

Reusable Menstrual Underwear: Use and Acceptability by Internally Displaced Women in Somalia

Abigail Gilmer

LSHTM

Shannon Holding

MedAir

Saido Omar

MedAir

Chibwe Mambwe

MedAir

Balqis Ali Mohamed

MedAir

Marian Hassan Elmi

MedAir

Ismahan Mohamed Ali

MedAir

Mohamed Ibrahim

MedAir

Lauren D'Mello-Guyett

`lauren.dmello-guyett@lshtm.ac.uk`

LSHTM <https://orcid.org/0000-0002-8174-1737>

Research Article

Keywords: menstrual hygiene, menstruation, displacement, underwear, reusable products, hygiene, acceptability, use, humanitarian

Posted Date: March 6th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8967777/v2>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: The authors declare no competing interests.

Reusable Menstrual Underwear: Use and Acceptability by Internally Displaced Women in Somalia

Abigail Gillmer^{1&2}, Shannon Holding², Saido Omar³, Chibwe Mambwe², Balqis Ali Mohamed³, Abukar Hassan Mohamed³, Marian Hassan Elmi³, Ismahan Mohamed Ali³, Mohamed Ibrahim³ and Lauren D'Mello-Guyett^{1&2*}

1 Health in Humanitarian Crises Centre, London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT, United Kingdom

2 Environmental Health Group, Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT, United Kingdom

3 Medair, Chem. du Croset 9, 1024 Ecublens, Switzerland

4 Medair, Mogadishu, Somalia

*Corresponding author: lauren.dmello-guyett@lshtm.ac.uk

Keywords: menstrual hygiene, menstruation, displacement, underwear, reusable products, hygiene, acceptability, use, humanitarian

Abstract

Background: Menstrual health and hygiene are often neglected in humanitarian crisis settings, where inadequate water and sanitation facilities, limited menstrual materials and information, restricted healthcare access, and unsupportive social environments undermine people's ability to manage menstruation safely, with dignity, without harm. Reusable menstrual hygiene materials may help address some of these gaps, but more evidence on the acceptability and use in such settings is needed. This study examines factors associated with the use and acceptability of REEMI™ menstrual underwear distributed to internally displaced women and girls in the Banadir region, Somalia.

Methods: This study was a prospective longitudinal study among a random sample of 295 internally displaced women who received menstrual underwear with bags for washing and drying. Surveys were completed, at and within 12 months after the distribution, to capture demographics, menstrual practices, use of the menstrual materials, and acceptability or issues with the materials. Descriptive statistics summarised key variables, and logistic regression was used to examine factors associated with the use of the menstrual underwear.

Results: 12 months after distribution, 89% of women used the menstrual underwear during their most recent menstruation, 96% used the washing bag, and 95% used the drying bag. Participants found the menstrual underwear comfortable (100%), reliable for heavy bleeding (95%), and led to fewer infections (93%), with no reported leakage or odour (0%). Among reasons for using the washing and drying bags, privacy was the most common (86–89%), followed by convenience (22–35%) and reduced water use (41%). The odds of using menstrual underwear were higher among participants who felt they received enough pairs for rotation. Compared to married participants, those divorced/separated or single had lower odds of using the menstrual underwear.

Conclusions: This study found high use and acceptability of menstrual underwear for IDPs. These findings suggest that including long-lasting reusable menstrual materials in emergency humanitarian settings can have positive effect on menstrual health and hygiene, particularly when context-specific and addressing key factors such as privacy and hygiene, which strongly influence use and acceptability.

Declarations

Ethics approval and consent to participate

Medair activities were implemented in line with agreements with local authorities for humanitarian assistance in the project areas. Medair determined the sampling design, sample size, and survey schedule. Participants were made aware of the study, any benefits and risks, and plans for publication of the data by the Medair team. Verbal informed consent was obtained for all participants. Medair shared anonymised data with the London School of Hygiene & Tropical Medicine (LSHTM) and they collaborated on secondary data analysis. All personal identifiers were removed before sharing the dataset and any analysis. Ethical approval for secondary data analysis was granted from the LSHTM Research Ethics Committee for the secondary analysis of this data (#32126).

Consent for publication

Consent for publication was provided by all participants.

Availability of data and materials

The datasets generated and/or analysed during the current study are available in the LSHTM Data Compass repository.

Competing interests

The authors declare that they have no competing interests. REEMI™ had no role in the study design, collection or analysis of the data, writing of the manuscript, or the decision to submit for publication.

Funding

Funding for the project activities was provided by the US Government. The funder had no role in the study design, collection or analysis of the data, writing of the manuscript, or the decision to submit for publication.

Author contributions

To be automatically generated by the journal

Acknowledgements

This study was made possible by the participation of our study population of Internally Displaced women in the Banadir Region of Somalia. Their participation and feedback have allowed us to make these contributions to menstrual health research. We acknowledge the contributions to program development, distribution, and data collection made by Medair and their local partner. The menstrual materials in this study were provided by Reemi, a non-profit organisation dedicated to improving menstrual health worldwide.

I. Introduction

Menstrual health and hygiene (MHH) is a fundamental, yet often neglected, determinant of health, dignity and well-being for women, girls, and people who menstruate. It refers to a state of well-being where individuals who menstruate can access reliable information, affordable materials, and safe facilities, while living in a positive and respectful environment and can participate in life without restrictions related to menstruation (1). Supporting MHH is foundational in advancing gender equality and improving global health by enabling full participation in daily activities, education, and work without being restricted by an individual's menstrual cycle (2,3). Yet, many of the two billion women, girls, and people who menstruate face persistent barriers to managing menstruation with ease, comfort, and dignity (2,4). Barriers such as poor facilities, unaffordable and unavailable materials, lack of privacy for washing and drying, and limited information, which undermine the education and economic opportunities, as well as sexual and reproductive health, and perpetuate cycles of inequality and vulnerability (5–7).

Conflict and displacement exacerbate challenges to MHH, as the conditions required for people to adequately manage menstruation are often inaccessible, insufficient, or restricted, leaving already vulnerable populations without the means to care for their menstrual health. Internally displaced persons (IDPs), individuals forced to flee their homes due to conflict, persecution, or disasters while remaining within their country's borders, are particularly vulnerable to these challenges. As of June 2025, there were 67.8 million IDPs globally (United Nations and High Commissioner for Refugees, 2025), among them, women, girls, and people who menstruate are disproportionately affected due to inadequate water, sanitation, and hygiene (WASH) facilities and limited privacy in camps and shelters (9).

