the contribution of religion, marital status, and various problems regarding getting medical help for self are negligible.

### Discussion

The primary objective of this study was to examine the differences in the use of hygienic materials during menstruation between Aspirational and the remaining districts of India and identify the factors contributing to the gap in the usage between these two sets of districts. To achieve this objective, data from the NFHS-5 conducted between 2019 and 2021 were analysed. The findings revealed significant disparities in the use of hygienic materials during menstruation between Aspirational and the remaining districts. While nearly half of the women in India used hygienic



**Table 2.** Exclusive use of hygienic materials among adolescent women by selected background characteristics in Aspirational and the remaining districts in India, NFHS-5 (2019–2021)

Background characteristics	Aspirational districts (N = 20,835)		Remaining districts (N = 93,970)	
	Weighted %	95% CI	Weighted %	95% CI
<b>Age at menarche (in years)</b>	<b>(<math>\chi^2</math>: 44.65 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 152.88 p: &lt;0.001)</b>	
≤12	39.64	[37.37,41.96]	56.52	[55.21,57.83]
13–15	37.11	[35.82,38.42]	51.33	[50.62,52.05]
≥16	51.77	[36.69,39.11]	55.04	[52.40,57.64]
<b>Age at marriage (in years)</b>	<b>(<math>\chi^2</math>: 64.52 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 111.25 p: &lt;0.001)</b>	
Not married	38.61	[37.32,39.91]	52.83	[52.12,53.53]
Married <18 years	30.02	[27.40,32.77]	45.99	[44.06,47.93]
Married ≥18 years	40.93	[37.42,44.54]	52.35	[50.42,54.29]
<b>Level of education</b>	<b>(<math>\chi^2</math>: 1019.24 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 3992.12 p: &lt;0.001)</b>	
No education	15.35	[13.14,17.85]	18.49	[16.66,20.47]
Primary	16.51	[14.32,18.96]	24.28	[22.49,26.15]
Secondary	40.92	[39.63,42.22]	53.76	[53.07,54.46]
Higher	63.78	[59.55,67.80]	69.76	[68.17,71.29]
<b>Religion</b>	<b>(<math>\chi^2</math>: 104.45 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 764.67 p: &lt;0.001)</b>	
Hindu	38.64	[37.33,39.97]	52.43	[51.71,53.15]
Muslim	30.98	[28.08,34.04]	45.87	[44.07,47.70]
Christian	40.06	[34.31,46.09]	67.63	[64.56,70.56]
Others	50.78	[46.16,55.38]	73.21	[70.67,75.61]
<b>Social group</b>	<b>(<math>\chi^2</math>: 181.93 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 1304.48 p: &lt;0.001)</b>	
SC	35.39	[33.19,37.66]	50.9	[49.73,52.08]
ST	31.54	[29.53,33.62]	43.26	[41.57,44.96]
OBC	38.73	[37.06,40.42]	49.99	[49.10,50.88]
Other	46.87	[43.87,49.89]	63.35	[61.99,64.68]
<b>Household wealth index</b>	<b>(<math>\chi^2</math>: 2206.86 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 11800.00 p: &lt;0.001)</b>	
Poorest	22.49	[21.12,23.91]	27.26	[26.21,28.34]
Poorer	35.16	[33.34,37.02]	39.68	[38.65,40.72]
Middle	47.60	[45.22,49.99]	54.00	[52.90,55.11]
Richer	60.84	[57.92,63.69]	65.73	[64.59,66.85]
Richest	73.30	[69.42,76.84]	79.11	[77.97,80.21]
<b>Exposure to mass media</b>	<b>(<math>\chi^2</math>: 953.35 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 4383.50 p: &lt;0.001)</b>	
No exposure	22.08	[20.57,23.68]	28.83	[27.72,29.97]

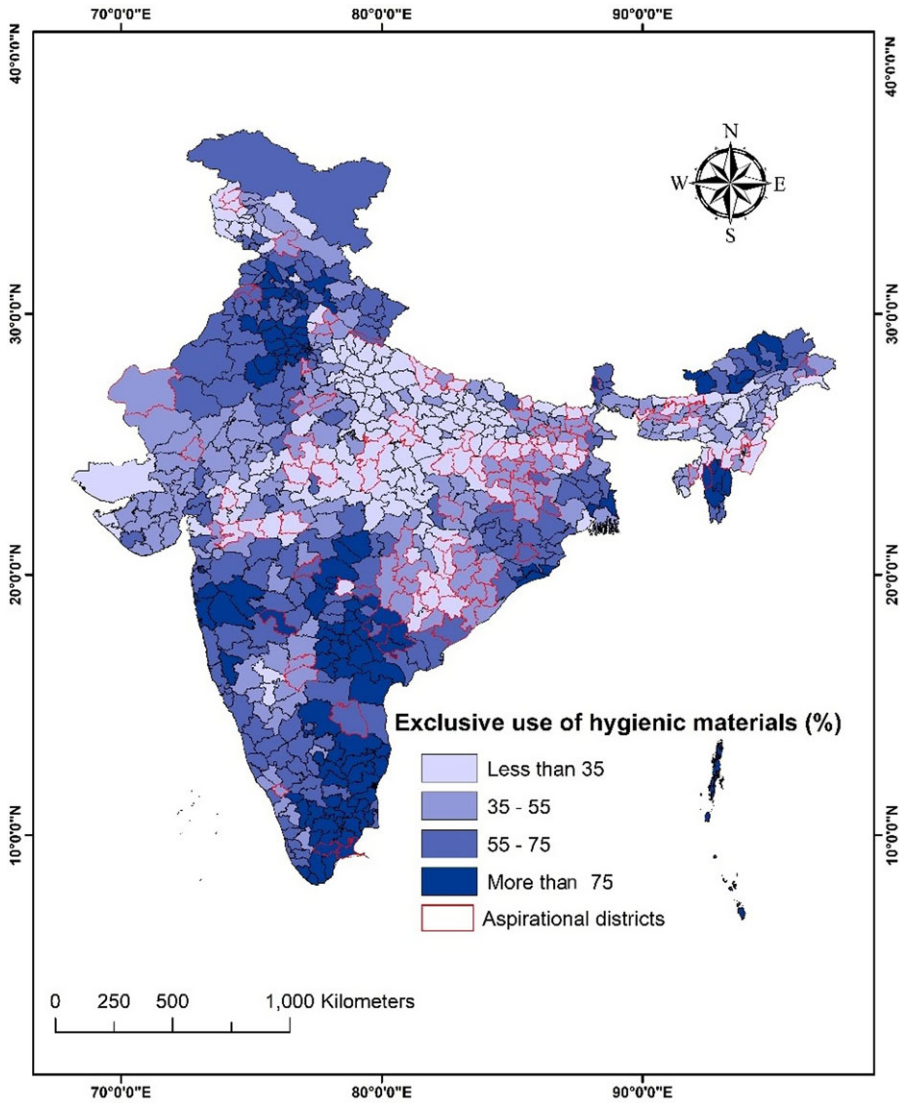
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Table 2. (Continued)

