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Effects of climate change on menstrual health and hygiene: a global mixed-methods systematic review

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Abstract

Menstrual health and hygiene (MHH) encompasses access to menstrual materials; water, sanitation, and disposal facilities; privacy and safety; accurate information; supportive social environments; access to care for menstrual discomfort and disorders; enabling people to manage menstruation with dignity and choice. Climate change is disrupting these interlinked domains, disproportionately affecting women, girls, and people who menstruate. This review synthesises evidence on how climate change affects MHH across diverse climate hazard contexts.

We conducted a global mixed-methods systematic review of studies published in English between 1947 and 2025, examining associations between climate-related hazards and MHH. We conducted searches in Medline, Scopus, Embase, and Web of Science. Quantitative, qualitative, and mixed-methods studies were eligible. Given the heterogeneity in exposures, outcomes, and designs, findings were synthesised narratively.

From 3,890 records, 25 studies met inclusion criteria, covering floods (n=7), air pollution (n=6), cyclones (n=3), droughts (n=3), saltwater intrusion (n=2), and multiple hazards (n=4). Flood- and cyclone-related studies reported disrupted access to menstrual materials, damaged water and sanitation infrastructure, reduced privacy and safety, limited access to care for menstrual disorders, and unsupportive social environments characterised by stigma and restricted mobility. Drought and salinity intrusion constrained hygiene practices through reduced water availability and quality, affecting comfort, dignity, and infection risk. Across hazards, studies documented adverse physical outcomes, including dermatological irritation and reproductive or urinary tract infections, alongside psychosocial consequences such as shame, anxiety, and harassment. Air pollution studies linked exposures with earlier menarche and menstrual cycle irregularities. Evidence on extreme heat and several MHH domains, including access to information, was limited.

Climate-related hazards undermine multiple, interconnected domains of MHH. The evidence base remains fragmented across hazards, geographies, methods, underscoring the need to integrate MHH into climate adaptation, disaster preparedness, and humanitarian response frameworks and to address critical research gaps related to extreme heat, slow-onset hazards, and equity.

Introduction

Climate change refers to long-term shifts in temperature and weather patterns (1), driven primarily by human activity, which increasingly disrupt human settlements, infrastructure and ecosystems (2). These shifts are driving more frequent and severe climate-related hazards, associated with rising morbidity and mortality rates (3) and increased transmission of infectious diseases (4). According to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, an estimated 3.6 billion people live in climate-vulnerable contexts, with women, children, and people with disabilities disproportionately affected by climate-related hazards (5). The IPCC defines climate-related hazards as physical events or trends directly linked to climate variability or change, including extreme weather events such as heatwaves, floods, droughts, and cyclones. Although air pollution is not classified as a climate-related hazard within the IPCC framework, it also acts as a distinct environmental hazard arising from similar anthropogenic drivers and interacting with climatic processes, leading to compounding adverse effects on health.

Despite its central importance to physical, psychological, and social well-being, menstrual health and hygiene (MHH) remains largely overlooked within climate and health discourse (6–8). Menstrual health is increasingly recognised as a multidimensional construct. As defined by Hennegan et al. (2021), it encompasses access to

accurate and timely information; safe, effective, and acceptable menstrual materials; water, sanitation, and hygiene (WASH) facilities that ensure privacy, safety, and dignity; supportive social environments free from stigma and discrimination; and the ability to manage menstruation without adverse physical, mental, or social consequences (7). Deficits across these domains are associated with a range of negative outcomes (9, 10), including increased risk of reproductive and urinary tract infections (RTIs and UTIs) (11, 12), reduced school attendance and performance (13), and broader reduced participation in education, work and social life (7, 10, 14).

Yet conditions to support MHH are frequently unmet globally, particularly in low- and middle-income countries (LMICs) (15, 16). Across both LMICs and high-income countries (HICs), many women, girls, and people who menstruate experience “period poverty”, or the absence of good MHH, characterised by inadequate access to menstrual materials, limited access to safe and private WASH facilities, inaccurate information, unsupportive social environments, limited access to healthcare for menstrual pain or disorders, and the inadequate ability to manage menstruation with dignity, agency, and without physical, psychological, or social harm. In HICs, an estimated 10–19% of girls struggle to afford disposable or reusable menstrual products (15). In LMICs, individuals often rely on a range of materials, including disposable or reusable menstrual products, or improvised alternatives such as cloths, newspapers, or leaves (10, 17). Globally, more than 500 million women lack adequate facilities for menstrual management (18), including the safe spaces for changing and disposal and access to care for menstrual pain or disorders (19). Increasing reliance on single-use disposable menstrual products further intersects with MHH by generating plastic waste, microplastic pollution, and greenhouse gas emissions across production, use, and disposal (20), particularly in settings with limited waste-management infrastructure. Inadequate disposal options can exacerbate stigma, compromise privacy and dignity, and undermine safe menstrual hygiene practices, highlighting how environmental sustainability, infrastructure, health services and social conditions are integral to achieving holistic MHH (7, 15). These structural and environmental constraints render MHH particularly vulnerable to climate-related disruptions in water, sanitation, waste management, participation in daily life, and privacy.

The compounded risks posed by poor MHH and climate-related hazards disproportionately affect women, girls and people who menstruate (8). The 2022 Lancet Countdown has identified food and water scarcity, poor sanitation, migration, disease pattern shifts, and displacement as major health threats (21). Women, particularly in LMICs and including women with disabilities, face increased vulnerability due to their caregiving roles, responsibility for water and food management and social marginalisation, factors that directly shape their ability to manage menstruation safely and with dignity (22, 23). The United Nations Development Programme (UNDP) estimates suggest that women comprise 80% of those displaced individuals by climate-related disasters (24). These intersecting vulnerabilities increase susceptibility to climate-related health outcomes, including heat stress, infectious disease, and psychological trauma (25).

Recent reviews have begun to synthesise evidence on the intersection of climate change, gender and menstrual health, including examining the effects of disasters such as earthquakes and floods on MHH (26), and exploring gender-climate frameworks in water and sanitation access (27). A 2025 scoping review highlighted how climate shocks and environmental stressors can disrupt access to menstrual materials, WASH infrastructure, and safe spaces for menstrual management, while exacerbating gendered vulnerabilities and social stigma (8). However, despite this growing body of work, important gaps remain in the evidence base (28, 29). In particular, there is limited synthesis of how the different climate-related hazards affect specific menstrual and gynaecological health outcomes, including menstrual cycle characteristics, timing of menarche, RTI and UTI symptoms, and longer-term health consequences. Evidence also remains fragmented regarding changes in menstrual hygiene behaviours,

disposal practices, and the coping strategies adopted by women, girls, and people who menstruate across diverse climatic and sociocultural contexts. Further synthesis is therefore needed to move beyond descriptive accounts of access disruptions towards a more comprehensive understanding of how climate-related hazards interact with the multiple domains of MHH.

This systematic review aims to synthesise empirical evidence on the associations between climate-related hazards and MHH, and to identify specific challenges faced by women, girls and people who menstruate in maintaining MHH under changing climatic conditions.

Methods

Search strategy and definitions

We conducted a systematic review of studies published until October 2025 using the databases Embase, Medline, Scopus, and Web of Science, supplemented by manual searches in Google Scholar and references lists of included studies. The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines (Supplementary Material 1). Our search strategy incorporated terms across three concepts (Supplementary Material 1) 1) menstrual health (e.g., disorders, early menarche, dysmenorrhea, UTIs, RTIs, bacterial vaginosis (BV), rashes) and concepts of discomfort, stigma, privacy, or dignity-related issues; 2) menstrual hygiene materials (e.g., disposable or reusable sanitary napkins, tampons, cloths, rags, menstrual cups, and other materials), facilities, practices and waste disposal management; and, 3) climate change related terms, including floods, drought, water scarcity, high temperature, extreme heat, rainfall, heat waves, extreme weather, rainfall, rising sea levels, salinity and air pollution. Given their shared anthropogenic origins and overlapping physiological pathways, air pollution was included as a relevant environmental stressor when examining how climate-related exposures affect MHH.

Titles and abstracts were screened independently by two reviewers (NJ and LDG), and full texts were retrieved for all articles meeting the inclusion and exclusion criteria.

Studies were included if they: 1) presented original research of any design, published in peer-reviewed journals between 1947 to October 15th, 2025, in English; 2) included menstruating adolescent girls, women of reproductive age (15–49 years), or other menstruating individuals; and 3) investigated the effects of climate-related hazards or air pollution on MHH. No geographical limits were applied.