Despite its importance, MHH has been historically neglected in humanitarian response, partly due to the overwhelming need or prioritisation of health, food, water, and shelter over other aspects of care (5,10,11). While progress has been made (10,12,13), persistent challenges remain, including inconsistent guidance and standards, unclear sectoral roles, challenges of multiple distributions to renew supply, and limited dissemination of evidence-based practices (7,10,14–16). Access and affordability of menstrual materials, clean water, disposal options, and information on menstrual hygiene practices is often limited (5). Privacy, for washing, bathing and laundering menstrual materials, can be minimal due to crowded living conditions and poorly designed washrooms that lack gender segregation, doors, locks, or safe access at night (5,7,11,17).

Reusable menstrual materials, such as pads, cups and underwear, offer a potential solution to MHH challenges in resource-constrained environments (18–20). Unlike disposable options, which are often costly, unavailable, or replaced with unsafe alternatives such as unclean cloths, rags, paper or other items, reusable menstrual materials are safe, effective, and acceptable. They can offer comfort, cost savings, and environmental sustainability (18–20). Their durability and affordability make them particularly suitable for fragile and crisis contexts where ongoing distributions may not be feasible, and their use may also help normalise menstruation and reduce stigma and shame (21).

Evidence on the acceptability and effectiveness of reusable menstrual materials in low- and middle-income countries (LMICs) remains sparse (22). While studies have evaluated reusable pads (19) and cups (20,23–27), research on menstrual underwear in LMICS, and particularly in crisis settings, is scarce (18,28,29). To address this gap, this study examined the use, acceptability, and factors associated with the use of menstrual underwear distributed to internally displaced women in the Banadir region, Somalia. Specifically, it aimed to assess sustained use over 12 months, acceptability in terms of comfort, practicality, and satisfaction, and identify factors associated with the use of reusable menstrual underwear that may be used to inform future MHH interventions.

II. Methods

Study design

This prospective longitudinal study was conducted among internally displaced women over 12 months. Surveys took place in July 2024 and from April to May 2025.

Study site

The study was conducted in IDP settlements outside Mogadishu, Banadir region, Somalia, a country hosting one of the largest IDP populations globally (30). According to a WHO/UNICEF Joint Monitoring Program (JMP) 2023 progress report, only 21% of the displaced population in Somalia have access to basic sanitation services and 7% to basic hygiene services, compared with 35% of non-displaced populations and 14% among non-displaced groups, respectively (31). Across the Banadir region, there are 1,091 verified IDP sites hosting approximately 674,000 individuals (32). The targeted settlements surveyed are characterised by repeated displacement due to flooding, drought, and conflict (33,34).

Study population and intervention

In March 2024, Medair, a humanitarian organisation assisting those affected by disaster, disease, and conflict, implemented a menstrual health intervention targeting IDP women and girls of reproductive age in the Banadir region. Menstruation kits were distributed to 2,700 women participating in Medair's Care Group network- a peer-education model where local women meet regularly to support community learning on health and hygiene topics. Discussions were facilitated on menstrual health and use of the menstrual hygiene materials. The menstrual materials selected for the menstruation kits was from Reemi (<https://reemi.org/>), a nonprofit developing innovative menstrual materials that offers menstrual underwear designed for repeated use in low-resource settings with high absorbency, anti-microbial fabric (Figure 1). The menstruation kits contained four pairs of medium-sized underwear, a washing bag, and a drying bag designed to enhance privacy and water use for washing the underwear.



Figure 1. Reemi™ reusable menstrual underwear, <https://reemi.org/>

Sample size

Following the distribution, Medair designed and conducted a survey to assess use and acceptability. A beneficiary list provided the sampling frame, and simple random sampling was applied to ensure equal selection probability. The sample size was calculated using a Beneficiary-Based Survey (BBS) calculator for a population of 2,700, assuming a standard deviation of 0.5, a 5% margin of error, and a 95% confidence level. After applying a finite population correction and a 5% non-response rate adjustment, the final sample was 355 women (35).

Data collection

Data were collected through structured surveys administered at two time points: in July 2024 (3 months after distribution) and in April-May 2025 (approximately 1 year after distribution). The survey instrument was pre-tested to ensure appropriate language and cultural

approaches and was conducted in Somali by trained female enumerators. Each survey took place at participants' homes and lasted about 20 minutes. Enumerators were drawn from a Medair-trained roster, had completed at least secondary education, and received training on ethics, informed consent, and interviewing practices. Surveys were administered using Open Data Kit (ODK) on tablets.

Study outcome

The study outcome was based on participants' reported use of the menstrual underwear. Participants were asked 12 months after distribution whether they still had the menstrual underwear at the time of the survey and used them during their last menstruation.

Data analysis

Survey data from both rounds were merged to enable longitudinal analysis. Categorical variables were recoded into meaningful data-driven groupings to facilitate statistical comparison. Descriptive analyses were performed using frequency tabulations in Stata 18.5 (StataCorp LLC, USA) to summarise participant characteristics. Univariate logistic regression was first performed to estimate the crude unadjusted odds ratios (ORs), with 95% confidence intervals, for associations between the outcome and explanatory variables, including demographic and acceptability factors. Variables associated at $p < 0.1$ were included in the multivariable logistical regression models, along with a priori variables identified from existing literature (2,5,18,36). Models were adjusted for clustering by area and confounders, including age and education. Variables were added stepwise, with Wald tests used to assess model fit, and a significance threshold of $p < 0.05$ was used. Results from the univariate analysis can be seen in Supplementary Material 1.

III. Results

Characteristics of study participants

A total of 357 women participated in the first survey and 297 at follow-up; the final analytical sample included 295 women who completed both survey rounds (Figure 2, Table 1). Most women were aged 20-26 years (28%), married (73%), had 4-6 children (36%), and had been living in an IDP camp for 2-5 years (46%). Education levels were low, with 86% reporting no formal education, and 63% had a monthly income of 0-20 USD (63%). Within the Care Group network, 25% held a "volunteer" role.