Background characteristics	Aspirational districts (N = 20,835)		Remaining districts (N = 93,970)	
	Weighted %	95% CI	Weighted %	95% CI
Any one type of media exposure	44.71	[43.33,46.09]	57.29	[56.59,57.98]
<b>Discussed menstrual hygiene with healthcare workers in past three months</b>	<b>(<math>\chi^2</math>: 0.43 p: 0.586)</b>		<b>(<math>\chi^2</math>: 28.56 p: &lt;0.001)</b>	
No	37.87	[36.65,39.09]	52.21	[51.52,52.89]
Yes	39.47	[33.85,45.38]	58.23	[55.01,61.38]
<b>Place of residence</b>	<b>(<math>\chi^2</math>: 693.51 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 693.51 p: &lt;0.001)</b>	
Rural	34.01	[32.79,35.25]	34.01	[32.79,35.25]
Urban	58.04	[54.58,61.43]	58.04	[54.58,61.43]
<b>Problem regarding getting medical help for self: getting permission to go</b>	<b>(<math>\chi^2</math>: 197.83 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 1587.92 p: &lt;0.001)</b>	
No problem	42.27	[43.49,47.00]	57.34	[56.57,58.12]
Big problem	31.87	[29.78,34.04]	41.04	[39.75,42.34]
Not a big problem	33.74	[31.83,35.71]	46.9	[45.79,48.02]
<b>Problem regarding getting medical help for self: getting money needed for treatment</b>	<b>(<math>\chi^2</math>: 362.16 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 2543.53 p: &lt;0.001)</b>	
No problem	45.24	[43.18,46.03]	60.39	[59.55,61.22]
Big problem	29.90	[28.10,31.75]	41.03	[39.87,42.20]
Not a big problem	35.81	[34.07,37.58]	46.87	[45.86,47.88]
<b>Problem regarding getting medical help for self: distance of health facility</b>	<b>(<math>\chi^2</math>: 364.27 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 2491.78 p: &lt;0.001)</b>	
No problem	46.73	[44.85,48.62]	61.45	[60.55,62.35]
Big problem	31.13	[29.44,32.86]	42.52	[41.43,43.61]
Not a big problem	35.90	[34.25,37.59]	47.37	[46.40,48.34]
<b>Problem regarding getting medical help for self: transportation</b>	<b>(<math>\chi^2</math>: 403.28 p: &lt;0.001)</b>		<b>(<math>\chi^2</math>: 2671.29 p: &lt;0.001)</b>	
No problem	46.55	[44.72,48.40]	61.57	[60.68,62.45]
Big problem	30.03	[28.35,31.76]	42.87	[41.77,43.99]
Not a big problem	36.21	[34.58,37.88]	45.99	[45.03,46.97]
<b>Type of materials used during menstruation</b>				
Unhygienic	62.10	[60.90,63.30]	47.66	[46.99,48.34]
Hygienic	37.90	[36.70,39.10]	52.34	[51.66,53.01]

Note: CI = confidence interval, N = sample size, SC = Scheduled Caste, ST = Scheduled Tribe, OBC = Other Backward Classes

materials during menstruation, only 37% of adolescent women in Aspirational districts reported use of such materials, which was lower than the national average and the average of the remaining districts. Therefore, it is crucial to include menstrual health in the 'Aspirational District Programme' to ensure that women's sexual and reproductive health needs are adequately addressed.



**Figure 3.** District-wise map showing exclusive use of hygienic materials among adolescent women in Aspirational and the remaining districts in India, NFHS-5, 2019–2021.

This study also found that the use of hygienic materials varied significantly across Aspirational districts, with Aspirational districts in southern states performing better than those in Uttar Pradesh, Bihar, and Chhattisgarh. This discrepancy within Aspiration districts underscores the importance of further investigation into the factors contributing to such disparities and the implementation of targeted interventions to address them. Furthermore, Fairlie decomposition analysis identified household wealth, place of residence, exposure to mass media, and level of education as significant factors contributing to the gap in the use of hygienic materials between Aspirational and the remaining districts. These factors collectively accounted for over 90% of the gap in the use of hygienic materials, with household wealth being the most significant contributor, followed by the place of residence, exposure to mass media, and education level.