Data extraction and synthesis

Search results were exported into EndNote 21 for screening and selection. Data were extracted on country, setting, study design, study population, climate-related hazard or exposure, and quantitative or qualitative outcomes. Given the heterogeneity of included studies, a quantitative meta-analysis was not feasible. Instead, we used Hennegan et al's 2021 definition of menstrual health to deductively define thematic categories when extracting from the original studies (7), and conducted a thematic content analysis to identify recurrent themes across studies and structured them into pathways linking climate-related hazards or climate-impact drivers with MHH (30). We also conducted inductive coding within each domain to extract further detail on specific challenges or outcomes related to MHH and climate change. Coding was conducted using NVivo Version 14. A narrative synthesis was then applied to summarise findings (31).

The methodological quality of included studies was assessed using established critical appraisal tools appropriate to study design. Qualitative studies were appraised using the Critical Appraisal Skills Programme (CASP) checklist, mixed-methods studies using the Mixed Methods Appraisal Tool (MMAT), and quantitative studies using the Joanna Briggs Institute (JBI) Critical Appraisal Tool. Each study was scored according to tool-specific criteria. All studies were retained regardless of quality rating, and quality assessments were used to support the interpretation of findings rather than as exclusion criteria.

The protocol was registered on the PROSPERO international prospective register of systematic reviews (https://www.crd.york.ac.uk/PROSPERO/view/CRD420261294720).

Results

The search identified 3,872 studies, with an additional 18 identified through manual searches (Fig. 1). After removing duplicates, the titles and abstracts of 2,179 studies were screened against inclusion and exclusion criteria, resulting in 49 full-text articles assessed for eligibility. Ultimately, 25 studies met the inclusion criteria and were retained in the final review

Study Characteristics

Of the 25 included studies (Fig. 2), most were conducted in Bangladesh (n = 10) and India (n = 5), with others from Vanuatu (n = 2), Pakistan (n = 2) and Poland (n = 2). Single studies were conducted in the United States of America (USA), South Korea, Taiwan (China), and France.

Study populations varied widely in age and context (Table 3 and Table 4). Most studies focused on women and adolescent girls of reproductive age, typically ranging from 10 to 50 years. Several studies included specific subgroups such as women with disabilities, indigenous adolescent girls, or women at different life stages, including those who had reached menopause. Sample sizes ranged from up to 30 in qualitative studies to studies with several thousand respondents in quantitative studies. Eleven were quantitative, ten qualitative, and four mixed methods; all were observational.

Quality of included studies

Study quality ranged from moderate to high. Qualitative studies scored between 6–9 out of 10 on the CASP checklist, with common limitations related to reflexivity and reporting of analytic procedures. Mixed-methods studies scored 3–4 out of 5 on the MMAT, largely due to weak integration of qualitative and quantitative components. Quantitative studies scored 5–9 out of 11 on JBI tools, with higher scores among air-pollution cohort studies and greater limitations among cross-sectional studies relying on self-reported outcomes.

Measures of exposure to climate-related hazards

The most frequently assessed climate-related hazards or impact drivers were floods (n = 7) and air pollution (n = 6), followed by drought and water scarcity (n = 3), cyclones (n = 3), and saltwater intrusion (n = 3). Four studies examined multiple climate hazards. Since one study reported outcomes on both floods and cyclones separately, the total number of hazards reported exceeds the number of included studies. Notably, no studies investigated heat exposure and its effect on MHH.

Studies reported climate and environmental exposures using a wide range of approaches, reflecting heterogeneity in measurement methods (Table 1). Many studies relied on self-reported experiences of environmental hazards, such as annual or flash floods, recurrent flooding, seasonal or dry-season water scarcity, saltwater intrusion, or sea invasions. In contrast, a second group of studies defined exposures through documented extreme weather events, drawing on named cyclones or floods, including the 1998 Bangladesh floods, 2012 and 2017 Assam floods, Cyclone Phailin in 2013, Cyclone Amphan in 2020, the 2022 super floods in Sindh province, and 2015 Tropical Cyclone Pam. A third set of studies used objective environmental monitoring and geospatial data, linking regulatory or municipal air quality measurements, including total suspended particles (TSP), nitrogen dioxide (NO_2), nitric oxide (NO), and the combined group of nitrogen oxides (NO□), along with coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2), carbon monoxide (CO), and benzene (C_6H_6), taken from defined exposure windows and linked to residential addresses or public records. Several studies also captured overlapping or recurrent hazards, including floods, cyclones, droughts, and salinity intrusion, reflecting complex climate exposures in highly vulnerable settings.

Table 1
Measurement of exposure to climate-related hazards and air pollution, including year, location, and data source

#	Study	Ref.	Country	Climate hazard or driver	Year, location, and data source
1	**Rashid & Michaud (2000)**	(32)	Bangladesh	Floods	1998 Bangladesh floods
2	**Azad et al. (2013)**	(33)	Bangladesh	Floods	Severe annual floods, self-reported
3	**Krishnan & Twigg (2016)***	(34)	India	Floods	2012 Assam Floods
4	**Maknun et al. (2017)**	(35)	Bangladesh	Floods	Annual flash floods, self-reported
5	**Bhattacharjee et al. (2019)**	(36)	India	Floods	2017 Assam floods
6	**Sadique et al. (2024)**	(37)	Pakistan	Floods	2022 Super floods in Sindh province
7	**Al-Mamun et al (2025)**	(38)	Bangladesh	Floods	2024 floods in Noakhali, Feni, Barisal, Khulna, and Satkhira, linked with the Global Flood Awareness System (GloFAS News)
8	**Alam and Rahman (2014)**	(39)	Bangladesh	Multiple (Floods, Cyclone, Drought, Salinity intrusion)	Recurrent hazards in Barguna district, self-reported
9	**Hallad et al. (2023)**	(40)	India	Multiple (Floods & Cyclones)	Climate-vulnerable regions of India, identified by the Council on Energy, Environment and Water (CEEW)
10	**Hirani (2024)**	(41)	Pakistan	Multiple (Floods and Earthquakes)	Recurrent hazards in the Chitral region, self-reported
11	**Nawaz et al (pre-print)**	(42)	Bangladesh	Multiple (Floods & Cyclones)	Recurrent floods in Gaibandha between 2019–2023 and 2020 Cyclone Amphan in Satkhira districts
12	**Krishnan & Twigg (2016)***	(34)	India	Cyclones	2013 Cyclone Phailin
13	**Downing et al. (2021)**	(43)	Vanuatu	Cyclones	2015 Tropical Cyclone Pam
14	**Wilbur et al. (2022)**	(44)	Vanuatu	Cyclones	2015 Tropical Cyclone Pam
15	**Talukdar et al. (2023)**	(45)	Bangladesh	Drought/Water Scarcity	Seasonal water scarcity, self-reported
16	**Choudhary et al. (2023)**	(46)	India	Drought/Water Scarcity	Areas of water scarcity, self-reported
17	**Sarkar et al. (2024)**	(47)	Bangladesh	Drought/Water Scarcity	Dry season water scarcity, self-reported

#	Study	Ref.	Country	Climate hazard or driver	Year, location, and data source
18	**Khanam et al. (2023)**	(48)	Bangladesh	Saltwater Intrusion	Geographic proximity to saline coastal areas, identified by the Soil Resources Development Institute (SRDI), 2010, Ministry of Agriculture, Government of the People's Republic of Bangladesh
19	**Prabhakar et al (2025)**	(49)	India	Saltwater Intrusion	Recurrent sea invasions, self-reported
20	**Sinha et al (2024)**	(50)	Bangladesh	Saltwater Intrusion	Saltwater incursion in Koyra Upazila, self-reported
21	**Merklinger-Gruchala et al. (2017)**	(51)	Poland	Air Pollution	PM_{10}, SO_2, CO and NO_x levels from municipal ecological monitoring data from 2000 to 2003 linked to women recruited by advertisements between June 2001 and June 2003
22	**Mahalingaiah et al. (2018)**	(52)	USA	Air Pollution	TSP levels from the US Environmental Protection Agency, 1960–1983, linked to data from women enrolled in 1989 in the Nurses' Health Study II (NHSII)
23	**Jung et al. (2018)**	(53)	South Korea	Air Pollution	PM_{10} levels from Air Korea 2022 to 2012 linked to data from the fifth Korea National Health and Nutrition Examination Survey (KNHANES V)
24	**Giorgis-Allemand et al. (2019)**	(54)	France	Air Pollution	NO_2 and PM_{10} from national environmental data 2007 linked to Obseff (the Observatory of fecundity in France) study, a transversal sample of couples from the French general population not using contraceptive methods
25	**Li et al (2021).**	(55)	Taiwan	Air Pollution	NO_x, NO, NO_2, CO, and $PM_{2.5}$ from the Taiwan Air Quality Monitoring from 2000 to 2013 linked to date from the Taiwan National Health Research Institutes
26	**Wronka et al. (2022)**	(56)	Poland	Air Pollution	PM_{10}, $PM_{2.5}$, SO_2, NO and C_6H_6 levels from the Chief Inspectorate for Environmental Protection, 1995 to 2017, linked to recruited female university students aged 19–25 years (girls born in the years 1993–1998)

Benzene (C_6H_6), carbon monoxide (CO), combined group of nitrogen oxides (NO), coarse particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), nitric oxide (NO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and Total Suspended Particles (TSP)

Effects of Climate-related Hazards on MHH

Across the included studies, climate-related hazards were found to impair MHH through multiple pathways aligned with the five domains of the definition of the MHH framework, with considerable variation by hazard type (Table 2).

