

MENSTRUAL CUPS AS A MENSTRUAL HYGIENE SOLUTION FOR RESOURCE-LIMITED ADOLESCENT GIRLS

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Introduction

For women and girls in low and middle-income countries (LMIC), menstrual hygiene can be difficult to manage due to the widespread social stigmas associated with menstruation (Chandra-Mouli & Patel, 2017) and limited access to high-quality menstrual products (Chandra-Mouli & Patel, 2017; Juma et al., 2017). In school-age girls, insufficient menstrual hygiene management (MHM) can promote school absenteeism and leave girls socially isolated (Chandra-Mouli & Patel, 2017; Phillips-Howard et al., 2016). Commercial disposable pads and tampons are often cost-prohibitive (M. Beksinska et al., 2020) and many women resort to low-quality hygiene products such as cloth, toilet paper, newspaper, or sponges (Chandra-Mouli & Patel, 2017; Hennegan et al., 2016; Juma et al., 2017). Such products, in conjunction with poor menstrual hygiene practices, are physically irritating and expose women to various urogenital health risks. These risks include bacterial, fungal, viral, and toxigenic vaginal conditions, as well as physical irritation (Juma et al., 2017; Phillips-Howard et al., 2016; van Eijk et al., 2018, 2019).

The menstrual cup is an alternative intravaginal menstrual hygiene device; it is a small, bell-shaped cup typically comprised of medical-grade silicone that collects (rather than absorbs) menstrual blood (van Eijk et al., 2019). The collected blood is emptied and the cup is reinserted multiple times throughout the day (van Eijk et al., 2019). Unlike disposable products, menstrual cups can be washed and reused for up to 10 years (van Eijk et al., 2019). Compared to reusable cloths and pads, which are cleaned through soaking in water for extended periods of time, menstrual cups can be washed quickly and discreetly (van Eijk et al., 2019). The menstrual cup's reusability, discreetness, and cost-effective nature warrant its consideration as a high-quality MHM solution for this vulnerable demographic (van Eijk et al., 2019).

While the menstrual cup is generally regarded to be safe in high-income populations (van Eijk et al., 2019), the risk of bacterial infections and menstrual toxic shock syndrome is still under investigation by the NIH. Additionally, it is unclear if adolescent girls in many countries would be receptive to the menstrual cup. The purpose of this review is to summarize previous research on menstrual cup usage in LMIC and identify logistical complications associated with menstrual cup implementation. This paper will focus on hindrances to sufficient hygiene management, menstrual cup safety, and the acceptability of menstrual cups with respect to school-age girls in LMIC.

Barriers to high-quality menstrual hygiene management

Access to menstrual hygiene products

On the global scale, conventional menstrual products are physically and financially inaccessible. Products such as disposable pads and tampons are frequently unavailable for purchase in rural areas (Juma et al., 2017); when these products are available, they are expensive to the point that girls and women cannot feasibly repurchase the products on a consistent basis (Chandra-Mouli & Patel, 2017). Instead, women must rely on hygiene products made from household materials: most frequently cloth, paper, and cotton (Chandra-Mouli & Patel, 2017; Hennegan et al., 2016; Juma

et al., 2017). These lower-quality products often lead to leakage issues and physical irritation, which compromises the woman's privacy about her menstruation status to peers and impacts her health and comfort (Chandra-Mouli & Patel, 2017; Hennegan et al., 2019).

Social stigma

Menstruation is a topic that is heavily stigmatized and taboo in many cultures; school-age girls in India (23.4%), Lebanon (30.5%), Malaysia (48.9%), and Uganda (69.2%) reported feeling "dirty," "disgusted," or "ashamed" by their periods (Chandra-Mouli & Patel, 2017; Hennegan et al., 2016). In combination with a lack of discreet MHM, visible blood leakage can leave girls vulnerable to public humiliation and harassment in social and educational settings. Female Ugandan students reported humiliation and bullying from boys when visibly bleeding through their clothing (Hennegan et al., 2019; Miiro et al., 2018). In Kenya and Uganda, male teachers were found to have teased their female students who skipped class while menstruating, publicly embarrassed girls that were concealing blood-stained clothes, and berated students that began menstruating unexpectedly during class (Chandra-Mouli & Patel, 2017; Miiro et al., 2018).