The disparity in household wealth is one of the main contributing factors behind the gap in the use of hygienic materials between the Aspirational districts and the remaining districts. The

**Table 3.** Summary result of Fairlie decomposition analysis showing the mean differences in the use of hygienic materials among adolescent women between Aspirational and the remaining districts of India, NFHS-5, 2019–2021

Total number of observations	1,14,805
Total number of observations (remaining districts)	93,970
Total number of observations (Aspirational districts)	20,835
Mean prediction for remaining districts	0.52
Mean prediction for Aspirational districts	0.38
Mean difference (remaining districts – Aspirational districts)	0.14
Total explained	0.10
Percentage explained	70.82

**Table 4.** Fairlie decomposition of the average gap in the exclusive use of hygienic materials among adolescent women between Aspirational and the remaining districts of India, NFHS-5, 2019–2021

Variables	Coefficient	95% CI		% Contribution	p-value
		Lower	Upper		
Age (in years)	–0.0002	–0.0003	0.0000	–0.15	0.024
Age at menarche (13 years or above)	–0.0004	–0.0006	–0.0003	–0.43	<0.001
Marital status (married before 18 years)	–0.0015	–0.0021	–0.0008	–1.44	<0.001
Level of education (secondary or above)	0.0112	0.0105	0.0120	10.98	<0.001
Religion (Hindu)	0.0002	0.0001	0.0002	0.15	<0.001
Social group (non-SC/ST)	–0.0012	–0.0017	–0.0008	–1.20	<0.001
Household wealth (rich)	0.0472	0.0449	0.0495	46.08	<0.001
Exposure to mass media (at least any one type of media exposure)	0.0155	0.0141	0.0169	15.15	<0.001
Place of residence (urban)	0.0184	0.0170	0.0199	18.02	<0.001
Problem regarding getting medical help for self: getting permission to go	0.0028	0.0019	0.0036	2.72	<0.001
Problem regarding getting medical help for self: getting money needed for treatment	0.0045	0.0034	0.0056	4.39	<0.001
Problem regarding getting medical help for self: distance of health facility	0.0017	0.0003	0.0031	1.65	0.016
Problem regarding getting medical help for self: transportation	0.0042	0.0029	0.0055	4.09	<0.001
Total	0.1024			100	

Note: CI = confidence interval

findings of this study align with the previous studies, which suggest that household wealth is an essential factor associated with the use of hygienic menstrual materials in India (Anand *et al.*, 2015; Goli *et al.*, 2013; Singh *et al.*, 2022c). Furthermore, studies have identified that most women in Aspirational districts belong to the bottom 10% wealth quintile (Jain *et al.*, 2023). Hence, efforts to improve access to and affordability of menstrual hygiene products, particularly among women

from economically disadvantaged households in Aspirational districts, can significantly improve menstrual hygiene practices and women's health in India.

The findings of this study indicate that women's level of education is a significant factor contributing to the gap in the use of hygienic materials among adolescent women between both sets of districts in India. Previous research underscores the positive correlation between education and the use of hygienic materials (Chauhan *et al.*, 2021; Ram *et al.*, 2020; Rani, 2014; Roy *et al.*, 2021). Although the quality of education in the Aspirational districts and its impact on the use of hygienic materials needs to be further explored, existing evidence has consistently highlighted the poor state of education in Aspirational districts of India, including poor literacy and school enrolment rates, shortages of trained teachers, inadequate infrastructure, and limited basic facilities, all of which contribute to poor academic performance and affect women's knowledge and understanding of health and hygiene practices (NITI Aayog, 2021; Sarangapani *et al.*, 2021; Vanlalchhanhimi, 2020). Educational interventions promoting menstrual hygiene and health are crucial for improving the use of hygienic materials during menstruation among women in Aspirational districts.

This study highlights that the place of residence significantly contributes to the gap in the use of hygienic materials between Aspirational and the remaining districts. This could be due to the poor water, sanitation, and hygiene facilities in rural India, including Aspirational districts, as documented by several studies (India Water Portal, 2022; Kathuria and Raj, 2018; MacRae *et al.*, 2019). For instance, a study revealed only 45% of rural households in India have access to improved sanitation facilities (Prakash *et al.*, 2022). The situation worsens in Aspirational districts, with fewer households accessing safe drinking water and sanitation facilities (Khasnobis *et al.*, 2020). Moreover, rural areas often face challenges in accessing and availability of hygienic materials, which may further contribute to lower usage among rural adolescent women (Chakrabarty *et al.*, 2023; Singh *et al.*, 2022b).

The lack of access to mass media, such as television and newspapers, in Aspirational districts significantly contributes to the wider gap in the use of hygienic materials among adolescent women in Aspirational and the remaining districts. Previous research has shown that mass media exposure has a positive association with the use of hygienic materials during menstruation (Chauhan *et al.*, 2021; Malhotra *et al.*, 2016; Singh *et al.*, 2022a). As the primary source of information on menstrual hygiene, frequent exposure to mass media can potentially increase the use of hygienic materials (Babbar *et al.*, 2021; Singh *et al.*, 2023). Therefore, efforts should be made through campaigns and outreach programmes to raise awareness of best menstrual hygiene practices and the consequences of using unhygienic materials, such as the increased likelihood of reproductive tract infections.