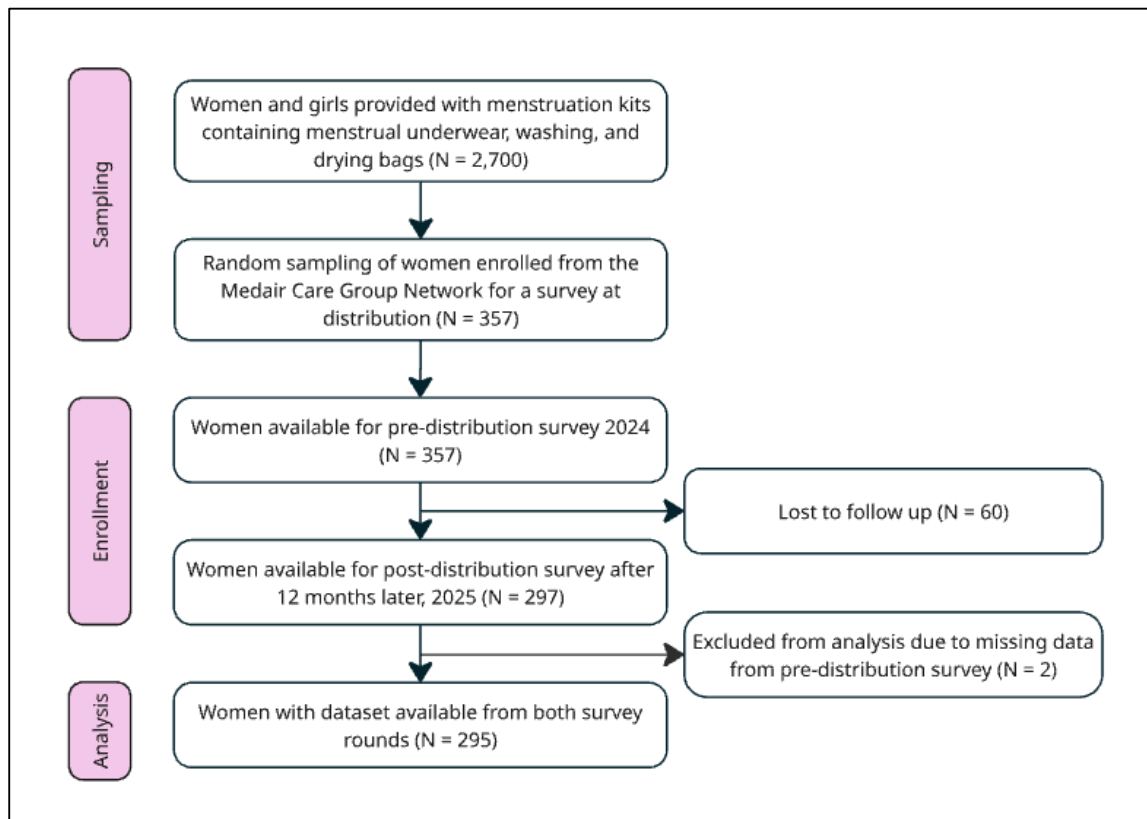


Figure 2. Participant flow diagram

Table 1. Characteristics of study participants, Banadir region, Somalia

Demographics	N	n	%
Number of participants	295		
Age (years)			
14-19	295	32	11%
20-26	295	82	28%
27-33	295	62	21%
34-40	295	66	22%
>40	295	53	18%
Years living in the IDP camp			
≤1	295	53	18%
2-5	295	137	46%
≥6	295	105	36%
Marital status			
Married	295	214	73%
Divorced/separated	295	34	12%
Widow	295	25	8%
Single	295	22	7%
Number of children			
0	295	27	9%
1-3	295	83	28%
4-6	295	105	36%
7-9	295	69	23%
≥10	295	11	4%
Role in care group network			
Volunteer	295	74	25%
Neighbour woman	295	221	75%
Education			
No formal education	295	253	86%
Some formal education	295	42	14%
Monthly income (\$USD)			
0-20	295	185	63%
21-40	295	36	12%
41-60	295	35	12%
>60	295	39	13%
Household's source of income			
Casual labour	295	179	61%
Other	295	82	28%
Business, trade, and crafts	295	16	5%
Agricultural work or production	295	16	5%
Private sector employment	295	2	1%

Receipt of the intervention

Before distribution, participants commonly relied on multiple materials to manage their most recent menstruation, most often scrap cloths (67%), disposable pads (37%), and regular underwear (32%), with smaller proportions reporting the use of new cloths (11%), reusable pads (9%) and 2% nothing (Table 2). After distribution, 265 (90%) of participants reported using the menstrual underwear, 98% used the washing bag and 94% used the drying bag.

Among recalled messages during distribution, the most frequent messages recalled were that poor menstrual hygiene can lead to infections (69%), that the drying bag should be used outside in the sun (68%), and that the menstrual underwear should be washed daily with soap (62%) (Table 2). Engagement with the Care Group network was also high, with 95% of participants receiving regular messages from a volunteer, 90% reporting exposure to menstrual information from a volunteer or health promoter within the past three months and 84% reporting that they received training on how to use the underwear. Participants also reported comfort with distribution processes; 100% felt comfortable receiving materials and high awareness of why they were selected (94%) to receive materials.

Twelve months after distribution, 263 participants (89%) reported using the menstrual underwear during their most recent menstruation, 96% used the washing bag and 95% used the drying bag. For the 11% of women who did not use the menstrual underwear 12 months later, only one participant who used scrap cloths answered the survey on what other materials they used instead.

Table 2. Receipt and use of the menstrual underwear, washing bag and drying bag among internally displaced women in the Banadir region, Somalia

Receipt of the Intervention	N	n	%
Number of participants	295		
Materials used before the distribution of menstrual underwear			
Scrap cloths	295	198	67%
Disposable pads	295	110	37%
Regular underwear	295	94	32%
New cloths	295	33	11%
Reusable pad	295	26	9%
Nothing	295	6	2%
Received menstrual underwear	295	295	100%
Pairs of menstrual underwear received			
2-3	295	12	4%
≥4	295	283	96%
Received washing bag	295	295	100%
Received drying bag	295	295	100%
Recall of messages			
Poor menstrual hygiene can lead to infections	200	137	69%
Use drying bag outside in the sun	200	136	68%
Wash materials daily with soap	200	123	62%
Washing bag uses less water	200	117	59%
Menstruation is part of fertility	200	65	33%
Menstruation is a healthy process	200	60	30%
Aware of why you were selected for distribution	250	236	94%
Taught how to use the materials at the distribution	291	243	84%
Felt comfortable receiving menstrual materials during distribution	295	294	100%
Received regular messages from the neighbour	221	209	95%
Received menstrual information from a volunteer/promoter in the past 3 months	221	200	90%
Use of menstrual materials during last menstruation			
Used menstrual underwear during last menstruation 3 months after distribution	295	265	90%
Used a reusable washing bag during the last menstruation 3 months after distribution	265	259	98%
Used a reusable drying bag during the last menstruation 3 months after distribution	265	249	94%
Used menstrual underwear during last menstruation 12 months after distribution	295	263	89%
Used a reusable washing bag during the last menstruation 12 months after distribution	280	268	96%
Used a reusable drying bag during the last menstruation 12 months after distribution	273	258	95%