Access to information was the least represented domain. Only one study on cyclones reported barriers to understanding menstrual hygiene guidance, where displacement conditions and literacy constraints rendered menstrual hygiene kit instructions inaccessible.

Materials, facilities, and services emerged as the most consistently affected domain across all hydrological hazards. Floods and cyclones disrupted supply chains, leading to acute shortages of menstrual materials and widespread reliance on improvised absorbents, e.g., leaves, newspapers, or the reuse of unclean menstrual materials, e.g., cloths and rags. These hazards, along with drought, water scarcity, and saltwater intrusion, substantially constrained MHH through limited access to clean water, frequent washing in contaminated or saline water, and an inability to adequately dry materials. Damage to sanitation facilities, overcrowded shelters, and the absence of private washing, bathing, or changing areas further undermined menstrual hygiene management. Hazard conditions also contributed to unsafe disposal practices, including burying or burning materials.

Diagnosis, care and treatment for discomforts and disorders were restricted in all climate-affected settings. Floods, droughts, cyclones, and salinity exposure contributed to the prevalence of UTIs, BV, rashes, and fungal infections, driven by unsafe hygiene conditions. Concurrently, limited health system functionality, travel constraints, and discomfort seeking care from male healthcare providers impeded access to treatment. Air pollution studies documented menstrual disorders requiring clinical attention, including dysmenorrhea and cycle irregularity, or disturbances to the menstrual cycle, such as earlier menarche, altered menstrual cycle phases. One study from a flood-prone region reported effects on cycle irregularity.

A positive and respectful environment was consistently undermined across the hydrological hazards examined. Women and girls reported heightened shame and embarrassment associated with washing or drying materials in publicly visible or mixed-gender spaces, exacerbated by overcrowded shelters and the destruction of private facilities. Fear of male observation and discomfort receiving menstrual supplies from male responders were prominent in flood and cyclone settings. Psychological distress, including anxiety, insecurity, and exhaustion, was reported across floods, cyclones, drought, and salinity contexts. Several studies also documented increased risks of harassment and sexual violence associated with attempts to locate secluded spaces for menstrual management.

Freedom to participate in all spheres of life was compromised across floods, drought, cyclones, and salinity-affected regions. Women frequently travelled several kilometres to access private locations or clean water, limiting their mobility and exposing them to safety risks. Daily activities, including schooling, work, and household responsibilities, were disrupted by damaged WASH infrastructure and the de-prioritisation of menstrual hygiene amidst competing survival needs. Social exclusion linked to shame or insufficient materials was reported under floods, cyclones, and drought, while constrained autonomy arising from unsafe shelter conditions and male-controlled mobility was observed in floods, cyclones, and saline-intruded areas.

Table 2 provides a summary of the outcomes by MHH domain from the included studies. Quantitative and mixed methods studies are reported in Table 3 and qualitative studies in Table 4. A narrative summary of studies, by hazard type, is detailed below.

Table 2

Effects of climate change on menstrual health and hygiene (MHH)

Menstrual Health and Hygiene domains*	Flood	Cyclone	Drought & Water Scarcity	Saltwater Intrusion	Multiple hazards	Air Pollution
Information						
Inaccessible or overly complex menstrual hygiene kit instructions		(44)				
Materials, facilities, and services						
Shortage of menstrual materials (pads, cloths, etc.) or disrupted supply chains	(35, 37, 38)	(43, 44)		(49)	(41)	
Reliance on old cloths, rags, leaves, newspapers, or improvised absorbents	(35–38)	(44)	(45)	(48, 50)	(40–42)	
No or limited access to water or sanitation facilities	(33, 34, 37, 38)	(34, 43, 44)	(45, 47)		(39–42)	
No or limited soap for washing clothes or menstrual materials	(33, 35)					
Washing materials or oneself in contaminated water (floodwater or saline water)	(32, 35)			(48, 50)	(40, 42)	
Reduced frequency of washing materials and bathing		(43)	(45, 46)		(40)	
Inability to dry menstrual materials safely or privately	(36)	(44)		(48)	(39–41)	
Damaged, submerged, or overcrowded water or sanitation facilities	(36, 38)		(45)	(49)		
No private wash/changing areas	(32–38)	(34, 44)		(49)	(39–42)	
Unsafe or absent disposal systems, e.g., burying/burning used materials	(36, 38)			(49)	(40–42)	
Diagnosis, care and treatment for discomforts and disorders						
Infections: urinary tract infections (UTIs), bacterial vaginosis (BV), rashes, itching, fungal infections due to poor hygiene	(32, 33, 35, 37, 38)	(34)	(47)	(48, 50)	(42)	
Limited medical access during disasters	(35)					
Physiological menstrual changes: earlier menarche, altered cycle	(33)					(51–56)

*as defined by Hennegan et al (2021){Hennegan, 2021 #7875}

Menstrual Health and Hygiene domains*	Flood	Cyclone	Drought & Water Scarcity	Saltwater Intrusion	Multiple hazards	Air Pollution
phases, dysmenorrhea, irregular cycles						
Menstrual cycle disturbances requiring medical care (dysmenorrhea)						(55)
Lack of female healthcare providers	(35)					
A positive and respectful environment						
Shame or embarrassment washing materials in public or mixed-gender spaces	(35)	(43)		(49)		
Criticism or social stigma from using scarce water for menstruation		(43)	(46)			
Fear of male observers or reactions	(32, 35, 37)	(43)	(46)		(41)	
Embarrassment receiving pads from male responders	(37)	(43)				
Psychological distress: stress, anxiety, insecurity, exhaustion	(32, 37, 38)	(43, 44)	(46)		(41, 42)	
Increased risk of physical harassment or sexual violence during attempts to find private spaces	(34, 35)				(39, 41)	
Freedom to participate fully in all spheres of life						
Need to travel or travel long-distance (~ 3–5 km) to find private spaces or water to wash	(34, 35)		(45)			
Reduce water consumption to avoid toileting	(35)					
Interrupted daily activities (e.g., chores, work, schooling) due to breakdown of water and sanitation facilities or de-prioritisation of menstrual hygiene	(38)		(46)		(42)	
Social exclusion, limited participation or powerlessness due to shame or lack of materials	(37, 38)		(46)		(41)	
Constrained autonomy due to male-controlled mobility					(41)	

*as defined by Hennegan et al (2021){Hennegan, 2021 #7875}

Table 3
Quantitative and mixed methods studies climate change exposures and associated menstrual health and hygiene outcomes

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
Floods	Azad et al. (2013)(33)	Bangladesh	Women, N = 185	Mixed methods (surveys, FGDs, KIIs)	2/5	During floods, 79% of women lacked sanitation facilities, 46% experienced menstrual management difficulties, 20% had irregular menstruation, and 15% reported gynaecological problems from unsafe water. 16% struggled to maintain hygiene and wash clothes due to insufficient clean water, inadequate soap, and lack of privacy in overcrowded or damaged facilities.
	Maknun et al. (2017)(35)	Bangladesh	Adolescent girls; Middle-aged women; Aged women having menopause, N = 100	Mixed methods (surveys, KIIs, FGDs)	2/5	Before floods, 82% of women had no menstrual hygiene preparation and only 18% stored materials. During floods, it was not possible to buy menstrual materials, 62% used rags, 6% sanitary pads, and 9% both, while 23% had none. Women had to leave the shelter to clean and dry their menstrual cloths in their homes, due to the shameful nature of washing and

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						drying materials before male members. 81% washed cloths in floodwater, 44% without soap. 24% reported rashes due to inability to maintain menstrual hygiene, 22% urinary infections from drinking less water or using cloths for too long, and 19% reported an increase in vaginal infections after the floods. Physical assaults were reported as common while living in the shelter or riverbank, as there is no privacy or safety situation 15% of the women have reported about sexual harassment, such as being inappropriately touched by other men while staying in embankments when they go to collect water or use the washrooms. Additionally, the clinic has only one male doctor who visits every three months, so they feel hesitant and cannot tell their problems regarding menstruation.