Several initiatives have been implemented to address menstrual hygiene issues in India and its states. For example, the 'Suvidha' initiative by the Central Government of India offers a four-pack of affordable, biodegradable sanitary napkins sold at government-owned pharmacies (Ministry of Chemical and Fertilizers, 2019). Additionally, the Menstrual Hygiene Scheme, initiated in 2011, offers free sanitary napkins to girls in government schools, benefiting over 10 million girls nationwide (Shah, 2016). However, challenges such as inadequate absorbent quality and inconsistent funding hinder their effectiveness (Shah *et al.*, 2013). To ensure sustainability, one proposed solution is to engage stakeholders and guarantee a steady supply of subsidized sanitary napkins (Anand *et al.*, 2015; Shah *et al.*, 2013). Self-help groups could play a pivotal role in advancing menstrual hygiene in Aspirational districts through schemes such as the National Rural Livelihoods Mission, empowering women financially and socially while advocating for the use of hygienic materials (Department of Social Justice & Empowerment, Government of Himachal Pradesh, 2019; National Rural Health Mission, 2016).

Furthermore, the government has established the National Health Mission and the *Swachh Bharat Abhiyan* (Clean India Mission) to improve the overall health and sanitation conditions in rural areas (Ministry of Jal Shakti, 2022). These programmes aim to provide access to clean

drinking water, sanitation facilities, and health services essential for maintaining menstrual hygiene (Ministry of Health & Family Welfare, 2018). The government has also taken steps to train healthcare workers, including Accredited Social Health Activists (ASHA) and *Anganwadi* workers, to educate women and girls about menstrual hygiene and promote using hygienic materials (Anand *et al.*, 2015). Despite these efforts, the adoption of menstrual hygiene practices, particularly in Aspirational districts, remain low, highlighting the need for further support for these initiatives in these districts. By continuing to invest in these programmes and increasing access to hygienic materials and education, particularly in poorly performing Aspirational districts, the government can help mitigate the negative health impacts of using unhygienic materials.

The findings of this study have significant implications for policymakers and practitioners advocating for the adoption of hygienic materials during menstruation in India. The findings of this study indicate that interventions directed towards women from impoverished households, residing in rural areas, with limited exposure to mass media, and possessing lower educational attainment, could contribute to narrowing the disparity in the usage of hygienic materials during menstruation between Aspirational and the remaining districts. Additionally, this study highlights the need for tailored approaches that account for the variations in menstrual hygiene practices across different regions of India.

The current study has several limitations that warrant acknowledgement. Firstly, cross-sectional nature of the data restricts the ability to establish causal relationships between the variables of interest. Additionally, despite utilizing the most recent nationally representative dataset, reliance on self-reported data introduces potential biases, such as recall and social desirability biases. Additionally, the study solely focused on the use of hygienic materials during menstruation, which may not provide a comprehensive understanding of other menstrual hygiene practices that could potentially impact adolescent women's health outcomes. Future studies could encompass these practices to gain a more comprehensive understanding of the issue. Furthermore, it is important to note that the NFHS-5 dataset does not contain specific data on stigma and social factors related to menstrual hygiene in both sets of districts in India, which could be a possible factor behind this gap. Also, the NFHS dataset lacked supply side variables, such as the availability and pricing of hygienic materials at pharmacies and provision stores and the provision of sanitary napkins in schools. The exclusion of such critical factors may limit the interpretation of the study's results. Finally, the Fairlie decomposition method employed in this study has certain limitations. For example, it relies on the selection of variables included in the model, and the inclusion of unobserved factors could impact the estimation of the gap in the use of hygienic materials. While this research provides valuable insights into the factors contributing to the gap in the use of hygienic materials between these two sets of districts in India, highlighting the need for targeted policies and interventions to address this gap, a deeper inquiry is warranted to gain a comprehensive understanding of this issue.

## Conclusion

This study highlights a disparity in the use of hygienic materials during menstruation between Aspirational and the remaining districts in India. With almost two-thirds of Aspirational districts reporting less than 50% use of hygienic materials, urgent action is required to increase the use of hygienic materials during menstruation among adolescent women. The decomposition analysis results suggest that household wealth, place of residence, exposure to mass media, and education level are the key drivers of the gap in the use of hygienic materials between Aspirational and the remaining districts of India. Therefore, interventions to improve the use of hygienic materials should target these factors, particularly in the Aspirational districts of Uttar Pradesh, Bihar, and Chhattisgarh. Menstrual hygiene must be prioritized as a public health issue and access to the necessary resources to maintain menstrual hygiene must be ensured for every woman.

**Data availability statement.** The dataset used in the current study is available in the Demographic and Health Surveys (DHS) repository available online at <https://dhsprogram.com>