Widespread knowledge gaps about menstruation are the product of stigma surrounding menstruation and puberty, as girls' parents often face discomfort and avoid discussing the topic until girls reach menarche (first menstrual cycle) (Chandra-Mouli & Patel, 2017; Hennegan et al., 2019; Miiro et al., 2018). Bangladeshi mothers associated menstruation with fertility and sex and felt it inappropriate to discuss menstruation with their daughters before menarche (Chandra-Mouli & Patel, 2017). Kenyan and Tanzanian teachers reported feeling unprepared to educate students on menstrual topics and opined that the girls' mothers would be better suited for that role (Chandra-Mouli & Patel, 2017). Although girls expressed strong interest in gaining information about menstruation (Chandra-Mouli & Patel, 2017; Hennegan et al., 2019), many described embarrassment and shame as factors that prevented communicating with an adult (Chandra-Mouli & Patel, 2017; Miiro et al., 2018). As a result of the delayed information, menarche was frequently reported as an unfamiliar and fearful experience; many newly-menstruating girls initially believed that they were ill or dying, which establishes future confusion and social discomfort surrounding menstruation (Chandra-Mouli & Patel, 2017; Hennegan et al., 2019; Miiro et al., 2018). In Mexico, prior knowledge and preparedness for menarche was associated ($p < 0.0001$) with long-term positive attitudes towards menstruation (Chandra-Mouli & Patel, 2017).

Misinformation

The most common source of information about periods is the girls' mothers, followed by their sisters, and then other female relatives (Chandra-Mouli & Patel, 2017; Miiro et al., 2018). Misconceptions about menstruation are perpetuated through this mother-to-daughter hear-say method of education. In Ethiopia, Ghana, and Mali, there are popular misconceptions about menstruation; for instance, menarche is sometimes believed to be an indication that a girl is sexually active (potentially encouraging unwanted male sexual advances), and tampon use is believed by some to encourage sexual activity (Hennegan et al., 2019; Barrington et al., 2021). A survey of 150 girls in rural Nepal found that 82% of participants believed that menstrual cycles were a "curse" and 14.7% believed menstruation was "caused by a curse" (Adhikari et al., 2007). These misconceptions led girls to disguise the fact that they began menstruating (Hennegan et al., 2019). Associations between "impurity" and menstrual blood in India, Bangladesh, Nepal, and Nairobi prompted girls to modify their behavior in home and religious settings by avoiding contact with men and missing religious rituals (Hennegan et al., 2019). Girls in Malawi are often told by their mothers that men become sick or injured when they come into contact with menstrual blood (Chandra-Mouli & Patel, 2017),

leading girls to avoid social interaction with male peers and family members during their period (Hennegan et al., 2019). In addition to reinforcing stigmatized attitudes towards menstruation, misinformation disrupts menstruating girls' daily lives and social interactions.

Safety of Menstrual Cups

Current literature suggests that health risks related to menstrual cups are similar to those posed by comparable insertable products (i.e., tampons), but researchers raise concerns about the limited sanitation measures available in many countries that are necessary for menstrual cup maintenance and hygiene. Intravaginal menstrual devices like tampons and menstrual cups allow menstrual blood to stagnate within the vaginal canal for prolonged periods of time (van Eijk et al., 2019). Without regular cup cleanings during and between menstrual cycles, pathogenic bacterial colonization and urogenital infections may result (Phillips-Howard et al., 2016; van Eijk et al., 2018, 2019). For instance, girls may be unable to access sufficiently private spaces or functional bathrooms to clean and reinsert the cup (M. Beksinska et al., 2020). The aspect of reinsertion and storage of menstrual cups further increases the risk of infection, as improper cup maintenance between menstrual cycles can provide bacteria repeated opportunities to colonize. The primary risks posed by menstrual cups appear to be urogenital infections (van Eijk et al., 2019) and *Staphylococcus aureus*-related toxic shock syndrome (Mitchell et al., 2015).

Urogenital infections

In a menstrual cup feasibility trial on 188 Kenyan school-girls, *Escherichia coli* (*E. coli*) was isolated from one-third of the 188 cup-users (Phillips-Howard et al., 2016); another Kenyan study found *E. coli* in 37% (13/35) of sampled cups (Juma et al., 2017; Phillips-Howard et al., 2016; van Eijk et al., 2018, 2019). *E. coli* is a bacterium found in fecal matter, and its presence is indicative of cross-contamination between menstrual cup changes and defecation (Phillips-Howard et al., 2016; van Eijk et al., 2018, 2019). Opportunities for cross-contamination events might be facilitated by the reportedly insufficient school bathroom access and privacy available to study participants (M. Beksinska et al., 2020), which is consistent with water access reports in similar LMIC, such as South Africa (van Eijk et al., 2019). *E. coli* contamination of the urogenital region is also a risk factor in urinary tract infections (UTIs) (Phillips-Howard et al., 2016; van Eijk et al., 2018, 2019), although researchers did not monitor UTI prevalence in the Kenyan study participants (Juma et al., 2017; Phillips-Howard et al., 2016).