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
	Bhattacharjee et al. (2019) (36)	India	Adolescent girls and women (15 and 50 years), N = 84	Mixed methods (surveys, IDIs, FGDs)	2/5	During floods, 66% of women used cloth as before disasters, as they found it hard to shift to disposable pads distributed by humanitarian agencies. Over half discreetly washed and dried menstrual cloths, rather than discarding them, including 32% who burnt them, 43% buried, and 20% bagged used pads (in plastic bags weighed down with pebbles). Over 40% practised open defecation due to unusable toilets, crowding, and lack of privacy, forcing women to manage menstruation and sanitation under unsafe conditions. Some women reported creating temporary private spaces in shelters with tarpaulin or sheets as an area for drying materials.
Drought/Water Scarcity	Talukdar et al. (2023)(45)	Bangladesh	Indigenous adolescent girls (10–19 years), N = 242	Cross-sectional study (survey)	8/8	Among adolescents, 50% used disposable sanitary pads, 27.3% used cloths or towels, and 2.9% used no materials.

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						Coping strategies included reducing washing frequency (6.6%), limiting water for genital cleaning (19%), and bathing less often (26.9%). Regression analyses showed menstrual hygiene difficulty was significantly associated with water source degradation (β = 0.247, p < 0.001), poor water quality (β=−0.335, p = 0.004), need to purify water (β = 0.287, p = 0.044), difficulty obtaining water (β = 0.449, p < 0.001), longer water collection time (β = 0.013, p = 0.003), and family relocation due to scarcity (β=−0.485, p = 0.006).
	Sarkar et al. (2024)(47)	Bangladesh	Indigenous adolescent girls (10–19 years), N = 242	Cross-sectional study (survey)	8/8	Among respondents, 54% reported water scarcity during their last menstrual period; 36% experienced urinary tract infections (UTIs), 29% had bacterial vaginosis (BV), and 44% reported either or both

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						conditions during these periods. Women who perceived their water quality as poor had significantly higher odds of reporting UTI or BV symptoms (aOR 0.23, 95% CI 0.08–0.63, p = 0.005), whereas reported water shortage itself was not significantly associated (aOR 0.50, 95% CI 0.19–1.27, p = 0.14).
Multiple (Floods, Cyclone, Drought, Salinity intrusion)	Alam and Rahman (2014)(39)	Bangladesh	Women (31–60 years), N = 105	Mixed methods (survey, FGDs, IDIs, case studies)	2/5	In shelters, 90% of women reported no separate toilets or washrooms (χ^2=149.200, df = 2, P = 0.829, φc = 0.084), and 78% lacked access to fresh water (χ^2=95.829, df = 2, P = 0.837, φc = 0.083). A further 90% indicated that shelters failed to consider women's needs, including privacy for changing wet cloths, breastfeeding, and change of sanitary napkin and washing menstrual cloth (χ^2=149.314, df = 2, P = 0.929, φc = 0.064), with 60% reporting harassment of pregnant and

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						adolescent girls including unwelcome body touch, urges to physical touch, unwanted physical contact, taking advantage of physical proximity of a young girl, look intently at female organs ($\chi 2$ = 34.114, *df* = 2, *P* = 0.564, φc = 0.119), highlighting gaps in gender-sensitive WASH provision during emergencies.
Multiple (Floods & Cyclones)	Hallad et al. (2023)(40)	India	Women who have attained menarche (13–19 years), N = 6715	Cross-sectional study (survey)	6/8	In drought- and flood-affected rural areas, 30% of girls lacked sufficient water for bathing or household use, 14% could not bathe regularly, and 18% did not wash menstrual cloths. Around 16–20% had no safe disposal options for sanitary napkins, while 11% used newspapers as absorbents, and 8–9% buried or discarded used materials. There was no place to wash or dry menstrual materials in flood-affected areas. Limited privacy, contaminated

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						bathing water, and open-air bathing further compromised menstrual hygiene and health.
Saltwater Intrusion	Sinha et al (2024)(50)	Bangladesh	Women (18–45 years), N = 101	Cross-sectional study (survey)	7/8	In the last three months, women reported diarrhoea (27.7%), skin itching (12.9%), and 4.6% reported lower abdominal pain (LAP) with burning micturition from using pond water infiltrated with saline. Women often used old cloth rags and reused them after washing them in salt water (72.3%).
	Prabhakar et al (2025)(49)	India	Displaced menstruating women aged 18 – 49 years, N = 335	Cross-sectional study (survey)	6/8	In coastal areas affected by sea invasions, 81% reported damaged toilet facilities. During disasters, 62% preferred disposable pads for ease and hygiene, 25% used menstrual cups, and 13% used reusable cloth. Although 81% reported privacy for menstrual hygiene in relief camps, disposal remained difficult: 46% used bins or incinerators, 70% feared visibility of

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						used materials, and only 7.7% could always dispose of them immediately, with some women taking pads home for private disposal.
Air Pollution	Giorgis-Allemand et al. (2019)(54)	France	Women (18–44 years), N = 184	Prospective cohort study	11/11	In the adjusted regression model, NO_2 exposure during the 30 days before the cycle starts increased mean follicular length by 0.7 days (95%CI: 0.2–1.3). Similarly, for each 10 mg/m³ increase in PM_{10}, the mean follicular length increased by 1.6 days (95%CI: 0.3–2.9). There was no strong evidence of associations of exposures in this time window with luteal phase or with total menstrual cycle durations ($p > 0.2$). Exposures in the 10 days before the cycle started were also associated with increased follicular phase duration.
	Jung et al. (2018)(53)	South Korea	Female nurses (25–42 years), N = 34832	Retrospective cohort study	11/11	Increased PM_{10} exposure was significantly associated with earlier age at menarche.

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						Multiple linear regression analyses found that each 1 $\mu g/m^3$ increase in the 1-year, 2-year, and 3-year averages of annual mean PM_{10} exposure decreased age at menarche by 0.046 years(95%CI: −0.064, −0.027; p < 0.0001), 0.038 years (95%CI: −0.059, −0.018; p:0.0003), and 0.031 years (95%CI: −0.047, − 0.015; p:0.0002), respectively, after adjusting for household income, city size, body mass index (BMI), maternal age at menarche. Shorter exposure times to PM_{10} showed a stronger correlation with earlier menarche. An elevation of 1 μg/m3 of PM_{10} in 1 year was linked to 1.08 times increased odds of experiencing early menarche (95%CI:1.08–1.12), while in 3 years, the OR was 1.05.
	Mahalingaiah et al. (2018) (52)	USA	Girls (13–17 years), N = 639	Prospective cohort study	8/11	In multivariable-adjusted models, every 45 $\mu g/m^3$

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						increase in average total suspended particulate (TSP) exposure during high school was associated with an increased odds of 1.08 (95%CI: 1.03–1.14) moderate and 1.08 (95%CI:1.02–1.15) persistent menstrual cycle irregularity, especially among women with older ages at menarche and those living in the Northeast or the West of the USA.
	Merklinger-Gruchala et al. (2017)(51)	Poland	Women (24–35 years), N = 133	Retrospective cohort study	11/11	Elevated fossil fuel combustion pollutants (PM_{10} and SO_2) were associated with shortening of luteal phase length by 0.32 days after adjusting for age, menarche age, alcohol intake, caffeine intake and smoking status, usual menstrual cycle length, and other principal components (β:0.32; 95%CI:0.60 − 0.04; p:0.02). PM_{10} and SO_2 pollutants did not affect the follicular phase length and

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						overall cycle length, neither in single-nor in multi-pollutant models. CO and NOx, assessed either separately or together as a traffic emission, were not associated with overall cycle length or the length of cycle phases.
	Lin et al (2021)(55)	Taiwan	Women (30–44 years), N = 296,078	Prospective cohort study	11/11	In total, 12,514 individuals developed dysmenorrhea during the 12-year follow-up. Relative to women exposed to Q1 concentrations of NOx, women exposed to Q4 concentrations exhibited a significantly higher dysmenorrhea risk [adjusted hazard ratio (aHR) = 27.9, 95% confidence interval (CI) = 21.6–31.3]; similarly higher risk was found for exposure to NO (aHR = 16.7, 95% CI = 15.4–18.4) and NO_2 (aHR = 33.1, 95% CI = 30.9–37.4). For CO, the relative dysmenorrhea risk in women with Q4 level exposure was 28.7 (95% CI 25.4–33.6). For $PM_{2.5}$, women at the Q4 exposure level

Climate hazard	Author, year	Country	Study population	Study design	Quality	Findings
						were 27.6 times (95% CI = 23.1–29.1) more likely to develop dysmenorrhea than those at the Q1 exposure level.
	Wronka et al. (2022)(56)	Poland	Women (19–25 years), N = 1257	Retrospective cohort study	11/11	The odds of early onset of menstruation were 3.18 (95%CI:2.29–4.69; p:0.0182) for PM_{10} and 3.25 (95%CI:2.34–4.80; p:0.01043) for $PM_{2.5}$, indicating that the likelihood of accelerated age at menarche in areas with high particulate matter levels was more than three times higher compared to areas with low levels of particulate matter.

