A SYSTEMATIC REVIEW OF THE IMPACT OF MENSTRUAL HYGIENE MANAGEMENT INTERVENTIONS IN LOW- AND MIDDLE-INCOME COUNTRIES

by

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Abstract

Adolescent girls in low- and middle-income countries often lack access to adequate menstrual hygiene management supplies, which results in lower school attendance rates. This paper systematically reviews the impact of menstrual hygiene management interventions. Eighteen studies were included in this review based on seven eligibility criteria. Education-based interventions are associated with significantly ($p<0.05$) higher levels of knowledge and hygienic behaviors during menstruation. The impact of interventions on school attendance was not statistically significant, and risk of selection bias and reporting bias was relatively high. Additional research on menstrual hygiene management interventions is necessary. Interventions should be multipronged to target the underlying factors contributing to girls not having access to menstrual hygiene management products and continuing to miss school during menstruation.

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Introduction/Background

The importance of girls' education and gender disparities in education are widely recognized in the global health agenda. Millennium Development Goals 2 and 3 focused on the need for gender equality and female empowerment.[1] The Sustainable Development Goals 4 and 5 among other goals continue to recognize the need to achieve gender equality and to empower all women and girls.[2] However, barriers at the societal, community, interpersonal and individual levels exist and continue to perpetuate disparities in education around the world.

Although many factors collectively contribute to girls missing school, it is estimated that 200 million menstruating women and girls in low-income countries lack access to water and supplies to manage menstruation each day.[3] As a result, girls miss school and educational attainment is disrupted despite efforts to close the gender gaps in education. When girls miss school, they fall behind and the chance of them dropping out increases. Also, when a girl is not educated, there is a higher risk of child marriage, teenage pregnancy, and diseases like HIV/AIDS, which perpetuates cycles of gender and economic inequalities.[4]

Menstruation Knowledge

Numerous studies highlight why the normal biological and physiological process of menstruation has a significant impact on girls and their educational attainment in developing countries. One of the biggest contributing factors is the gap in knowledge about menstruation in the home and school environments both before the onset of menstruation and once a girl begins menstruating.[5] In sub-Saharan Africa adequacy of menstrual hygiene management knowledge is limited. A qualitative study in Kenya found that the majority of girls were not adequately prepared or informed of menstruation prior to when they began menstruating, because menstruation is a secret topic in their community, and thus many people including adolescent

girls feel ashamed to talk about it.[6] In Southwestern Nigeria when secondary school girls were asked about menstrual hygiene, only 60.8% of the girls had correct knowledge about menstruation.[7] Similarly, in Northern Ethiopia a study found that 51.4% of adolescent girls have adequate knowledge and awareness about how to manage menstruation.[8] Although girls in a study in Mali reported discussing menstruation with female relatives and friends before its onset, the knowledge was not adequate to prepare girls to know how to manage menstruation.[9]

The trends in menstruation knowledge are similar in South Asia and the Middle East. Studies in West Bengal and South India found that only 37.5% and 64.2% of adolescent schoolgirls, respectively, knew about menstruation before their menses commenced.[10,11] Although about one third of girls surveyed in Pakistan received menstrual hygiene information in school or at home, the girls' knowledge was misinformed as they reported believing that bathing during menstruation can increase menstrual pain, and eating certain types of food like chilies and sour food can increase the amount of menstrual blood.[12] A study in Egypt found that most girls get information about menstrual hygiene from various sources, but that information is not adequate as 83.6% of the girls expressed a desire for more information about menstrual hygiene.[13]

Menstrual hygiene knowledge is also linked to interpersonal factors. Sufficiency of menstrual hygiene and puberty knowledge in Tehran, Iran was correlated with family economic status and paternal education level.[14] A similar association was reported in Nigeria as level of knowledge about menstruation was significantly higher among girls whose parents had completed secondary education or higher compared to girls whose parents were less educated.[7] Additionally, the previously cited study in West Bengal found that knowledge about

menstruation management was significantly higher among girls living in urban areas compared to those in rural areas.[10]