Acceptability of menstrual underwear

Acceptability of the menstrual underwear was high (Table 3). All participants reported receiving menstrual underwear, and almost all (96%) received four or more pairs. The majority (93%) felt this was enough to allow rotation during menstruation, with 74% reporting using the underwear when not menstruating. All participants found the menstrual underwear comfortable (100%), 95% said it worked for heavy bleeding days, and 94% would recommend it to friends. There were no reports of leakage or odour during use (0%), and almost all participants said the menstrual underwear improved their privacy (99%) and convenience (100%) in managing menstruation compared with previous methods. Most women (93%) reported fewer infections or irritation since using the menstrual underwear.

Nearly all respondents had sufficient resources for washing, 89% had enough water, and 83% enough soap, and 97% reported the menstrual underwear dried completely before reuse. Around half dried them outside in the sun (54%) and the rest in private (46%). Most women washed the menstrual underwear daily (88%), found the washing (100%) and drying (98%) bags easy to use, and preferred them to standard methods.

When asked what they liked most about the underwear, women most often cited that it worked well to catch all menstrual flow (62%), was easy to use (61%), comfortable to wear (55%), and gave confidence against leaks (54%). Privacy was also important, with 50% describing the menstrual underwear as discreet. Among reasons for using the washing and drying bags, privacy (86–89%) was the most common, followed by convenience (22-35%) and reduced water use (41%).

Table 3. Acceptability of the REEMI™ menstrual materials among internally displaced women in the Banadir region, Somalia

Acceptability of the Materials	N	n	%
Number of participants	295		
Enough water to wash menstrual underwear	265	237	89%
Enough soap to wash menstrual underwear	265	220	83%
Menstrual underwear was able to dry completely before using again	265	258	97%
Where menstrual underwear was dried			
Outside in the sun	241	129	54%
Inside in private	241	112	46%
Wash menstrual underwear every day	265	233	88%
Washing bag is easy to use	259	258	100%
Prefer the washing bag over hand washing	259	252	97%
Drying bag is easy to use	249	243	98%
Prefer the drying bag over drying like normal laundry	249	233	94%
Household members are aware of reusable menstrual material use			
No one	265	150	57%
Someone	265	115	43%
Menstrual underwear changed the privacy of managing menstruation	290	288	99%
Enough menstrual underwear to allow rotation	291	271	93%
Wear menstrual underwear when not menstruating	289	213	74%
Use menstrual underwear only on certain days of menstruation			
No, all days	292	282	97%
Yes, only certain days	292	10	3%
Menstrual underwear is comfortable	292	292	100%
Menstrual underwear works for heavy bleeding days	289	275	95%
Experienced leakage when using menstrual underwear	292	0	0%
Experienced an odour when using menstrual underwear	292	0	0%
Menstrual underwear had an odour after cleaning and drying	290	6	2%
Menstrual underwear changed the convenience of managing menstruation	291	290	100%
Fewer infections since using the menstrual underwear	292	273	93%
Recommend that friends use menstrual underwear	265	250	94%
Reasons they liked menstrual underwear			
Works well to catch all menstruation	292	180	62%
Easy to use	292	178	61%
Comfortable to wear	292	161	55%
Gives confidence for leaks	292	158	54%
Discrete/private	292	146	50%
Feels clean and dry	292	82	28%
Reasons for using the washing bag			
Private	295	253	86%
Less water needed	295	122	41%
Convenient	295	104	35%
Don't have to handle dirty water	295	12	4%

Acceptability of the Materials	N	n	%
Reasons for using a drying bag			
Private	295	263	89%
Convenient	295	64	22%

Factors associated with use of menstrual underwear

Participants who felt they had received enough underwear to allow rotation during menstruation had significantly higher odds of using them compared with those who did not (aOR = 6.63, 95% CI [1.37, 32.10], $p = 0.019$) (Table 4). Marital status was also associated with use. Divorced or separated women (aOR = 0.28, 95% CI [0.09, 0.86], $p = 0.027$) and single women (aOR = 0.25, 95% CI [0.13, 0.48], $p < 0.0001$) were less likely to use the menstrual underwear compared to married participants.

Associations with income were less clear. Compared to those with a household income of 0-20 USD per month, participants with incomes of 21-40 USD had lower odds of use (aOR = 0.25, 95% CI [0.13, 0.48], $p < 0.0001$) while higher income groups showed no significant differences (aOR = 1.45, 95% CI [0.52, 4.09], $p = 0.479$; aOR = 1.01, 95% CI [0.11, 8.93], $p = 0.996$), likely reflecting small subgroup sizes.

Participants who recalled menstrual health messages including “Gives confidence for leaks” (aOR = 0.22, 95% CI [0.08, 0.63], $p = 0.005$), “Menstruation is a healthy process” (aOR = 0.33, 95% CI [0.21, 0.51], $p < 0.0001$), and “Poor menstrual hygiene leading to infections” (aOR = 0.23, 95% CI [0.07, 0.74], $p = 0.014$) all had lower odds of use.