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## References

- Ademas A, Adane M, Sisay T, Kloos H, Eneyew B, Keleb A, Lingerew M, Derso A and Alemu K (2020) Does menstrual hygiene management and water, sanitation, and hygiene predict reproductive tract infections among reproductive women in urban areas in Ethiopia? *PLoS ONE* 15(August), 1–15. <https://doi.org/10.1371/journal.pone.0237696>
- Anand E, Singh J and Unisa S (2015) Menstrual hygiene practices and its association with reproductive tract infections and abnormal vaginal discharge among women in India. *Sexual and Reproductive Healthcare* 6(4), 249–254. <https://doi.org/10.1016/j.srhc.2015.06.001>
- Anand E, Unisa S and Singh J (2015) Menstrual hygiene management among young unmarried women in India. *Social Science Spectrum* 1(1), 20–31.
- Babbar K, Saluja D and Sivakami M (2021) How socio-demographic and mass media factors affect sanitary item usage among women in rural and urban India. *Waterlines* 3, 160–178.
- Bhusal CK (2020) Practice of menstrual hygiene and associated factors among adolescent school girls in Dang District, Nepal. *Advances in Preventive Medicine* 2020, 1–7. <https://doi.org/10.1155/2020/1292070>
- Chakrabarty M, Singh A, Let S and Singh S (2023) Decomposing the rural–urban gap in hygienic material use during menstruation among adolescent women in India. *Scientific Reports* 13(1), 22427. <https://doi.org/10.1038/S41598-023-49682-1>
- Chakravarthy V, Rajagopal S and Joshi B (2019) Does menstrual hygiene management in urban slums need a different lens? Challenges faced by women and girls in Jaipur and Delhi. *Indian Journal of Gender Studies* 26(1–2), 138–159. <https://doi.org/10.1177/0971521518811174>
- Chauhan S, Kumar P, Marbaniang SP, Srivastava S, Patel R and Dhillon P (2021) Examining the predictors of use of sanitary napkins among adolescent girls: a multi-level approach. *PLoS ONE* 16(April), 1–14. <https://doi.org/10.1371/journal.pone.0250788>
- Das P, Baker KK, Dutta A, Swain T, Sahoo S, Das SB, Panda B, Nayak A, Bara M, Bilung B, Mishra PR, Panigrahi P, Cairncross S and Torondel B (2015) Menstrual hygiene practices, WASH access and the risk of urogenital infection in women from Odisha, India. *PLoS ONE* 10(6), 1–16. <https://doi.org/10.1371/journal.pone.0130777>
- Das P, Lisnek D, Sahoo CK, Sinha S, Mohanty J, Sahoo P, Bilung B, *et al.* (2021) Identifying risk factors for lower reproductive tract infections among women using reusable absorbents in Odisha, India. *International Journal of Environmental Research and Public Health* 18(9), 1–15. <https://doi.org/10.3390/ijerph18094778>
- Department of Social Justice & Empowerment, Government of Himachal Pradesh. (2019) *Draft of Shashkat Mahila Yojna*. Available at [https://himachal.nic.in/WriteReadData/1892s/176\\_l892s/Sashakt%20Mahila%20Yojna-30901215.pdf](https://himachal.nic.in/WriteReadData/1892s/176_l892s/Sashakt%20Mahila%20Yojna-30901215.pdf) (accessed 3 October, 2024).
- Elledge MF, Muralidharan A, Parker A, Ravndal KT, Siddiqui M, Toolaram AP and Woodward KP (2018) Menstrual hygiene management and waste disposal in low and middle income countries—a review of the literature. *International Journal of Environmental Research and Public Health* 15(11), 2562. <https://doi.org/10.3390/ijerph15112562>
- Fairlie R (2005) An extension of the Blinder–Oaxaca decomposition technique to logit and probit models. *Journal of Economic and Social Measurement* 30, 305–316.