Menstruation Management

In addition to gaps in knowledge about menstruation, published articles also demonstrate disparities in the products that girls in developing countries use to manage menstruation. Access to and use of menstrual hygiene products is low; girls often use alternative materials to absorb menstrual blood, like spare pieces of cloth, old clothes, blankets, mattress pieces, socks, and cotton wool for menstruation.[8] Girls in Kenya report having to resort to using grass, leaves, and materials from sacks, especially when their cycle begins unexpectedly in school.[6] The use of unsanitary methods such as homemade cloths to manage menstruation ranges from 55.6% of girls in Northern Ethiopia to 70% of girls in Pakistan to 87.1% of girls in Uganda.[8,15,16] Using inadequate and unsanitary menstrual hygiene management products is associated with a high risk of leakage and infection, and many girls report itching, pain, and irritation as a result of using those products.[6]

The use of disposable or reusable sanitary napkins in low and middle-income countries is limited because of cost and availability. A small-scale study in Northern Ethiopia found that only 35.4% of girls report using sanitary napkins due to lack of knowledge on utilization of the napkins and the high cost of the products.[8] Factors like urban residence, higher maternal and paternal education status, and higher income are associated with access to and use of disposable sanitary napkins.[8] Availability of sanitary napkins at shops is one of the most common barriers reported in Uganda.[16] Place of residence also contributes significantly to management of menstruation: a study in West Bengal reports that 54.9% of girls from rural areas use homemade sanitary pads compared to 36% of girls living in urban areas.[10] A community-based study on

schoolgirls from the Nagpur District of India found similar results as 60.6% of urban girls reported using sanitary pads compared to 30.8% of girls from rural areas, and this difference was statistically significant.[17] Although most girls living in two Northwestern regions of Mali prefer using commercially produced sanitary napkins, cost and access to those products restricted their use.[9]

Water and Sanitation Hygiene (WASH) Facilities

The water and sanitation infrastructure in school and at home is also a barrier to menstrual hygiene management. In one study, none of the toilets in a Ugandan school were adequate for proper menstrual hygiene management as there was a lack of light, soap, and water, and there were not enough toilets for girls.[16] Additionally, girls interviewed in Mali reported that latrines were not clean or private, because the latrines did not have soap, water, or locks, and there were not any buckets for washing and bathing.[9] In Egypt, although the general trend is that more girls are using sanitary pads, only 6.7% of the girls reported changing their sanitary pads at school, and 97% of the girls stated that lack of privacy at school is a significant barrier to managing menstruation at school.[13] In addition to school WASH facilities, one study from Zimbabwe found that lack of adequate water and sanitation facilities at home is tied to not attending school during menstruation.[18]

School Attendance and Performance during Menstruation

As a result of inadequate menstrual hygiene management products and WASH facilities, girls in low- and middle-income countries report not attending school during menstruation. For example, in Northern Ethiopia the majority of girls (54.5%) in the study missed at least one day of school during their last menstrual period.[8] The number of days of missed school increased among girls in Northern Ethiopia that did not use sanitary napkins (2.3 days) compared to those

who did (2.1 days), and the likelihood of missing school during menstruation was significantly higher for girls that did not use sanitary napkins (OR: 5.4; 95% CI: [3.0-9.5]).[8] In Uganda 61.7% of the surveyed girls reported missing school each month for reasons related to menstruation. Most girls missed school because there were not any facilities to wash or change their sanitary towels at school, they were scared of leakages and stains, and other factors like pain, bloating, and tiredness.[16] The previously cited qualitative study conducted in Mali found that the majority of girls went home immediately after their period started if they were at school, because they did not have any materials with them to manage menstruation.[9] Schoolgirls in Kenya estimate that about one fourth of girls stay home during menstruation, and that about three fourths of girls will go to school during menstruation, but will not return after lunch because of discomfort from using inadequate menstrual hygiene products and fear of leakage.[19]