Table 4. Factors related to the use the menstrual underwear among internally displaced women in the Banadir region, Somalia

Multivariate Analysis		Used the menstrual underwear			
	Unadjusted Odds Ratio (OR)	Adjusted OR	95% CIs		p-value
Number of participants: 295					
Income per month (\$USD)					
0-20					
21-40	0.37	0.25	0.13	0.48	<0.0001
41-60	0.68	1.45	0.52	4.09	0.479
>60	0.49	1.01	0.11	8.93	0.996
Marital status					
Married					
Divorced/separated	1.12	0.28	0.09	0.86	0.027
Single	0.49	0.25	0.13	0.48	<0.0001
Widow	0.57	1.15	0.23	5.78	0.865
Enough menstrual underwear to allow rotation	3.43	6.63	1.37	32.10	0.019
Reasons liked menstrual underwear-discreet/private	1.26	2.76	0.13	57.79	0.513
Recall message on "Gives confidence for leaks"	0.50	0.22	0.08	0.63	0.005
Recall message on "Menstruation is a healthy process"	0.55	0.33	0.21	0.51	<0.0001
Recall message on "Poor menstrual hygiene can lead to infections"	0.21	0.23	0.07	0.74	0.014
CIs = Confidence Intervals The multivariate analysis was adjusted for age and education.					

IV. Discussion

Use of the menstrual underwear was high 12 months after distribution, with 89% of participants reporting use during their most recent menstruation. Almost all participants also reported use of the accompanying washing (96%) and drying bag (95%). This high uptake, 12 months after distribution, suggests strong acceptance of the intervention and supports its potential to address documented barriers to MHH identified in humanitarian settings (5). Participants described the menstrual underwear as comfortable, suitable for heavy bleeding, and associated with fewer infections, with no reports of leakage or odour. Many also noted improvements in convenience, privacy, and infections and irritation since adopting the menstrual underwear and bags for washing and drying. Although our survey did not include follow-up questions to explore these experiences in depth, the self-reported improvements indicate that menstrual underwear may offer meaningful benefits in resource-constrained contexts.

These findings align with the growing body of evidence showing that reusable menstrual materials are generally acceptable across crisis and non-crisis settings when they meet users' expectations of comfort, hygiene control, absorbency, and ease of washing and drying (7,18,28). Previous research among refugee and displaced women has similarly found that reusable menstrual materials can enhance comfort, confidence, hygiene, body image, and social participation, provided the users have access to water, soap, privacy, and drying space (18). Reusable menstrual materials have also been viewed as cleaner, more cost-effective, environmentally-friendly, and odourless relative to disposable materials (20,21,37). In particular, the cost and environmental sustainability of reusable menstrual materials have contributed to the appeal and growing popularity globally (19,38). This consistency across diverse settings suggests that comfort, reliability, and environmental or cost benefits are broad determinants of reusable menstrual underwear acceptability.

A 2025 published report evaluating the effectiveness of REEMI™ menstrual underwear, washing bags, and drying bags in Gaza and Lebanon had similar findings, with 86% and 99.8% of women reporting menstrual underwear use after 3 and 6 months, respectively (29). Women also used the washing bag (77% and 100% after 3 and 6 months) and drying bag (84% and 100% after 3 and 6 months). Their participants similarly found the materials comfortable, absorbent and affordable. However, the evaluation identified some challenges not seen in our study, such as limited access to clean water and soap, which did not emerge as significant issues in our setting. The report also noted difficulties with underwear sizing, as limited supplies meant some women received their second choice, which may have

affected acceptability and ease of use. In our study, only size medium was distributed and less than 2% reported size to be an issue. The results from both studies demonstrate the importance of supportive services and facilities, particularly water and soap, for MHH interventions to be successful (2).

Our study identified several factors associated with continued use of menstrual underwear. The clearest predictor was whether women felt they had received enough pairs of menstrual underwear to allow rotation during menstruation. Participants who reported an adequate number had significantly higher odds of continued use. This aligns with qualitative evidence showing that managing a period with only a one or two pairs of menstrual underwear is challenging due to the frequency of washing required and the limited drying time available for consecutive use (37). Having multiple pairs facilitates hygiene, reduces stress, and supports autonomy over managing menstruation, particularly in settings with limited water, privacy, or drying space (2). While multiple studies have noted the need for more than two pairs, the optimal number remains unclear and warrants further research (18,37,39). For program design, our findings reinforce the need to provide enough pairs to enable rotation.

Marital status was also associated with use. Divorced, separated, and single women had lower odds of using menstrual underwear than married women. In IDP camps, limited privacy and overcrowded housing may restrict opportunities for washing and drying menstrual materials (29). Married women have relatively more control over private space or household routines, enabling easier menstrual management (40). Cultural norms may also influence comfort in managing menstruation (40). Some studies have shown that unmarried women may prefer using disposable menstrual materials due to concerns that practices would reveal their menstrual status, harming their reputations (40), or contributing to feelings of shame, social exclusion, and reinforcement of taboos and negative cultural beliefs (18). However, evidence from India found mixed associations between marital status and hygienic practices (41), indicating that the relationship is likely context-specific. Further research in Somalia would help clarify how marital and household arrangements shape MHH behaviours.

Associations between income and menstrual underwear use were less clear. Women in the second-lowest income group had lower odds of use compared with those in the lowest income group, while higher-income groups showed no significant associations. Given wide confidence intervals and small subgroup sizes, these results should be interpreted cautiously. Previous research has shown that lower income is associated with greater unmet MHH needs, including limited access to soap, water and private space for washing and

drying (3,36). Our study did not find strong evidence linking income to these practical factors. However, it is possible that higher-income women had more stable living conditions or greater autonomy in household decision-making (42), which may influence how reusable menstrual materials are managed. Further research with a larger and more diverse sample is needed to understand how socioeconomic differences may shape sustained use.

A cluster of unexpected associations emerged around reasons for use and their recall of menstrual health messages. Women who cited “confidence for leaks” as a benefit, or who recalled message such as “menstruation is a healthy process” or “poor menstrual hygiene can lead to infections”, had lower odds of current use. These findings should be interpreted cautiously, as they may reflect recall bias, misclassification, or selective resonance with existing beliefs rather than true behavioural effects. Leak protection may have been expressed as a general preference across materials rather than specific to the menstrual underwear (7). Messages framing menstruation as healthy may have reduced perceived need for additional materials, while infection-related messaging may not have increased perceived susceptibility. Women involved in message dissemination, thus more likely to recall messages, were also more likely to have used dedicated materials prior to the intervention and may have been less motivated to switch. Higher recall may also reflect socioeconomic differences, as seen among volunteer participants. Together, these inverse associations likely reflect interpretation and recall dynamics, rather than evidence that messaging or leak protection discouraged uptake. Further qualitative research is needed to understand how menstrual health messages are interpreted and shape material uptake.