Bacterial vaginosis (BV), benzene (C_6H_6), Body Mass Index (BMI), carbon monoxide (CO), combined group of nitrogen oxides (NO□), coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2·5}$), focus group discussion (FGD), lower abdominal pain (LAP), nitric oxide (NO), nitrogen dioxide (NO_2), odds ratio (OR), sulphur dioxide (SO_2), Total Suspended Particles (TSP), urinary tract infections (UTIs), and water, sanitation and hygiene (WASH)

Table 4
Qualitative studies on climate change exposures and associated with menstrual health and hygiene outcomes

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
Floods	Rashid & Michaud (2000)(32)	Bangladesh	Girls (15–19 years), N = 9	Qualitative (IDIs)	8/10	Adolescent girls reported shame and distress when bathing or toileting near men during floods, with little privacy for washing menstrual materials in shelters. Girls were worried about people knowing they were menstruating or finding time to wash and dry menstrual materials. Washing the cloths in dirty water and reusing them was reportedly related to persistent perineal rashes and cramps.
	Krishnan & Twigg (2016)(34)	India	Women and adolescent girls, NGO staff, experts and government officials, N = *not stated*	Qualitative (IDIs, FGDs)	7/10	Women reported that menstrual hygiene was overlooked in household preparedness during floods, and in relief camps, they lacked private areas and safe water for washing or changing. Many travelled 3–5 km in darkness to meet personal needs such as open defecation or changing cloths, exposing them to insecurity, exhaustion, and physical danger.

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
	Sadique et al. (2024) (37)	Pakistan	Menstruating women and girls, N = 30	Qualitative (IDIs, FGDs)	10/10	Women and girls faced persistent shortages of menstrual materials, often relying on old cloths, rags, or leaves, with one packet of pads distributed every two months, which sometimes had to be shared among all the women in one household. Poor sanitation and limited privacy for washing led to rashes, infections, and urinary tract infections (UTIs). They were also distressed, while male-led kit distribution and cultural taboos created embarrassment, compromised social norms, and restricted safe menstrual management. Women indicated extreme discomfort at the thought of changing their menstrual materials inside their shelters, although inadequate, shared toilets were still preferred for changing menstrual materials over a shared shelter.
	Al-Mamun et al (2025)(38)	Bangladesh	Women and adolescent girls, N = 30, NGO	Qualitative (IDIs)	10/10	Floods disrupted supply chains of menstrual

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
			representatives, N = 12			materials and submerged toilets and washing facilities, leaving women with limited access to menstrual materials, clean water, or private spaces. Menstrual hygiene became deprioritised amid loss of homes and essential needs. Many reused cloths, rags, or leaves, increasing risks of infections and rashes, while the disposal of non-biodegradable materials contributed to environmental hazards. Stigma, embarrassment, and the lack of safe sanitation heightened stress, anxiety, and feelings of powerlessness among displaced women.
Cyclones	Krishnan & Twigg (2016)* (34)	India	Women and adolescent girls, NGO staff, experts and government officials, N = *not stated*	Qualitative (IDIs, FGDs)	7/10	Post-disaster assessments revealed that menstrual hygiene needs, particularly among girls, young women, and single women-headed households, were frequently overlooked in relief responses. In overcrowded camps, women lacked privacy and space to

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
						maintain hygiene, while inadequate menstrual care and insufficient WASH facilities heightened risks of fungal infections and rashes. Gender experts highlighted these gaps as critical failures in addressing women's health and dignity within humanitarian recovery efforts.
	Downing et al. (2021)(43)	Vanuatu	Reproductive-age women and adolescent girls with disability, N = 136	Mixed methods (IDIs, FGDs and survey)**	9/10	Women frequently reported poor access to sanitary pads during disasters, as rapid displacement, shop and road closures, and limited supplies restricted availability, while costs were prohibitive amid recovery. Increased water needs for bathing, cleaning stained clothing, and rinsing pads conflicted with shortages and social stigma around menstrual blood, leading to apprehension about male reactions. Menstruation was considered shameful and offensive by male community members. Lack of privacy in

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
						evacuation centres and embarrassment over receiving menstrual hygiene kits with general relief items, or from male humanitarian responders, compounded these challenges.
	Wilbur et al (2022) (44)	Vanuatu	Young people who menstruate with intellectual disability; Caregivers; Humanitarian actors, N = 41	Qualitative (KIIs, IDIs, observations)	10/10	Caregivers of women and girls with intellectual disabilities reported significant privacy and hygiene challenges during Tropical Cyclone Harold, sometimes bathing at relatives' homes or outdoors for greater seclusion than in shelters. They called for a wider range of menstrual materials, particularly diapers that could address both menstruation and incontinence, which worsened under stress. Information provided about using menstrual materials in the hygiene kits was too complex and detailed for everyone, including those with limited literacy and education, to understand. Diapers from hygiene kits

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
						were washed and reused due to cost, but heavy rain hindered drying. Complex instructions and inaccessible WASH facilities further limited safe menstrual management and personal care.
Drought/Water Scarcity	Choudhary et al. (2023)(46)	India	Women(18-40years), N = 20	Qualitative (IDIs, FGDs)	10/10	Women described adopting multiple strategies to cope with water scarcity, including reducing household cleaning to reserve water for menstrual hygiene. Menstruation in a water-scarce context threatened their *izzat* (personal dignity) both directly, through visible stains on clothing, and indirectly, as daily chores were neglected to prioritise hygiene. Inadequate water for bathing or washing was emotionally distressing, with women expressing embarrassment and humiliation if others noticed blood or uncleanliness. Managing menstruation was viewed extra water demand necessitated by managing

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
						menstrual blood, which intensified stress and household strain.
Multiple (Floods & Cyclones)	Nawaz et al (pre-print)(42)	Bangladesh	Women with disabilities, N = 17, and their caregivers, N = 17	Qualitative (IDIs, Photovoice)	10/10	Floods and cyclones disrupted access to tube wells and stored household water, forcing women to wash menstrual materials in contaminated floodwater. With limited privacy and no disposal systems, many dried cloths indoors, buried or discarded worn-out ones in the floodwater, and reused damp materials. Women with disabilities experienced rashes, allergies, and difficulty washing frequently, while caregivers in makeshift shelters faced emotional strain balancing menstrual and other care responsibilities during extreme weather.
Multiple (Floods, Cyclones, Earthquakes)	Hirani (2024)(41)	Pakistan	Women (18–40 years), N = 18	Qualitative (IDIs, observations)	10/10	Women residing in overcrowded disaster-relief tents reported using old clothes for menstruation because menstrual materials and financial resources were unavailable.

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
						They lacked water, washrooms, privacy, and designated spaces to change, wash, or dry materials. Damp cloths were buried or burned for disposal, occasionally provoking disputes about waste near shelters. Women mentioned that they had no financial resources to purchase menstrual materials or that supply chains were disrupted. Religious and cultural restrictions, male-controlled mobility, and overcrowded, male-shared living conditions heightened women's discomfort, stress, and loss of dignity and power during menstruation.
Saltwater Intrusion	Khanam et al. (2023) (48)	Bangladesh	Adolescent girls and women, N = 25	Qualitative (IDIs)	9/10	Coastal women and adolescent girls routinely used saline water for bathing and washing menstrual cloths, which were reused for 4–6 months and dried in hidden places. Repeated washing made the cloths stiff and uncomfortable,

Climate Hazard	Author, year	Country	Study population	Study design	Quality	Findings
						exacerbating irritation during long walks to collect water. Limited access to affordable materials led most to rely on old cloths, contributing to rashes, itching, fungal infections, and urinary tract infections (UTIs) linked to prolonged reuse and poor water quality.

*Krishnan & Twigg (2016) reported on climate hazards, floods and cyclones separately, so it has been included twice in the table.

**Downing et al. (2021) was reported as a mixed-methods study; however, the quantitative component evaluated an intervention and did not relate to climate change or menstrual health outcomes. Only qualitative findings relevant to MHH and climate-related hazards were extracted for this review.

Urinary tract infections (UTIs), and water, sanitation and hygiene (WASH)

Floods

Seven studies, four qualitative and three mixed methods, from Bangladesh, India, and Pakistan reported that floods disrupted MHH by limiting access to menstrual materials, safe water, sanitation, and privacy, forcing women to wash or reuse materials in contaminated water and resulting in infections, psychosocial distress, and increased vulnerability to abuse (32–38). Adolescent girls in Bangladesh described shame and distress when bathing or toileting near men, often using contaminated floodwater to wash menstrual cloths and developing rashes, boils, and cramps (32). In the same context, 79% of women lacked sanitation facilities, 46% faced menstrual management difficulties, and 15% reported gynaecological problems linked to unsafe water use (33).