The same feasibility studies in Kenya found that menstrual cup-users had lower rates of bacterial vaginosis, a microbial-shift disease of the vagina causing inflammation (Nonfoux et al., 2018); 12.9% of cup-users presented with bacterial vaginosis, compared to 19.8% of pad-users ($p=0.018$). As silicone does not promote microbial growth (compared to cotton-based pads and tampons), cups may in fact reduce certain health risks (Mitchell et al., 2015; Nonfoux et al., 2018).

Toxic Shock Syndrome

Menstrual toxic shock syndrome (mTSS) is a rare and severe disease that is most commonly associated with extended, high-absorbency tampon usage (Mitchell et al., 2015). It is caused by *S. aureus*, a resident bacterium of the skin microbiota and an opportunistic pathogen that can improperly colonize the vagina in a menstrual blood medium. Toxigenic strains of *S. aureus* may produce toxic shock syndrome toxin 1 (TSST-1), which initiates the excessive cytokine release that induces mTSS symptoms: sepsis, multisystemic organ failure, and limb loss (Mitchell et al., 2015).

Few studies have been conducted on the specific mTSS risk posed by menstrual cups. Historically, tampon-induced mTSS is more clinically studied than menstrual cups and thus better understood—blood accumulation in tampon fibers acts as a growth medium and promotes bacterial adhesion, allowing for *S. aureus* colonization. In menstrual cups, the silicone medium does not support microbial growth but researchers theorize that the pooled menstrual blood alone can allow for colonization (Nonfoux et al., 2018). A 2018 *in vitro* study found that unlike tampons, menstrual cups posed an additional risk of *S. aureus* biofilm formation (Nonfoux et al., 2018). Biofilms allow bacterial colonies to form extracellular structures that increase their proliferation, pathogenicity, and adhesion to polymeric surfaces such as menstrual cups; biofilms therefore are more resistant to sterilization than their planktonic (free-floating) bacterial counterparts (Nandakumar et al., 2012). While biofilms were not formed in tampon fibers of various materials (cotton, rayon, viscose), stable *S. aureus* biofilms were discovered on the silicone surfaces of the menstrual cups (Nonfoux et al., 2018). These biofilms cannot be removed by washing alone, but the cups can be fully sterilized through boiling (Chandra-Mouli & Patel, 2017).

Reports of insufficient access to clean water, private toilets, and disposal methods in many LMIC complicate the sanitary methods required to hygienically use and store the menstrual cup (M. Beksinska et al., 2020). Of 509 college-age trial participants in South Africa, only one-third had running water and two-thirds had a flushing toilet in their homes (Juma et al., 2017; Phillips-Howard et al., 2016; van Eijk et al., 2018). Still, clinical data indicates that mTSS is a minimal health risk for the young female population (Juma et al., 2017; Phillips-Howard et al., 2016). A feasibility study on 644 Kenyan school-girls found 0 cases of mTSS out of 177 cup-users after 10 months of use, although *S. aureus* was isolated from the 17 cups *in vitro* (none of which were toxigenic strains) (M. Beksinska et al., 2020). Despite initial concerns about unreliable access to water and sanitation methods, the practical insignificance of these concerns demonstrated in these studies suggest that the benefits of cup usage outweigh these potential risks.

Acceptability of Menstrual Cups

Ease of Use

The insertion and placement of menstrual cups is not intuitive and requires instruction on correct technique. First-time cup users often report a learning curve; initial insertion and removal is difficult, but user-related issues are often resolved after practice and gained experience with the cup (M. Beksinska et al., 2020). In a South African study on college-age female students, 44.7% of 463 participants had difficulty with their first attempt of cup insertion; however, 82.8% of those participants reported improvement after 2-3 practice insertions (M. Beksinska et al., 2020). After 6 months, the main deterrent to cup-usage was not user frustration or dissatisfaction with cup performance, but rather generalized fear of cup insertion that prevented any attempts of usage (Phillips-Howard et al., 2016). These findings suggest that this initial learning curve may prevent girls from considering menstrual cups as an option, but once this learning curve is overcome, user satisfaction is high.