Age was treated as a confounder in multivariate models, but descriptively women over 40 years old were less likely to use the menstrual underwear. This likely reflects reproductive life stage, as perimenopause or menopause reduce or end menstruation. While WHO estimates menopause typically occurs between the ages of 45 and 55 (43), it may occur earlier among women exposed to displacement or conflict (44). For women no longer menstruating regularly, menstrual underwear for menstrual absorption may be less relevant. At the same time, some older participants reported wearing the underwear outside of menstruation, possibly for comfort or urinary incontinence (18). These observations highlight the importance of reproductive life stage and context in interpreting use, but should not be over-interpreted, given that age was included as a confounder.

Together, our findings show that reusable menstrual underwear can be a highly acceptable and effective option for women in displacement contexts, especially when designed for adequate distribution quantities and complemented with information on menstrual health.

The sustained use observed in this study suggests that such innovations can meaningfully expand access to menstrual materials for a sustained period of time resulting from a single distribution event. More broadly, this supports wider evidence calling for stronger prioritisation of MHH in humanitarian response, for donor and organisational leadership to ensure that menstrual needs are consistently addressed (10). Ensuring women have access to reliable, comfortable, and sustainable menstrual materials is essential not only for health and hygiene but also for dignity, autonomy and gender equality.

Limitations

The survey relied on self-reported data introducing potential recall and social desirability bias. Responses may have been affected by the private and culturally sensitive nature of menstruation or the desire to provide favourable responses. Misclassification of responses may have occurred, which could lead to inaccurate or incomplete data. To address these potential limitations, enumerators were trained in creating a comfortable environment to promote candidness and cultural competency. All enumerators were female to foster gender sensitive environments. Close supervision was also maintained throughout the intervention to ensure accurate and reliable data collection (45,46). Surveys were given at three and twelve months after distribution, which introduced a degree of loss to follow-up (17% LTFU), non-response and recall bias. Collecting data at only two points in time limited the ability to capture changes in use or acceptability patterns over time, including seasonal variations to managing menstruation (e.g., differences in washing or drying practices during dry or rainy seasons) (40,47,48). In the analysis, categorical variables were used to capture non-linear relationships, but small subgroup sizes may have reduced the precision of some estimates and, therefore, require thoughtful interpretation. Additionally, data on the types of menstrual materials used by few participants not using menstrual underwear 12 months after distribution was not completed in the survey, limiting our knowledge of what alternative materials were being used. Finally, the findings are specific to this IDP population in Somalia, which could limit generalisability to other contexts. Future research should continue to employ context-specific, longitudinal approaches to better capture behavioural and seasonal variations in menstrual material use that may be unique to participants' social, cultural, and environmental factors.

Conclusions

The findings of this study demonstrate that reusable menstrual underwear can be a highly acceptable and effective option for MHH in crisis settings, particularly when distributed in sufficient quantities to enable rotation and coupled with appropriate information on MHH.

High use of the menstrual underwear was observed 12 months post distribution, with participants reporting positive experiences with comfort, hygiene, and convenience. The results highlight factors influencing use, such as marital status, income, and number of menstrual underwear received. These insights reinforce the need for programs with a culturally sensitive community-led approach, strong and carefully designed MHH messaging, an adequate amount of menstrual underwear to allow for rotation, and integration into broader humanitarian planning. There should be continued research on which reusable menstrual materials enhance use and acceptability when distributed across diverse settings. This research should include a qualitative component to add context and provide deeper insights.

References

1. Hennegan J, Winkler IT, Bobel C, Keiser D, Hampton J, Larsson G, et al. Menstrual health: a definition for policy, practice, and research. *Sex Reprod Health Matters*. 2021 Dec;29(1):1911618. doi:10.1080/26410397.2021.1911618 PubMed PMID: 33910492; PubMed Central PMCID: PMC8098749.
2. Hennegan J, Shannon AK, Rubli J, Schwab KJ, Melendez-Torres GJ. Women's and girls' experiences of menstruation in low- and middle-income countries: A systematic review and qualitative metasynthesis. *PLOS Med*. 2019 May 16;16(5):e1002803. doi:10.1371/journal.pmed.1002803
3. Plesons M, Patkar A, Babb J, Balapitiya A, Carson F, Caruso BA, et al. The state of adolescent menstrual health in low- and middle-income countries and suggestions for future action and research. *Reprod Health*. 2021 Feb 8;18(1):31. doi:10.1186/s12978-021-01082-2 PubMed PMID: 33557877; PubMed Central PMCID: PMC7869499.
4. UN Women. Period Poverty – why millions of girls and women cannot afford their periods [Internet]. 2025 Jul 28 [cited 2025 Aug 25]. Available from: <https://www.unwomen.org/en/articles/explainer/period-poverty-why-millions-of-girls-and-women-cannot-afford-their-periods>
5. Patel K, Panda N, Sahoo KC, Saxena S, Chouhan NS, Singh P, et al. A systematic review of menstrual hygiene management (MHM) during humanitarian crises and/or emergencies in low- and middle-income countries. *Front Public Health*. 2022;10:1018092. doi:10.3389/fpubh.2022.1018092 PubMed PMID: 36249215; PubMed Central PMCID: PMC9555566.
6. World Bank Group. Menstrual Health and Hygiene [Text/HTML] [Internet]. [cited 2025 Aug 24]. Available from: <https://www.worldbank.org/en/topic/water/brief/menstrual-health-and-hygiene>
7. Schmitt ML, Clatworthy D, Ratnayake R, Klaesener-Metzner N, Roesch E, Wheeler E, et al. Understanding the menstrual hygiene management challenges facing displaced girls and women: findings from qualitative assessments in Myanmar and Lebanon. *Confl Health*. 2017 Oct 16;11(1):19. doi:10.1186/s13031-017-0121-1
8. United Nations, High Commissioner for Refugees. Mid-Year Trends: Forced displacement in the first half of 2025 [Internet]. Copenhagen, Denmark: High Commissioner for Refugees; 2025 [cited 2025 Dec 15]. Report. Available from: <https://www.unhcr.org/media/mid-year-trends-2025>
9. Betsu BD, Medhanyie AA, Gebrehiwet TG, Wall LL. “We pray for the night to be shorter, so we can change our menstrual pads”: A qualitative exploration of menstrual hygiene challenges among internally displaced adolescent girls in Northern Ethiopia, 2023. *PLOS ONE*. 2024 Oct 22;19(10):e0309985. doi:10.1371/journal.pone.0309985
10. Sommer M, Schmitt ML, Clatworthy D, Bramucci G, Wheeler E, Ratnayake R. What is the scope for addressing menstrual hygiene management in complex humanitarian emergencies? A global review. *Waterlines*. 2016;35(3):245–64.