- Gibson L, Yamakoshi B, Burgers L and Alleman P** (2019) UNICEF Guidance on Menstrual Health and Hygiene [Internet]. New York: UNICEF. Available at <https://www.unicef.org/media/91341/file/UNICEF-Guidance-menstrual-health-hygiene-2019.pdf>
- Goli S, Doshi R and Perianayagam A** (2013) Pathways of economic inequalities in maternal and child health in urban India: a decomposition analysis. ed. César A. Hidalgo. *PLoS ONE* 8(3), e58573. <https://doi.org/10.1371/journal.pone.0058573>
- Goli S, Sharif N, Paul S and Salve PS** (2020) Geographical disparity and socio-demographic correlates of menstrual absorbent use in India: a cross-sectional study of girls aged 15–24 years. *Children and Youth Services Review* 117, 105283. <https://doi.org/10.1016/j.chidyouth.2020.105283>
- India Water Portal.** (2022) Rural Sanitation. *Arghyam*. <https://www.indiawaterportal.org/topics/rural-sanitation>
- International Institute for Population Sciences (IIPS) & ICF.** (2021) *National Family Health Survey (NFHS-5), 2019–21 India Report*.
- Jain A, Rajpal S, Rana JM, Kim R and Subramanian SV** (2023) Small area variations in four measures of poverty among Indian households: econometric analysis of National Family Health Survey 2019–2021. *Humanities and Social Sciences Communications* 10(1), 18. <https://doi.org/10.1057/s41599-023-01509-0>
- Kathuria B and Raj S** (2018) Effects of socio-economic conditions on usage of hygienic method of menstrual protection among young women in EAG states of India. *Amity Journal of Healthcare Management* 3(1), 40–52.
- Kaur R, Kaur K and Kaur R** (2018) Menstrual hygiene, management, and waste disposal: practices and challenges faced by girls/women of developing countries. *Journal of Environmental and Public Health* 2018, 1730964. <https://doi.org/10.1155/2018/1730964>
- Khasnobis BG, Uthup CJ, Mohanty S, Sikri U, Singh D, Baheti D, Chandna S, Bansal A, Kashyap P** (2020) Aspirational Districts Programme: An Appraisal. New Delhi: United Nations Development Program. Available at [https://www.undp.org/sites/g/files/zskgke326/files/2023-06/adp\\_report.pdf](https://www.undp.org/sites/g/files/zskgke326/files/2023-06/adp_report.pdf) (accessed 3 October, 2024).
- MacRae ER, Clasen T, Dasmohapatra M and Caruso BA** (2019) ‘It’s like a burden on the head’: redefining adequate menstrual hygiene management throughout women’s varied life stages in Odisha, India. *PLoS ONE* 14(8), 1–23. <https://doi.org/10.1371/journal.pone.0220114>
- Mahajan T** (2019) Imperfect information in menstrual health and the role of informed choice. *Indian Journal of Gender Studies* 26(1–2), 59–78. <https://doi.org/10.1177/0971521518811169>
- Majeed J, Sharma P, Ajmera P and Dalal K** (2022) Menstrual hygiene practices and associated factors among Indian adolescent girls: a meta-analysis. *Reproductive* 19(1), 148. <https://doi.org/10.1186/s12978-022-01453-3>
- Malhotra A, Goli S, Coates S and Mosquera-Vasquez M** (2016) Factors associated with knowledge, attitudes, and hygiene practices during menstruation among adolescent girls in Uttar Pradesh. *Waterlines* 35(3), 277–305. <https://doi.org/10.3362/1756-3488.2016.021>
- McCammon E, Bansal S, Hebert LE, Yan S, Menendez A and Gilliam M** (2020) Exploring young women’s menstruation-related challenges in Uttar Pradesh, India, using the socio-ecological framework. *Sexual and Reproductive Health Matters* 28(1), 291–302. <https://doi.org/10.1080/26410397.2020.1749342>
- Ministry of Chemical and Fertilizers.** (2019) Janaushadhi Suvidha Sanitary Napkin Will Now Be Available at One Rupee per Pad. Press Information Bureau. [cited 2024 Oct 3]. Available at = <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1583141>
- Ministry of Health & Family Welfare.** (2018) *Implementation Guidelines Rashtriya Kishor Swasthya Karyakram (RKSK)*. New Delhi: Government of India. Available at <https://nhmmizoram.org/upload/RKSK%20Operational%20Guidelines%20Book%204%20July%202018.pdf>
- Ministry of Health: Republic of Kenya.** (2020) Menstrual hygiene management policy. *The Practitioner* 171(1024), 458–459.
- Ministry of Human Resource Development, Government of India.** (2014) *Clean India: Clean Schools A Handbook*. New Delhi. Available at [https://www.education.gov.in/sites/upload\\_files/mhrd/files/upload\\_document/Eng\\_Swachch-Bharat-Swachch-Vidhalaya.pdf](https://www.education.gov.in/sites/upload_files/mhrd/files/upload_document/Eng_Swachch-Bharat-Swachch-Vidhalaya.pdf)
- Ministry of Jal Shakti.** (2022) *Success Story: MHM in Swachh Bharat Mission Grameen Pathbreaking Initiatives in Menstrual Hygiene Management*. New Delhi: Government of India. Available at <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1837524>
- National Rural Health Mission.** (2016) *Operational Guidelines on Promotion of Menstrual Hygiene among Adolescent Girls (10–19 Years) in Rural Areas*. Available at <https://nhm.gov.in/images/pdf/programmes/arsh/guidelines/MHS-operational-guidelines.pdf>
- NITI Aayog** (2021) *Healthy States Progressive India: Report on the Ranks of States and Union Territories: Health Index Round IV 2019–20*. Available at [https://social.niti.gov.in/uploads/sample/SHI\\_Round\\_fourth\\_Report.pdf](https://social.niti.gov.in/uploads/sample/SHI_Round_fourth_Report.pdf)
- Pandit D, Bhattacharyya PK, Bhattacharya R, Bhattacharyya DPK and Bhattacharya DR** (2014) Menstrual hygiene: knowledge and practice among adolescent school girls in rural areas of West Bengal. *IOSR Journal of Dental and Medical Sciences* 13(6), 19–24. <https://doi.org/10.9790/0853-16631924>
- Prakash S, Kumar P, Dhillon P and Unisa S** (2022) Correlates of access to sanitation facilities and benefits received from the Swachh Bharat Mission in India: analysis of cross-sectional data from the 2018 National Sample Survey. *BMJ Open* 12(7), 1–10. <https://doi.org/10.1136/bmjopen-2021-060118>