In India, women reported that MHH was neglected in flood preparedness and relief, with inadequate facilities forcing them to travel long distances at night for privacy, exposing them to insecurity and exhaustion (34). Before floods, 82% of Bangladeshi women had no preparation and only 18% had stored menstrual materials; 81% later washed cloths in floodwater, and 44% did so without soap, resulting in high rates of rashes (24%), urinary infections (22%), and vaginal infections (19%) (35). Similar findings emerged in India, where women reused cloths, improvised drying and disposal methods, and often resorted to open defecation due to overcrowded or unusable toilets (36).

In Pakistan, women reported using old cloths, rags, or leaves due to shortages and embarrassment from male-led menstrual hygiene kit distribution (37). In Bangladesh, floods submerged toilets and washing areas, deprioritising menstrual hygiene amid loss of shelter and livelihoods. Women described reusing materials, suffering infections, and experiencing anxiety, stigma, and powerlessness (38).

Multiple hazards

Four studies, two qualitative, one quantitative and one mixed methods, from Bangladesh, India, and Pakistan, examined the effects of overlapping climate hazards, most commonly floods, cyclones, and droughts, on disruptions to WASH infrastructure and the absence of gender-sensitive facilities consistently constrained women's ability to manage menstruation safely and with dignity (39–42). In Bangladesh, 90% of women sheltering during disasters reported no separate toilets or washrooms (χ^2=149.200, df = 2, P = 0.829, φc = 0.084), 78% lacked fresh water (χ^2=95.829, df = 2, P = 0.837, φc = 0.083), and a further 90% said shelters failed to consider women's specific needs such as privacy for changing, breastfeeding, and menstrual care (χ^2=149.314, df = 2, P = 0.929, φc = 0.064) (39).

In India, drought- and flood-affected girls faced similar challenges: 30% lacked sufficient water for bathing, 14% could not bathe regularly, and 18% were unable to wash menstrual materials (40). Inadequate disposal systems led to the use of newspapers (11%) or burial and open disposal (8–9%), while contaminated bathing water and limited privacy increased infection risks.

In Pakistan, women living in overcrowded relief tents reported using old clothes for menstruation due to a lack of menstrual materials, water, and private spaces (41). Cultural restrictions and male-shared living conditions intensified stress, shame, and loss of dignity. Similarly, in Bangladesh, women with disabilities displaced by floods and cyclones washed menstrual cloths in contaminated floodwater, reused damp materials, and faced rashes and infections (42). Caregivers of women with disabilities described compounded emotional strain balancing menstrual care with other caregiving responsibilities during extreme weather events.

Cyclones

Across three qualitative studies from India and Vanuatu, cyclones compounded MHH challenges through loss of facilities, limited access to materials, privacy, and information, and harmful gender norms, leading to shame, stress, and neglect of MHH needs in disaster response (34, 43, 44). In India, post-disaster assessments highlighted that menstrual needs, particularly among adolescent girls, young women, and single-woman–headed households, were often overlooked (34). In overcrowded shelters, women reported having no privacy or dedicated space to wash, dry, or change materials, and inadequate WASH facilities contributed to rashes, fungal infections, and irritation. In the same study, gender experts interviewed described these omissions as critical failures to uphold women's health, dignity, and participation in recovery processes.

In Vanuatu, limited access to commercial sanitary pads was reported during and after cyclones due to disrupted supply chains, road closures, and unaffordable prices (43). Women described conflicting demands between increased water needs for bathing, cleaning blood-stained clothes, and rinsing pads, and the overall scarcity of clean water. Cultural stigma surrounding menstrual blood contributed to anxiety about men observing or commenting on women's water use. The lack of privacy in evacuation centres and embarrassment over receiving menstrual hygiene kits alongside non-food items compounded these challenges.

During Tropical Cyclone Harold, caregivers of women and girls with intellectual disabilities reported extreme difficulty maintaining hygiene and privacy (44). Rather than bathing at cyclone shelters, some resorted to returning home to bathe behind still-standing trees for greater seclusion. Caregivers called for a broader range of menstrual materials, especially adult-sized diapers, to address both menstruation and incontinence exacerbated by stress. However, heavy rain hindered drying reusable menstrual materials, and caregivers requested more so they could

have clean ones in rotation whilst drying. Without prior experience of the menstrual materials distributed in the menstrual hygiene kit, people found it difficult to understand the information and instructions for use, particularly for those with low literacy

Drought and Water Scarcity

Three studies, two quantitative and one qualitative, from India and Bangladesh, found that water scarcity reduced water availability for washing, bathing, and cleaning menstrual materials, contributing to unhygienic coping strategies, infections, and psychological strain from prioritising water use for household needs examined how limited water availability affects MHH (45–47). In Bangladesh, managing menstruation in water-scarce conditions was closely tied to *izzat* (personal dignity), with shame and humiliation experienced both directly, when menstrual stains were visible, and indirectly, as neglected household tasks drew attention to women's constrained circumstances (46). In another Bangladesh setting, adolescents reported reduced washing frequency (6.6%), limiting water for genital cleaning (19%), and bathing less often (26.9%) (45). Regression analyses showed significant associations between menstrual hygiene difficulty and degraded water sources ($\beta = 0.247$, $p < 0.001$), poor water quality ($\beta = -0.335$, $p = 0.004$), difficulty obtaining water ($\beta = 0.449$, $p < 0.001$), and longer collection times ($\beta = 0.013$, $p = 0.003$). Another study from the same area of Bangladesh found that 54% experienced water scarcity during their last menstrual period, with 36% reporting UTIs and 29% BV. Perceived poor water quality was significantly associated with infection symptoms (aOR 0.23, 95% CI 0.08–0.63, p = 0.005) (47).

Saltwater Intrusion

Three studies, two quantitative and one qualitative, from Bangladesh and India explored how high saline exposure and sea incursions forced women to wash menstrual materials in saline water, causing irritation, rashes, and infections, while damaged sanitation systems and limited disposal options undermined dignity and MHH (48–50). In coastal Bangladesh, women and adolescent girls routinely used saline water for bathing and washing menstrual cloths, which were reused for several months and often dried in hidden spaces. Repeated washing made the cloths stiff and uncomfortable, and limited access to affordable materials led many to rely on old rags, contributing to itching, rashes, and infections linked to poor water quality and prolonged reuse (48). In coastal India, 81% of women reported damaged toilet facilities following sea invasions, and among them, 62% preferred disposable pads, and 25% used menstrual cups. Although 81% reported privacy in relief camps, disposal remained difficult: 70% feared visibility of used materials, and only 7.7% could dispose of them immediately (49). In coastal Bangladesh, women reported diarrhoea (27.7%), skin itching (12.9%), and 4.6% reported lower abdominal pain (LAP) with burning micturition from using pond water infiltrated with saline (50).

Air Pollution

Six studies conducted across Poland, France, the USA, South Korea and Taiwan examined associations between air pollution and biological MHH outcomes, including age of menarche (53, 56), menstrual cycle irregularities (51, 52, 54) and dysmenorrhea (55).

In South Korea, analysis of 639 girls (13-17years) found that for each 1 $\mu g/m^3$ rise in PM_{10} concentration over one-, two-, and three-year exposure windows, the age at menarche decreased by 0.046 years (95% CI: −0.064, − 0.027; $p < 0.0001$), 0.038 years (95% CI: −0.059, − 0.018; $p = 0.0003$), and 0.031 years ((95% CI: −0.047, − 0.015; $p = 0.0002$), respectively (53). Adjusted odds ratios also indicated increased likelihood of early menarche: 1.08 per 1 $\mu g/m^3$ rise in PM_{10} over one year (95%CI:1.08–1.12) and 1.05 over 3 years. In Poland, a study of 1,257 female students found

that high exposure to PM_{10} and $PM_{2.5}$ was associated with 3.18-fold (95%CI: 2.29–4.69, p = 0.0182) and 3.25-fold (95%CI: 2.34–4.80, p = 0.01043) increased odds of early menarche, respectively .

In the USA, analysis of 34,832 women in the Nurses' Health Study II found that for every 45 µg/m3 increase in TSP exposure during adolescence was associated with higher odds of moderate and persistent menstrual cycle irregularities (OR 1.08, 95%CI: 1.03–1.14 and 1.02–1.15) (52). Evidence from Poland indicated that higher PM_{10} and SO_2 exposure shortened the luteal phase of the menstrual cycle by 0.32 days (β: 0.32; 95%CI: 0.60 to 0.04, p = 0.02) (51). While a French cohort of 184 women not using hormonal contraception found that each 10 mg/m³ increase in PM_{10} extended it by 1.6 days (95%CI: 0.3, 2.9), and higher NO_2 and $PM_{2.5}$ levels in the 30 days preceding menstruation were associated with a longer follicular phase (by 0.7 days, 95%CI: 0.2–1.3) (54).