Education and instruction on menstrual cup usage can be beneficial to increase receptivity and retention. In a Kenyan trial on school-age girls, participants were provided with classroom training on cup insertion, sterilization techniques, and storage—the study had a 89.1% retention rate in cup-users after 10 months (van Eijk et al., 2018). Another study that provided a similar demographic with menstrual cup training reported 70.8% (136/192) retention in cup-users over 9 months (Phillips-Howard et al., 2016). *E. coli* was isolated primarily from new users and no *E. coli* was detected in cup-users after 9 months, indicating that user technique and maintenance improved

over time (M. E. Beksinska et al., 2015). This suggests that with increased education and access to information about cup usage, safety risks are decreased which may contribute to higher user retention and acceptability.

Comfort and reception

In a smaller menstrual cup trial in South African women, the majority (89%) of participants prior to the study had used and preferred disposable pads while a minority (11%) used tampons. Researchers found that after 3 months of use, 94% of 106 participants expressed approval for the menstrual cup; 87% were likely to continue to use the cup after the study's completion and 89% would recommend the cup to their family and peers (M. E. Beksinska et al., 2015). After 3 months, menstrual cups were also rated as “better” than many of the participants' previous choice of hygiene product in comfort (91%), quality (92%), capacity (93%), and appearance (82%); 92% of the 106 participants described an overall preference for the menstrual cup compared to their previous product (M. E. Beksinska et al., 2015). This data indicates high satisfaction with menstrual cups compared to the menstrual products that are presently accessible to these girls and women.

Conclusion

Current literature on menstrual hygiene access and menstrual cups usage in LMICs indicates socio-cultural impediments and financial limitations to menstrual hygiene management, a general consensus on sufficient menstrual cup safety, and a positive reception of menstrual cups among users. Menstrual hygiene is often poorly managed as a combined result of the prevalent societal shaming of menstruating girls and women, delayed and inaccurate perceptions about menstruation, and economic barriers to high-quality product access (Chandra-Mouli & Patel, 2017). Menstrual cups are a reliable and sanitary solution to product access, although there are health risks of bacterial infections and menstrual toxic shock syndrome (especially in communities with limited water access). A potential limitation to menstrual cup acceptability is the hesitation and fear that prevents young female students from even attempting the cup; however, once a user became familiar with the device, she was likely to express approval and continue its usage.

There are few randomized controlled trials of menstrual cup receptivity in LMIC populations, and the existing ones are limited to communities in Kenya and South Africa. More research is needed in other continents whose residents face similar issues with menstrual hygiene management. Cultural differences and practices exist between sub-Saharan Africa, the Middle East, South Asia, and Southeast Asia that may impact the feasibility of menstrual cups. The Kenyan and South African trials encompassed a broad range of age groups—adolescent, young and mature adult, pre-menopausal—who are impacted by menstrual health, but there was a clear focus on the puberty to mid-twenties age range with scarce middle-aged participants; larger samples in each age group would elucidate age-related physiological and cultural nuances. The studies are further limited by a moderate to high attrition rate (~10-30%). It is unclear if participants left due to communication loss over time during the year-long studies or if dropout participants were significantly unreceptive to some aspect of menstrual cup usage.

Menstrual cups have high potential to improve menstrual hygiene management for school-age girls in LMICs. Reusability is a key benefit of menstrual cups in terms of accessibility and affordability, but reuse also poses unique bacterial health risks for users. Infrastructure limitations in many countries may not allow for sufficient sanitation and storage measures for the cups, suggesting that menstrual cup utilization necessitates simultaneous improvements to broader water access. Most critically, implementation of the menstrual cup for this population requires an involved

and education-based approach. Misconceptions about menstruation foster fear and negative associations, but sexual education courses can correct these knowledge gaps by providing students with accurate information through a trusted, neutral party other than students' potentially inaccurate family members. With some teachers reportedly shaming menstruating students in their classrooms, education programs for teachers may also be necessary in order to provide accurate information about menstruation and to introduce nonjudgmental perspectives to these educators. Courses in sexual education and puberty also present the opportunity to provide classroom training on the menstrual cup for correct usage, which would minimize unhygienic practices and health risks associated with the cup. Most critically, school-based menstruation classes would begin to normalize menstruation discussions outside of the home and reduce early exposure to cultural stigmas.

Tiffany Nguyen is a recent alumna of the University of Florida where she earned her BS in Microbiology & Cell Science. She is interested in the intersectionality of health, socioeconomic status, and culture; she hopes to raise awareness about the prevalence of gender-specific health inequities and period poverty on an international scale.

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