- Ram U, Pradhan MR, Patel S and Ram F (2020) Factors associated with disposable menstrual absorbent use among young women in India. *International Perspectives on Sexual* 46, 223–234. <https://doi.org/10.1363/46e0320>
- Rani PS (2014) Knowledge and practices of menstrual hygiene among married adolescents and young women in Chittoor District of Andra Pradesh: India. *IOSR Journal of Nursing and Health Science* 3(2), 06–15. <https://doi.org/10.9790/1959-03210615>
- Roeckel S, Cabrera-Clerget A and Yamakoshi B (2019) Guide to menstrual hygiene materials. *UNICEF*, 6–36.
- Roy A, Paul P, Saha J, Barman B, Kapasia N and Chouhan P (2021) Prevalence and correlates of menstrual hygiene practices among young currently married women aged 15–24 years: an analysis from a Nationally Representative Survey of India. *European Journal of Contraception and Reproductive Health Care* 26(1), 1–10. <https://doi.org/10.1080/13625187.2020.1810227>
- Sarangapani PM, Thirumalai B, Ramanathan A, Kumar R and Ramchand M (2021) *No Teacher, No Class: State of the Education Report for India 2021*.
- Shah P (2016) MDGs to SDGs: reproductive, maternal, newborn and child health in India. *Observer Research Foundation*, 1–26.
- Shah SP, Nair R, Shah PP, Modi DK, Desai SA and Desai L (2013) Improving quality of life with new menstrual hygiene practices among adolescent tribal girls in rural Gujarat, India. *Reproductive Health Matters* 21(41), 205–213. [https://doi.org/10.1016/S0968-8080\(13\)41691-9](https://doi.org/10.1016/S0968-8080(13)41691-9)
- Sharma S, Mehra D, Kohli C, Singh MM, Shantanu S, Mehra D, Kohli C and Singh MM (2017) Menstrual hygiene practices among adolescent girls in a resettlement colony of Delhi: a cross-sectional study. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology* 6(5), 1945. <https://doi.org/10.18203/2320-1770.ijrcog20171954>
- Singh A, Chakrabarty M and Chandra R (2023) Intra-urban differentials in the exclusive use of hygienic methods during menstruation among young women in India. *PLOS Global Public Health* 3(6), 1–22. <https://doi.org/10.1371/journal.pgph.0002047>
- Singh A, Chakrabarty M, Chowdhury S and Singh S (2022a) Exclusive use of hygienic menstrual absorbents among rural adolescent women in India: a geospatial analysis. *Clinical Epidemiology and Global Health* 17(May), 101116. <https://doi.org/10.1016/j.cegh.2022.101116>
- Singh A, Chakrabarty M, Singh S, Chandra R, Chowdhury S and Singh A (2022b) Menstrual hygiene practices among adolescent women in rural India: a cross-sectional study. *BMC Public Health* 22(1), 2126. <https://doi.org/10.1186/s12889-022-14622-7>
- Singh A, Chakrabarty M, Singh S, Mohan D, Chandra R and Chowdhury S (2022c) Wealth-based inequality in the exclusive use of hygienic materials during menstruation among young women in urban India. *PLoS one* 17(11), e0277095. <https://doi.org/10.1371/journal.pone.0277095>
- Sivakami M, van Eijk AM, Thakur H, Kakade N, Patil C, Shinde S, Surani N, *et al.* (2019) Effect of menstruation on girls and their schooling, and facilitators of menstrual hygiene management in schools: surveys in Government Schools in three states in India, 2015. *Journal of Global Health* 9(1), 010408. <https://doi.org/10.7189/jogh.09.010408>
- Sommer M, Torondel B, Hennegan J, Phillips-Howard PA, Mahon T, Motivans A, Zulaika G, *et al.* (2021) How addressing menstrual health and hygiene may enable progress across the sustainable development goals. *Global Health* 14(1), 1920315. <https://doi.org/10.1080/16549716.2021.1920315>
- Sonawal P and Talukdar K (2019) Menstrual hygiene knowledge and practices amongst adolescent girls in urban slums of Dibrugarh town—a cross sectional study. *Galore International Journal of Health Sciences and Research* 4(March), 44–51.
- Sumpter C and Torondel B (2013) A systematic review of the health and social effects of menstrual hygiene management. *PLoS ONE* 8(4), e62004. doi: [10.1371/journal.pone.0062004](https://doi.org/10.1371/journal.pone.0062004)
- The World Bank (2022) Menstrual health and hygiene. *The World Bank*, 1–12. <https://www.worldbank.org/en/topic/water/brief/menstrual-health-and-hygiene.print>
- Torondel B, Sinha S, Mohanty RJ, Swain T, Sahoo P, Panda B, Nayak A, *et al.* (2018) Association between unhygienic menstrual management practices and prevalence. *BMC Infectious Diseases* 18(1), 473.
- UNICEF (2018) Country snapshot: menstrual hygiene management in schools in South Asia: India, 1–4.
- United Nations (2015) *India and the MDGs towards a sustainable future for all*. Available at [https://repository.unescap.org/bitstream/handle/20.500.12870/613/India\\_and\\_the\\_MDGs.pdf?sequence=1&isAllowed=y](https://repository.unescap.org/bitstream/handle/20.500.12870/613/India_and_the_MDGs.pdf?sequence=1&isAllowed=y)
- van Eijk AM, Sivakami M, Thakkar MB, Bauman A, Laserson KF, Coates S and Phillips-Howard PA (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>
- van Eijk AM, Zulaika G, Lenchner M, Mason L, Sivakami M, Nyothach E, Unger H, Laserson K and Phillips-Howard PA (2019) Menstrual cup use, leakage, acceptability, safety, and availability: a systematic review and meta-analysis. *Lancet Public Health* 4(8), e376–e393. [https://doi.org/10.1016/S2468-2667\(19\)30111-2](https://doi.org/10.1016/S2468-2667(19)30111-2)
- Vanlalchhanhimi (2020) Implementation of Rashtriya Uchchar Shiksha Abhiyan in Mizoram: Status, Problems and Prospects. Unpublised Thesis. Available at <http://hdl.handle.net/10603/355546>

Vishwakarma D, Puri P and Sharma SK (2020) Interlinking menstrual hygiene with women's empowerment and reproductive tract infections: evidence from India. *Clinical Epidemiology and Global Health* 10, 100668. <https://doi.org/10.1016/j.cegh.2020.11.001>

Yaliwal RG, Biradar AM, Kori SS, Mudanur SR, Pujeri SU and Shannawaz M (2020) Menstrual morbidities, menstrual hygiene, cultural practices during menstruation, and WASH practices at schools in adolescent girls of North Karnataka, India: a cross-sectional prospective study. *Obstetrics and Gynecology International* 2020, 6238193. <https://doi.org/10.1155/2020/6238193>

## Appendix A

### Details of Fairlie decomposition

In this study, we wanted to understand why there is a difference in the use of hygienic materials between adolescent women in Aspirational and the remaining districts of India. To do this, we use a statistical technique called the Fairlie decomposition. The Fairlie decomposition breaks down the difference in outcomes between two groups (in our case, Aspirational and the remaining districts) into two parts: the 'explained' part and the 'unexplained' part. The explained part is due to differences in the characteristics of the two groups, such as their socioeconomic status. The unexplained part is due to other factors that we cannot measure, such as cultural or environmental differences, or supply side factors.