The majority of girls in Ethiopia (57.8%) perceive menstruation as something that impacts their academic performance because they are not able to concentrate or attend classes while they are menstruating, which holds true for other settings as well.[8] Lack of concentration in school and fear of menstrual cloths falling out are reported as barriers to attending school in Uganda during menstruation.[16] In Kenya girls report that their teachers are not understanding or helpful, and they have to stand up to answer questions, so they are ashamed to reveal possible leakages and spoiled dresses.[6] Similarly, in Pakistan girls report that menstruation adversely impacts their school attendance and ability to concentrate in school because of fear of stains and sanitary napkins falling out, and feelings of being tired.[12] Although many girls return to school once their menses are lighter, some girls do not ever return to school. For example, girls in Ethiopia reported that those who received a lot of teasing from other classmates due to stained clothes during menstruation were more likely to dropout of school.[8]

Although menstrual hygiene management is a factor that contributes to school absenteeism, it is important to also recognize the abundance of other factors contributing to missing school. In areas where malaria is endemic like Kenya, malaria accounts for 40% of all absences in the rural area, because of the impact of malaria on morbidity, and concentration and cognition.[19] Additionally, students often cannot attend school because their families are unable pay the school fees.[19] Other factors such as household work, lack of interest and motivation in education, distance to school, peer influence, harsh punishments at school, and illness contribute to school absenteeism.

Nevertheless, menstrual hygiene management is a factor that must be addressed. As noted above, many girls lack access to adequate knowledge, products, and facilities to manage menstruation. Schools in low- and middle-income countries are not usually equipped to provide girls with menstrual hygiene education, and many teachers lack the knowledge and skills to adequately support girls in school.[20] The need for interventions to improve proper menstrual hygiene management and to decrease the number of days of school that girls are missing due to menstruation is evident as the research on this topic is abundant. However, the evidence of the impact of programs and interventions to address this challenge is limited. To the best of my knowledge, there has not been a systematic review of the literature on the collective impact of menstrual hygiene management interventions on menstrual hygiene knowledge, menstrual hygiene practices, and school attendance.[21,22] Therefore, the aim of this systematic review is to assess if menstrual hygiene and WASH interventions are effective at improving menstrual hygiene management knowledge and practices, and decreasing the number of days of school missed during menstruation by adolescent girls in low- and middle-income countries in either school or community-based settings. I hypothesize that programs will be effective at improving

knowledge and behaviors surrounding menstrual hygiene, and decreasing the number of missed days of school during menstruation. However, those interventions will be limited in their sustainability and long-term impacts on girls succeeding in school.

Methods

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), I first developed a population, interventions, comparators, outcomes, timing, setting, and study design (PICOTSS) chart (Table 1) to establish my study question, determine the scope of the systematic review, and develop search terms and eligibility criteria.[23]

Table 1. PICOTSS Systematic Review Criteria

	Criteria
Population	Able-bodied girls in primary or secondary school, who have already started menstruating (usually 11 years of age or older). Exclusion factor: Adult females
Interventions	Menstrual hygiene management programs, which may be in the form of menstrual education programs, sanitation and hygiene education, sexual health education, water and sanitation hygiene programs, or sale or donation of menstrual hygiene products. Exclusion factor: Programs that do not have any form of menstrual hygiene management
Comparators	Girls that do not receive any form of intervention, and use traditional ways to manage menstruation like old cloths and rags that increase rates of infection.
Outcomes	Short-term: 1. Increased awareness of how to manage menstruation effectively (e.g., awareness of the need to change and wash menstrual products) 2. Decreased average number of days of school missed during menstruation Intermediate: 1. Increased number of girls managing menstruation effectively (e.g., frequency of changing products) 2. Increased school performance 3. Increased number of girls advancing to secondary school and to higher grade levels 4. Increased access to WASH facilities (private latrine, place to wash sanitary products, and place to wash hands) at school Long-term: 1. Increased percentage of girls progressing to secondary school 2. Indicators of female empowerment
Timing	Studies included were not limited by when the study was conducted or duration of the intervention.
Setting	School-based and community-based menstrual hygiene

	management programs in low and middle income countries.[24] Exclusion factor: programs in high income countries[24]
Study Design	All primary analyses of data. Exclusion factor: other systematic reviews and descriptive study designs