In Taiwan, in total, 12,514 individuals developed dysmenorrhea during the 12-year follow-up. Relative to women exposed to lower concentrations of NOx, women exposed to higher concentrations exhibited a significantly higher dysmenorrhea risk (adjusted hazard ratio (aHR) = 27.9, 95% CI = 21.6–31.3); similarly higher risk was found for exposure to NO (aHR = 16.7, 95% CI = 15.4–18.4) and NO_2 (aHR = 33.1, 95% CI = 30.9–37.4). For CO, the relative dysmenorrhea risk in women with higher level exposure was 28.7 (95% CI = 25.4–33.6). For $PM_{2.5}$, women at the higher exposure level were 27.6 times (95% CI = 23.1–29.1) more likely to develop dysmenorrhea than those at the lower exposure level. Results showed that women would have higher dysmenorrhea incidences while exposure to high concentrations of NO, NO_2, NOx, CO, and $PM_{2.5}$ (55).

Discussion

Our systematic review synthesising 25 studies demonstrates that climate-related hazards, including floods, cyclones, droughts, salinity intrusion, and air pollution, exacerbate existing challenges across domains of MHH. As summarised, the current evidence base is unevenly distributed across hazard exposures, outcomes, methodological approaches, and geographic regions, shaping both the nature of documented effects and the conclusions that can be drawn. Overall, women, girls and people who menstruate face heightened physical, behavioural, and psychosocial risks during and after climate-related hazards, primarily through disrupted access to menstrual materials, damaged or inaccessible WASH facilities, limited access to healthcare, compromised privacy, and unsupportive social environments.

Flood-related effects dominated the literature, with seven studies, predominantly qualitative, conducted largely in South Asia, particularly India and Bangladesh. These studies provided rich contextual accounts of disruptions to privacy, dignity, and access to menstrual materials during displacement and flooding, but offered limited quantitative evidence on health outcomes or longer-term effects. In contrast, the six studies on air pollution were exclusively quantitative and concentrated in HICs, focusing primarily on physiological outcomes such as early menarche and menstrual cycle irregularities. This divergence illustrates a broader methodological and epistemic divide, whereby climate hazards affecting low-income and disaster-prone settings are documented largely through qualitative narratives of access and dignity, while environmental exposures in high-income contexts are examined through biomedical and epidemiological lenses (57). This underscores the need for more diverse and inclusive research.

Other climate-related hazards, including cyclones, water scarcity, and salinity, despite their growing relevance in climate-vulnerable regions, remained underexplored. Where evidence does exist, it highlights how water scarcity and degraded water quality force women to modify hygiene practices, reuse menstrual materials, or reduce

washing frequency, with implications for comfort, dignity, and infection risk. Notably, no studies examined the effects of extreme heat and MHH, representing a critical gap given the physiological stress of high temperatures and their potential to disrupt water availability, sanitation infrastructure, and shelter conditions. The absence of evidence on heat underscores a misalignment between dominant climate risks identified by the IPCC and the current MHH evidence base.

Across studies, inadequate access to menstrual materials emerged as a prominent challenge (35–38, 40, 41, 43–45, 48, 49), driven by disrupted supply chains, affordability issues, and limited inclusion in relief efforts. As reflected in Table 2, this evidence is drawn predominantly from flood-, cyclone- and drought-affected settings, where women frequently reported reliance on improvised, and somewhat unsafe, alternatives such as old cloths, rags, leaves, or sarees. When reused without adequate washing, drying, or privacy, women experienced discomfort, dermatological irritation, and infections (33, 35). In drought-affected areas, water scarcity further influenced product choices, with women resorting to using materials requiring less water to clean or forgoing absorbents entirely (45). These findings reflect broader structural constraints, including poverty, gendered power imbalances, and restrictive cultural and social norms that limit access to menstrual materials, agency over menstrual management, particularly during climate shocks (58).

Lack of privacy for washing, drying, and changing menstrual materials was a cross-cutting concern during floods, cyclones and displacement, particularly in temporary shelters, overcrowded households or displacement camps (32–34, 36–44, 49). Women described indignity, restricted movement and the need to travel lengthy distances to find private space (34). In some cases, makeshift bathing areas were constructed by caregivers to provide a degree of privacy (44), highlighting both the adaptive strategies employed and the absence of institutionalised solutions. These findings align with humanitarian research in Lebanon and Myanmar, describing the compounded vulnerability of menstruating women and girls to find private spaces for menstrual hygiene and waste disposal in displacement contexts (59).

Climate hazards also directly damaged WASH facilities, reducing access to clean water, toilets, bathing facilities, and waste disposal (33, 34, 36–47). Menstrual waste management was often neglected in MHH efforts, with disposal practices posing challenges to users, sanitation systems, and the environment (59, 60). Open defecation was frequently reported in displacement settings (37, 41). Menstrual waste disposal was also limited, leading some women to burn or bury materials or dispose of them unsafely in floodwaters (36), with associated risks for health and dignity.

Droughts, water scarcity and saltwater intrusion constrained MHH by degradation of both the water available and water quality (48). Evidence from Pakistan, Bangladesh and India shows that women reused menstrual cloths, washed with contaminated or saline water (32, 35, 42, 48) or reduced cleaning frequency during periods of water scarcity (45). In coastal areas, saline water stiffened cloths, increased discomfort, contributed to infections and reduced dignity (48)

Health impacts of poor MHH practices were observed in flood-, cyclone-, drought- and salinity-affected settings. Studies reported increased risks of rashes, vaginal infections, UTIs, RTIs, and gynaecological issues due to inadequate hygiene, prolonged or repeated use of contaminated or reused materials, and exposure to contaminated water (32–34, 38, 42, 44, 47, 48). Importantly, flood-related disruptions also limited access to health services and care for menstrual discomfort and gynaecological conditions, with at least one study from a flood-affected population reporting delays in seeking care, lack of available services, and untreated pain and infections

during menstruation (35). These barriers compounded physical suffering and increased the risk of complications. Psychosocial distress, including shame, embarrassment, anxiety and stigma, was reported in nearly all studies (38, 41, 42, 44–46), often compounded by restrictive cultural norms and taboos around menstruation (33, 37, 46). Moreover, displacement and shelter conditions left women exposed to verbal abuse, sexual harassment, inappropriate behaviour from others, and even domestic or sexual violence, echoing broader concerns of gender-based violence post-disasters (15, 17, 26, 61–64).

In contrast to studies on acute climate-related hazards, research on air pollution focussed exclusively on physiological effects on MHH, including associations between exposure to PM_{10}, $PM_{2.5}$, SO_2, NO_2, and earlier onset of menstruation, as well as menstrual cycle irregularities (51–54, 56). These findings are consistent with other studies on environmental conditions and their influence on pubertal timing (65, 66).

Notably absent from the current literature is evidence on the impacts of extreme heat on MHH. Given the physiological stress caused by high temperatures and the potential for heat to disrupt water supply, hygiene behaviours, and even physiological management of pain and discomfort, this represents a critical gap. Additionally, a few studies noted where the there was a lack of attention the experiences of people with disabilities, gender minorities or those living in protracted crises, highlighting the limited equity lens of existing programmes or responses during extreme weather events, and underscoring the need for tailored, inclusive, and adaptive disaster preparedness.

Limitations

This systematic review provides a comprehensive analysis of the underexplored topic, drawing attention to how diverse climate-related hazards and exposures affect MHH. Inclusion of diverse methodological approaches strengthens the analysis and understanding of context-specific MHH needs. The review also highlights the experiences of groups that may be vulnerable, such as women with intellectual disabilities, Indigenous adolescent girls, and gender minorities. Furthermore, it identifies critical research gaps on climate-related coping mechanisms and evidence-based MHH interventions in climate-affected settings.

However, several limitations should be acknowledged. The evidence base was concentrated in South Asia, mainly Bangladesh and India, limiting generalisability to other climate-vulnerable regions such as Africa, North or South America, Europe, or island states. Heterogeneous study designs, exposures, and MHH outcome measures complicate analysis and comparisons. Most studies relied on self-reported data from surveys and interviews, which may introduce bias, affecting reliability. Additionally, the lack of longitudinal studies and research on less-studied hazards, such as saltwater intrusion, heat waves, and slow-onset climate change, restricts our understanding of long-term and hazard-specific impacts on MHH. The absence of studies on the intersection of climate change and MHH in displaced, nomadic, or urban populations also limits the inclusivity of the evidence base.

Conclusions

This systematic review synthesises the empirical evidence on how climate change affects MHH for women, girls and people who menstruate. Across diverse settings, hazards such as floods, cyclones, droughts, water scarcity, salinity intrusion, and air pollution undermine MHH through disruptions to menstrual materials access, WASH infrastructure, privacy, safety, access to care and treatment of discomfort and disorders and unsupportive social

environments. The evidence base, however, is uneven, with a concentration of qualitative studies on floods in South Asia, limited investigation of slow-onset hazards such as drought and salinity, and a complete absence of studies on extreme heat. Air pollution studies, while highlighting important physiological pathways, remain disconnected from broader social and infrastructural dimensions of menstrual health.