To calculate the contribution of each factor to the difference in outcomes, we start by estimating a logistic regression model using data from both Aspirational and the remaining districts. We then use this model to calculate the predicted probability of the outcome (the use of hygienic materials) for each observation in the Aspirational and the remaining districts' samples.

Next, we compare the predicted probabilities for the Aspirational and the remaining districts' samples to see how much of the difference in outcomes is due to differences in the independent variables. We do this separately for each independent variable. For example, if we have two independent variables (such as socioeconomic status and education), we can calculate how much of the difference in outcomes is due to differences in socioeconomic status, and how much is due to differences in education.

By using the Fairlie decomposition, we can identify and quantify the factors that contribute to the difference in hygienic material usage between Aspirational and the remaining adolescent women. This information can be used to develop policies and interventions aimed at reducing these disparities.

### Fairlie decomposition

This decomposition calculates the difference in the probability of an outcome between two groups and quantifies the contribution of group variations in the independent variables to the outcome differential (here, the two groups are Aspirational/remaining districts).

The equation for decomposition for a nonlinear equation  $y = F(x\beta)$  can be written as (Fairlie, 2005):

$$y^{N^j} - y^{A^j} = \left[ \sum_{i=1}^{N^N} \frac{F(x_i^N \beta^N)}{N^N} - \sum_{i=1}^{N^A} \frac{F(x_i^A \beta^N)}{N^A} \right] + \left[ \sum_{i=1}^{N^A} \frac{F(x_i^A \beta^N)}{N^A} - \sum_{i=1}^{N^A} \frac{F(x_i^A \beta^A)}{N^A} \right]$$

Here  $N^j$  is the sample size for any group  $j$  (here,  $j$  may be  $N$  or  $A$ , which represents the remaining and Aspirational districts, respectively),  $Y^j$  is the average probability of the binary outcome of the interest group  $j$ , and  $F$  is the cumulative distribution function from the logistic distribution. Finally,  $\beta$  is the coefficient estimate for group  $j$ . The first term in the brackets represents the portion of the group differences due to group differences in the distribution of the independent variable's characteristics, often known as the 'explained part'. The second term denotes the portion of  $y$  that is determined by differences in group processes. The second term additionally accounts for the fraction of the group gap caused by differences in immeasurable or unobserved endowments between groups.

To get the total contribution explained by each predictor, we must calculate two sets of predicted probabilities, one for the remaining and one for Aspirational, and then subtract the average values of the two. However, obtaining the contribution of a specific predictor is not straightforward.

Because the sample sizes of the two groups differ, we must do a regression for pooled data (Aspirational and the remaining districts' population combined) and calculate the predicted probability for each Aspirational and the remaining population observation in the sample. Because the remaining population sample is larger than the Aspirational population sample, a random subsample of the remaining population of the same size as the Aspirational sample should be drawn. Each observation in the remaining and Aspirational population samples is then ranked by predicted probabilities and matched by their respective rankings.

This approach pairs the remaining women with characteristics that place them at the bottom (top) of their distribution with Aspirational women with characteristics that put them at the bottom (top) of their distribution.

Now assume that Aspirational and the remaining samples are equal, i.e.,  $N^N = N^A$ , and a natural one-to-one matching of the remaining and Aspirational population observations exists. Also, consider that there are two independent variables ( $x_1$  &  $x_2$ ) to explain the Aspirational-remaining districts' gap in the use of hygienic materials among adolescent women.

Using coefficient estimates from a logit regression for a pooled sample ( $\hat{\beta}^*$ ), the independent contribution of  $x_1$  to the group gap can then be expressed as:

$$\frac{1}{N^A} \sum_{i=1}^{N^A} F(\hat{\alpha} + x_{1i}^N \hat{\beta}_1^* + x_{2i}^N \hat{\beta}_2^*) - F(\hat{\alpha} + x_{1i}^A \hat{\beta}_1^* + x_{2i}^N \hat{\beta}_2^*)$$

Similarly, the gap due to  $x_2$  can be expressed as:

$$\frac{1}{N^A} \sum_{i=1}^{N^A} F(\hat{\alpha} + x_{1i}^A \hat{\beta}_1^* + x_{2i}^N \hat{\beta}_2^*) - F(\hat{\alpha} + x_{1i}^A \hat{\beta}_1^* + x_{2i}^A \hat{\beta}_2^*)$$

Thus, the contribution of each variable to the gap is therefore equal to the change in average predicted probability from replacing the remaining distribution with Aspirational population distribution while holding the distributions of the other variables constant.

However, in practice, the assumption of equal sample size is rarely valid. Because the remaining population sample is significantly larger, many random subsamples of Aspirational women (equivalent in size to the whole remaining sample) are generated to match each to the remaining sample and calculate separate decomposition. Finally, the mean value of these individual decomposition estimations is used as an estimated decomposition for the remaining population sample.