Under the assistance of Rachael Posey, who is a librarian at the University of North Carolina-Chapel Hill (UNC) Health Sciences Library, I developed key search terms for this systematic review and identified three databases to utilize for my search (Table 2).

Table 2. Literature Search Terms for Search Conducted on January 28, 2016

Search Criteria	Search Phrase	Number of Results
PubMed		
Full Search	((((menstrual OR menstruation) AND hygiene) OR "sanitary pad" OR "sanitary pads" OR "feminine napkin" OR "feminine napkins" OR "sanitary napkin" OR "sanitary napkins") AND (school* OR student* OR youth OR teenage* OR adolescen*))	439
Filtered by only articles in English	((((menstrual OR menstruation) AND hygiene) OR "sanitary pad" OR "sanitary pads" OR "feminine napkin" OR "feminine napkins" OR "sanitary napkin" OR "sanitary napkins") AND (school* OR student* OR youth OR teenage* OR adolescen*)) Filters: English	390
Embase		
Full Search	menstrual OR 'menstruation'/exp OR menstruation AND ('hygiene'/exp OR hygiene) OR 'sanitary pad'/exp OR 'sanitary pad' OR 'sanitary pads'/exp OR 'sanitary pads' OR 'feminine napkin' OR 'feminine napkins' OR 'sanitary napkin'/exp OR 'sanitary napkin' OR 'sanitary napkins'/exp OR 'sanitary napkins' AND (school* OR student* OR 'youth'/exp OR youth OR teenage* OR adolescen*)	546
Filtered by only articles in English (and not in PubMed)	menstrual OR 'menstruation'/exp OR menstruation AND ('hygiene'/exp OR hygiene) OR 'sanitary pad'/exp OR 'sanitary pad' OR 'sanitary pads'/exp OR 'sanitary pads' OR 'feminine napkin' OR 'feminine napkins' OR 'sanitary napkin'/exp OR 'sanitary napkin' OR 'sanitary napkins'/exp OR 'sanitary napkins' AND (school* OR student* OR 'youth'/exp OR youth OR teenage* OR adolescen*) NOT menstrual OR 'menstruation'/exp OR menstruation AND ('hygiene'/exp OR hygiene) OR 'sanitary pad'/exp OR 'sanitary pad' OR 'sanitary pads'/exp OR 'sanitary pads' OR 'feminine napkin' OR 'feminine napkins' OR 'sanitary napkin'/exp OR 'sanitary napkin' OR 'sanitary napkins'/exp OR 'sanitary napkins' AND (school* OR student* OR 'youth'/exp OR youth OR teenage* OR adolescen*) AND [english]/lim	134
Scopus		
Full Search	TITLE-ABS-KEY (((((menstrual OR menstruation) AND hygiene) OR "sanitary pad" OR "sanitary pads" OR "feminine napkin" OR "feminine napkins" OR "sanitary napkin" OR "sanitary napkins") AND (school* OR student* OR youth OR teenage* OR adolescen*)))	433
Filtered by only articles in English	TITLE-ABS-KEY (((((menstrual OR menstruation) AND hygiene) OR "sanitary pad" OR "sanitary pads" OR "feminine napkin" OR "feminine napkins" OR "sanitary napkin" OR "sanitary napkins") AND (school* OR student* OR youth OR teenage* OR adolescen*))) AND (LIMIT-TO (LANGUAGE , "English"))	387