11. VanLeeuwen C, Torondel B. Improving menstrual hygiene management in emergency contexts: literature review of current perspectives. *Int J Womens Health*. 2018 Apr 10;10:169–86. doi:10.2147/IJWH.S135587 PubMed PMID: 29692636; PubMed Central PMCID: PMC5901152.
12. Sommer M, Schmitt ML, Ogello T, Mathenge P, Mark M, Clatworthy D, et al. Pilot testing and evaluation of a toolkit for menstrual hygiene management in emergencies in three refugee camps in Northwest Tanzania. *J Int Humanit Action*. 2018 May 3;3(1):6. doi:10.1186/s41018-018-0034-7
13. Wilbur J, Crow CL, Poilapa R, Morrison C. Feasibility study of a menstrual health behaviour change intervention for women and girls with intellectual disabilities and their caregivers for Vanuatu's humanitarian responses. *PLOS Glob Public Health*. 2024;4(1):e0002244. doi:10.1371/journal.pgph.0002244 PubMed PMID: 38241243; PubMed Central PMCID: PMC10798467.
14. Downing SG, Benjimen S, Natoli L, Bell V. Menstrual hygiene management in disasters: the concerns, needs, and preferences of women and girls in Vanuatu. *Waterlines*. 2021;40(3):144–59.
15. Krishnan S, Twigg J. Menstrual hygiene: a “silent” need during disaster recovery. *Waterlines*. 2016;35(3):265–76.
16. Prabhakar J, Mg A, Nazar AF, Ms A, Pj JJ, Ap N, et al. Exploring menstrual hygiene management practices among displaced coastal women in Kerala, India. *J Clim Change Health*. 2025 Jan 1;21:100375. doi:10.1016/j.joclim.2024.100375
17. Hirani SAA. Barriers to Women's Menstrual Hygiene Practices during Recurrent Disasters and Displacement: A Qualitative Study. *Int J Environ Res Public Health*. 2024 Jan 30;21(2):153. doi:10.3390/ijerph21020153 PubMed PMID: 38397644; PubMed Central PMCID: PMC10888390.
18. VanLeeuwen C, Torondel B. Exploring menstrual practices and potential acceptability of reusable menstrual underwear among a Middle Eastern population living in a refugee setting. *Int J Womens Health*. 2018 Jul 12;10:349–60. doi:10.2147/IJWH.S152483
19. Eijk AM van, Jayasinghe N, Zulaika G, Mason L, Sivakami M, Unger HW, et al. Exploring menstrual products: A systematic review and meta-analysis of reusable menstrual pads for public health internationally. *PLOS ONE*. 2021 Sep 24;16(9):e0257610. doi:10.1371/journal.pone.0257610
20. Medina-Perucha L, López-Jiménez T, Holst AS, Jacques-Aviñó C, Munrós-Feliu J, Martínez-Bueno C, et al. Use and perceptions on reusable and non-reusable menstrual products in Spain: A mixed-methods study. *PloS One*. 2022;17(3):e0265646. doi:10.1371/journal.pone.0265646 PubMed PMID: 35298550; PubMed Central PMCID: PMC8929555.
21. Kubovski A, Cohen Shabot S. Experience of menstruation with the use of reusable menstrual products: a qualitative study among menstruators in Israel. *Cult Health Sex*. 2024 Jul 1;26(7):904–19. doi:10.1080/13691058.2023.2260465 PubMed PMID: 37782548.
22. Roy N, Amin MB, Aktarujjaman M, Hossain E, Mugo C, Islam F, et al. Cross-national variation in the prevalence and correlates of current use of reusable

- menstrual materials: Analysis of 42 cross-sectional surveys in low-income, lower-middle-income, and upper-middle-income countries. *PLOS ONE*. 2024 Oct 7;19(10):e0310451. doi:10.1371/journal.pone.0310451
23. Gondwe M, Simuyaba M, Phiri M, Mwansa C, Schaap A, Sigande L, et al. Acceptability of and experiences with menstrual hygiene cups among adolescent girls and young women aged 15–24 in two communities in Lusaka, Zambia: an exploratory study nested in the Yathu Yathu trial. *Reprod Health*. 2025 Feb 6;22(1):20. doi:10.1186/s12978-024-01901-2
 24. K. T, Chidurala R. Acceptability and feasibility of using menstrual cups as an alternative menstrual hygiene product: a tertiary care-based prospective study. *Int J Community Med Public Health*. 2025 May 31;12(6):2779–84. doi:10.18203/2394-6040.ijcmph20251727
 25. Mason L, Nyothach E, Van Eijk AM, Obor D, Alexander KT, Ngere I, et al. Comparing use and acceptability of menstrual cups and sanitary pads by schoolgirls in rural Western Kenya. *Int J Reprod Contracept Obstet Gynecol*. 2019 Jul 26;8(8):2974. doi:10.18203/2320-1770.ijrcog20193506
 26. Phillips-Howard PA, Nyothach E, Ter Kuile FO, Omoto J, Wang D, Zeh C, et al. Menstrual cups and sanitary pads to reduce school attrition, and sexually transmitted and reproductive tract infections: a cluster randomised controlled feasibility study in rural Western Kenya. *BMJ Open*. 2016 Nov;6(11):e013229. doi:10.1136/bmjopen-2016-013229
 27. Pokhrel D, Bhattarai S, Emgård M, von Schickfus M, Forsberg BC, Biermann O. Acceptability and feasibility of using vaginal menstrual cups among schoolgirls in rural Nepal: a qualitative pilot study. *Reprod Health*. 2021 Jan 25;18(1):20. doi:10.1186/s12978-020-01036-0 PubMed PMID: 33487171; PubMed Central PMCID: PMC7831234.
 28. Bisimirwe C, Maombi S, Nabuki S, Mubelelwa L, Llosa AE, Palacios L. Feasibility and acceptability of menstrual underwear in a conflict and population displacement prone setting of Kalehe, Democratic Republic of the Congo [Internet]. 2025 [cited 2025 Sep 2]. Available from: <https://www.researchsquare.com/article/rs-6938601/v1> doi:10.21203/rs.3.rs-6938601/v1
 29. Groupe URD. Adopting Innovative Menstrual Hygiene Management Solutions in a Rapid Humanitarian Response [Internet]. 2025 Sep [cited 2025 Dec 15]. Report. Available from: <https://www.urd.org/en/project/evaluation-of-the-use-of-a-menstrual-hygiene-innovation-in-the-context-of-an-acute-crisis/>
 30. Romtveit G. Most people forced to flee never cross their country's borders. Norwegian Refugee Council [Internet]. 2025 May 14 [cited 2025 Aug 28]. Available from: <https://www.nrc.no/perspectives/2025/most-people-forced-to-flee-never-cross-their-countrys-borders>
 31. United Nations Children's Fund (UNICEF), World Health Organization (WHO). Progress on household drinking water, sanitation and hygiene 2000-2022: Special focus on gender [Internet]. New York; 2023 [cited 2025 Aug 25]. Report. Available from: <https://data.unicef.org/resources/jmp-report-2023/>