These findings underscore the need to integrate MHH into climate adaptation, disaster preparedness, and humanitarian response framework plans, prioritising MHH by ensuring access to menstrual materials, safe WASH, access to healthcare and supportive environments. Gender- and inclusion-responsive climate policies should explicitly prioritise MHH by ensuring access across emergency and non-emergency contexts (67, 68). Addressing stigma and restrictive norms, through engagement with communities, including men and boys, remains essential to enabling safe menstrual practices.

Further research should address key geographic and hazard-related gaps, particularly in Sub-Saharan Africa, Southeast Asia, Latin America, and small island states with a need for attention to extreme heat and slow-onset climate change. Longitudinal, mixed methods and quantitative studies to strengthen causal inference and capture cumulative effects of repeated or overlapping climate exposures on MHH. Greater focus on equity, including disability, displacement and protracted hazards, is essential to ensure that climate-resilient MHH interventions are inclusive, effective, and responsive to the needs of populations most affected by climate change.

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Figures

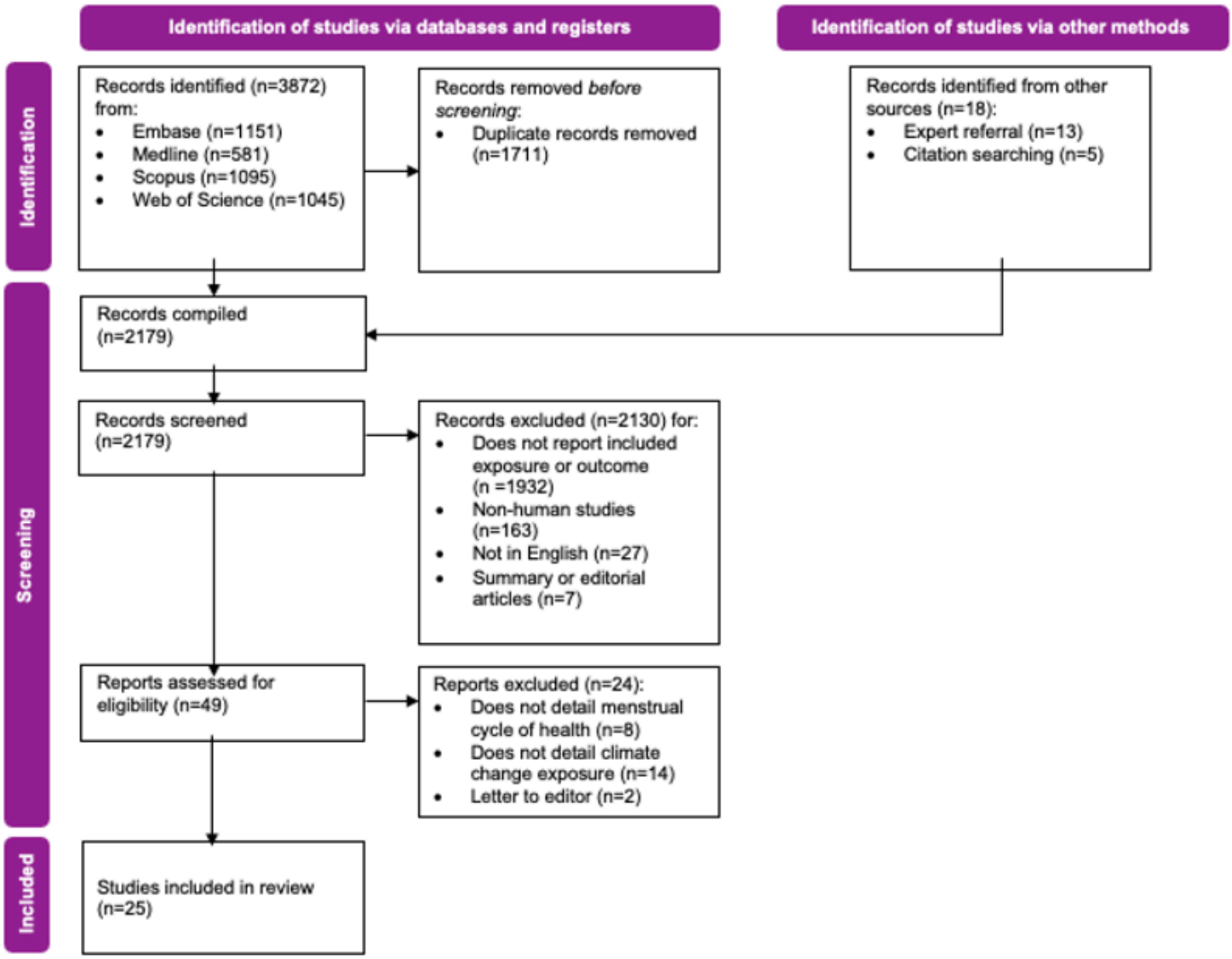

Figure 1

PRISMA flow diagram of included studies

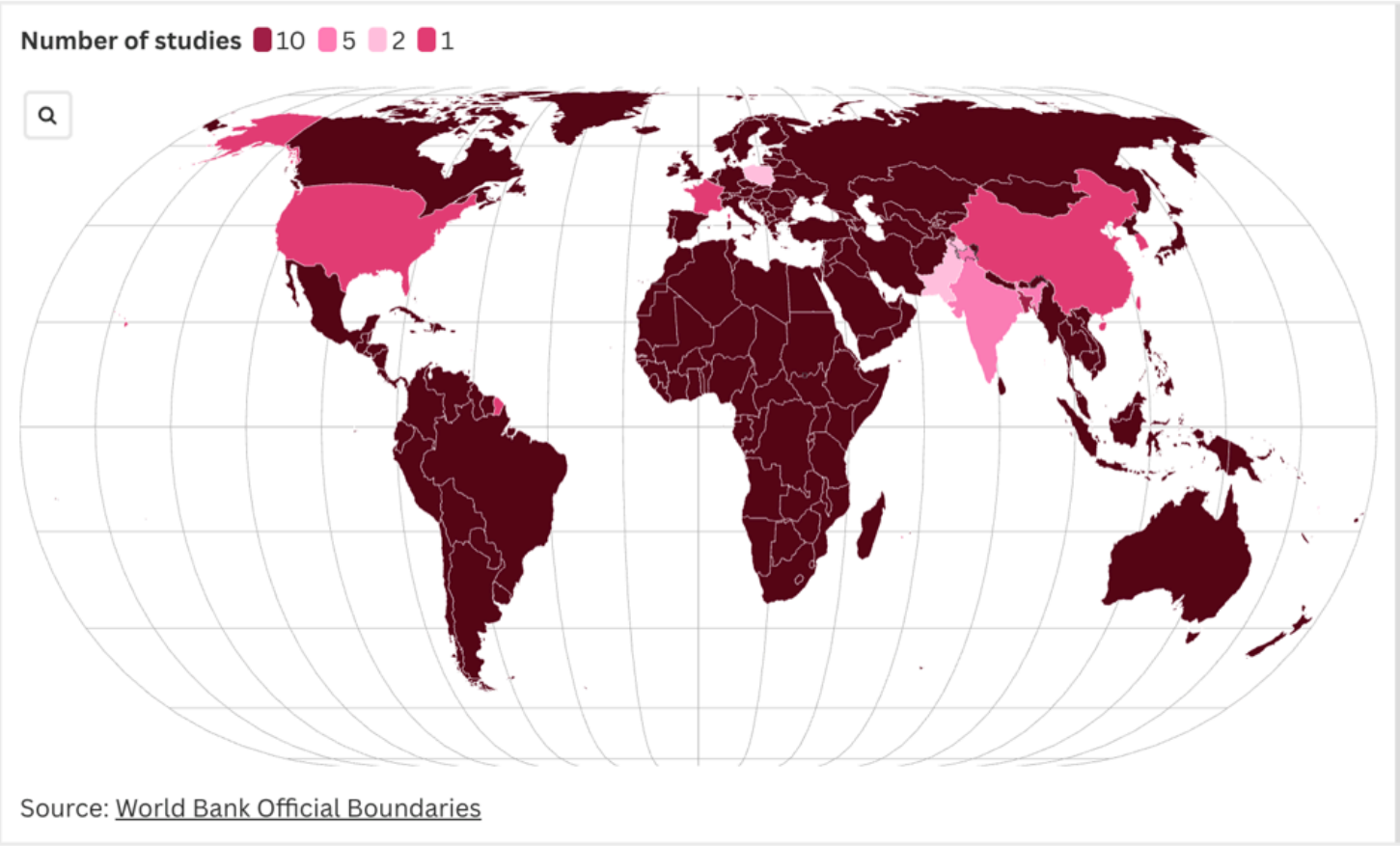

Figure 2

Geographic distribution of included studies

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