Totals	
Filtered by English language	911
After duplicates removed (n=275)	636

I then conducted a search on January 28, 2016 using PubMed, Embase, and Scopus. In addition to using those databases, I also searched the 3ieimpact site and Google scholar using search phrases like "effectiveness of school-based menstrual hygiene programs", "impact of menstrual hygiene programs", and "menstruation programs" (3ieimpact only) to identify additional articles for my systematic review.[25]

Population

Adolescence is a period of significant change for both boys and girls, and the World Health Organization (WHO) defines this period as the shift from childhood to adulthood, which occurs between the ages of 10 and 19 years.[26] Therefore, for papers to be included in this systematic review, participants had to classified as adolescent girls. This eligibility criteria was applied to capture the impact of interventions during the adolescent period when girls are going through puberty and beginning to menstruate.

Intervention

All articles had to have a menstrual hygiene-related intervention to be included in this systematic review. I focused on interventions in the form of menstrual education, sanitation and hygiene education, sexual health education, or water and sanitation hygiene programs. Studies assessing the impact of the sale or donation of menstrual hygiene products were also included to assess the range of different interventions. Programs that were solely focused on water and sanitation hygiene and those without a menstrual hygiene component were excluded.

Comparators

Because of the types of study designs included in this intervention, some articles did not have comparator groups. For articles with control groups, comparators are girls that did not receive any intervention and who most likely use traditional ways to manage menstruation like old cloths. However, articles were not excluded based on the lack of comparators.

Outcomes

I classified the outcomes of interest for this study into short-term, intermediate, and long-term outcomes. The short-term outcomes included increased awareness of how to manage menstruation effectively, increased menstruation knowledge, and decreased average number of days of school missed during menstruation. Intermediate outcomes were increased number of girls managing menstruation effectively (e.g., use of sanitary menstrual hygiene products, and frequency of washing during menstruation), increased school performance, increased number of girls advancing to secondary school and to higher grade levels, and increased access to water and sanitation facilities at school or in the community. Long-term outcomes include increased percentage of girls progressing to secondary school, and additional indicators of female empowerment. Any article that did not measure at least one of the short-term, intermediate, or long-term outcomes was excluded from this review.

Timing

In order to capture all of the available literature on menstrual hygiene-related interventions, studies were not limited by when the intervention was conducted or when the study was published.

Setting

I was most interested in menstrual hygiene-related interventions that are taking place within schools or in communities, so studies that discussed the impact of larger-scale interventions or interventions in other capacities were excluded from this review. Additionally, I decided to focus on the impact of interventions in low- and middle-income countries, where access to menstruation hygiene products, underlying socioeconomic factors, and access to menstrual hygiene education tend to be barriers to adequate menstrual hygiene management. Therefore, based on the World Bank classification of low- and middle-income countries, any study where the intervention was implemented in a high-income country was excluded from my review.[24]

Study Design

I limited my systematic review to full-text articles available through UNC and the UNC interlibrary loan system, and to articles written in English. Another one of my eligibility criteria was to only include experimental articles that reported findings from interventions to ensure that the intervention and the impact of the intervention could be compared. Cohort studies, quasi-experimental studies, cross-sectional studies, and randomized control trials are all included in my systematic review. Descriptive studies, other systematic reviews on similar topics, and publications reviewing the evidence of interventions and providing policy recommendations were excluded from this review.

Data Collection Process

I used the free online systematic review software, Covidence to first screen titles and abstracts of articles identified through my search on PubMed, Embase, and Scopus. I assessed those articles for relevance and excluded articles where there was clear evidence that the articles

were not relevant to my study question. For the articles that I did not exclude, I then did a full text review of each article. I excluded articles in this step based on my predetermined exclusion criteria: not relevant to study question; lack of intervention; adult population; descriptive study design, or other systematic reviews; setting not in low/middle income country; intervention not menstrual hygiene-related; and outcomes not relevant. Once I determined the articles for my systematic review, I read through each article to extract data (Tables 3-5).