32. United Nations High Commissioner for Refugees (UNHCR). Banadir IDP Site Verification [Internet]. ReliefWeb; 2024 Dec. Report. Available from: <https://reliefweb.int/attachments/808dae93-b8c6-48b9-bbbb-6730e2d5561c/Banadir%20IDP%20Site%20Verification%20-%20December%202024.pdf>
33. Office for the Coordination of Humanitarian Affairs (OCHA). Somalia [Internet]. 2025 [cited 2025 Aug 28]. Available from: <https://www.unocha.org/somalia>
34. International Organization for Migration (IOM). Four Challenges Facing Displaced Persons in Somalia [Internet]. 2022 Sep [cited 2025 Aug 27]. Report. Available from: <https://reliefweb.int/report/somalia/four-challenges-facing-displaced-persons-somalia>
35. Medair. Post Distribution Monitoring (PDM) Report for reusable menstrual hygiene management (MHM) materials distribution for IDPs in Garasbaaley District, Somalia. 2024 Oct. Report.
36. Muhaidat N, Al Karmi J, Ibrahim OB, Raiq NA, Alhanbali AE, Ghanem HH, et al. Menstrual hygiene practice needs, and depression among refugee women in Jordan: a cross-sectional study. *BMJ Open*. 2024 Dec 5;14(12):e083824. doi:10.1136/bmjopen-2023-083824 PubMed PMID: 39638597; PubMed Central PMCID: PMC11624710.
37. Ramsay C, Hennegan J, Douglass CH, Eddy S, Head A, Lim MSC. Reusable period products: use and perceptions among young people in Victoria, Australia. *BMC Womens Health*. 2023 Mar 11;23(1):102. doi:10.1186/s12905-023-02197-3
38. Hait A, Powers SE. The value of reusable feminine hygiene products evaluated by comparative environmental life cycle assessment. *Resour Conserv Recycl*. 2019 Nov 1;150:104422. doi:10.1016/j.resconrec.2019.104422
39. Wilbur J, Poilapa R, Morrison C. Menstrual Health Experiences of People with Intellectual Disabilities and Their Caregivers during Vanuatu's Humanitarian Responses: A Qualitative Study. *Int J Environ Res Public Health*. 2022 Nov 5;19(21):14540. doi:10.3390/ijerph192114540 PubMed PMID: 36361421; PubMed Central PMCID: PMC9653728.
40. MacRae ER, Clasen T, Dasmohapatra M, Caruso BA. "It's like a burden on the head": Redefining adequate menstrual hygiene management throughout women's varied life stages in Odisha, India. *PLoS ONE*. 2019 Aug 1;14(8):e0220114. doi:10.1371/journal.pone.0220114 PubMed PMID: 31369595; PubMed Central PMCID: PMC6675075.
41. Meher T, Sahoo H. Dynamics of usage of menstrual hygiene and unhygienic methods among young women in India: a spatial analysis. *BMC Womens Health*. 2023 Nov 6;23(1):573. doi:10.1186/s12905-023-02710-8
42. Singh A, Chakrabarty M, Singh S, Mohan D, Chandra R, Chowdhury S. Wealth-based inequality in the exclusive use of hygienic materials during menstruation among young women in urban India. *PLOS ONE*. 2022 Nov 29;17(11):e0277095. doi:10.1371/journal.pone.0277095 PubMed PMID: 36445854; PubMed Central PMCID: PMC9707774.

43. World Health Organization. World Health Organization [Internet]. 2024 [cited 2025 Aug 19]. Menopause. Available from: <https://www.who.int/news-room/fact-sheets/detail/menopause>
44. Balic D, Rizvanovic M, Cizek-Sajko M, Balic A. Age at natural menopause in refugee and domicile women who lived in Tuzla Canton in Bosnia and Herzegovina during and after the war. *Menopause*. 2014 Jul;21(7):721. doi:10.1097/GME.000000000000173
45. Vollmer N, Singh M, Harshe N, Valadez JJ. Does interviewer gender influence a mother's response to household surveys about maternal and child health in traditional settings? A qualitative study in Bihar, India. *PloS One*. 2021;16(6):e0252120. doi:10.1371/journal.pone.0252120 PubMed PMID: 34133433; PubMed Central PMCID: PMC8208568.
46. Davis RE, Couper MP, Janz NK, Caldwell CH, Resnicow K. Interviewer effects in public health surveys. *Health Educ Res*. 2010 Feb;25(1):14–26. doi:10.1093/her/cyp046 PubMed PMID: 19762354; PubMed Central PMCID: PMC2805402.
47. Talukdar IH, Rifat MA, Sarkar P, Saha N, Tessma MK, Miah Mdl. Perceived difficulties in maintaining menstrual hygiene practices among indigenous adolescents during seasonal water scarcity periods in Bandarban hill district of Bangladesh: A cross-sectional study. *Int J Hyg Environ Health*. 2023 Sep 1;254:114268. doi:10.1016/j.ijheh.2023.114268
48. Caruso BA, Clasen TF, Hadley C, Yount KM, Haardörfer R, Rout M, et al. Understanding and defining sanitation insecurity: women's gendered experiences of urination, defecation and menstruation in rural Odisha, India. *BMJ Glob Health*. 2017 Oct 9;2(4):e000414. doi:10.1136/bmjgh-2017-000414 PubMed PMID: 29071131; PubMed Central PMCID: PMC5640070.