In order to both classify the different types of interventions and to assess the impact, I cited descriptive data from each article on the study setting, study size, study design, major findings, study limitations, and study recommendations. I separated the findings by education-only interventions, product or service-based-only interventions, and combined education and service interventions for comparison purposes. The descriptive characteristics of each study are summarized in Table 3, and the quantitative and qualitative impacts of all of the studies are summarized in Tables 4 and 5, respectively. The implications of the results are discussed in following sections.

I also assessed the quality and risk of bias of each study included in this systematic review through assessment tools that I adapted from a previous systematic review on menstrual hygiene management and from the Cochrane tools for bias assessment.[21,27] The quality assessment tables (Tables 6-8) allow for assessment of bias within each article and between all articles at the study and outcome levels. Tables 6-8 highlight: randomization in study design; if comparison group characteristics were provided and if there was balance between comparison groups; generalizability of the study to the larger population; control for intervention contamination; objectivity of outcome measures; if there was reporting of lost to follow-up; if the follow-up in each arm was identical; if the measures of effect were reported; if a confidence

interval was reported; and if a p-value was reported. Footnotes are provided for each table to further describe each column if it was deemed necessary.

Overall, I used the PRISMA checklist to structure my systematic review and referred to the PRISMA checklist after each step of the review process.[23]

Results

Identification of Systematic Review Articles

Based on the PubMed, Embase, and Scopus search using the search terms in Table 2 and excluding articles that were not in English, I found 911 articles of relevance. After removing duplicate articles between the different databases (n=275), I identified a total of 636 resources from my search on January 28, 2016 (Figure 1). After the title and abstract screening of the 636 articles, I excluded 505 articles based on lack of relevance to my study question (Figure 1). Among the articles that I excluded, some of the most common topics were toxic shock syndrome, menstrual disorders, breast cancer, ovarian cancer, cervical cancer, fertility, sexually transmitted infections, urinary incontinence, and menstrual hygiene management among women and girls with developmental delays.

I screened the remaining 131 articles by reading through the full text of each article and including or excluding articles based on my eligibility criteria. Most of the studies (n=54) were excluded because the findings reported what adolescent girls know about menstrual hygiene management and how that impacts school attendance, but the researchers did not report any form of intervention to address those issues related to menstrual hygiene management. The next most common exclusion factors were non-relevant outcomes (n=20), and the scope of the study not being relevant to my study question (n=18), which I determined while reading through the full text of each article and comparing the articles to my short-term, intermediate, and long-term

outcomes, and to my research question. Other reasons for why I excluded studies were adult populations (n=10), descriptive study designs or other systematic reviews (n=3), and setting not in a low or middle-income country (n=3). There were not any studies excluded based on the intervention not being menstrual hygiene-related. As a result, I excluded 113 studies and identified 17 articles to be included in my systematic review (Figure 1). I also identified one article that met all of my inclusion criteria through independent searches and included that article in my systematic review as well (n=18) (Figure 1).

Figure 1. PRISMA Flowchart

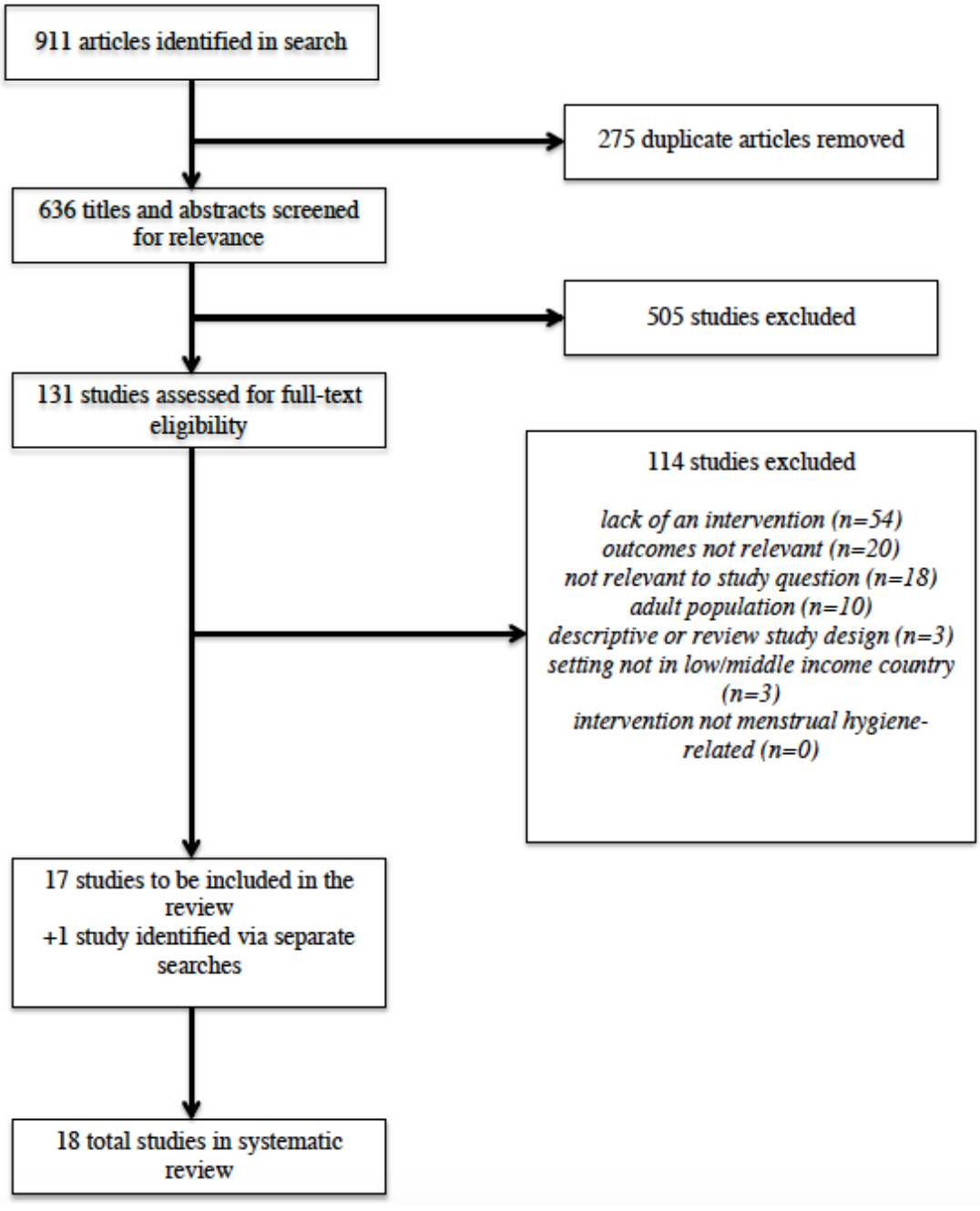

Table 3. Characteristics of 18 Menstrual Hygiene Management Intervention Studies

Author (Year)	Location	Design	Population (age range)	Timing Design		Intervention Type	Control Group(s)	Intervention and Comparison	Outcomes Evaluated
Djalalinia et al. (2012)[28]	Tehran, Iran	Longitudinal	1,231 adolescent females (11-15 years)	Baseline	Follow-up at 2 years	Education	Y	*Intervention:* Puberty health education by school teachers or parent trainers *Comparison*: No receipt of puberty health education	Use of menstrual hygiene products; Levels of bathing during menstruation
Haque et al. (2014)[29]	Araihazar area, Bangladesh	Longitudinal	416 adolescent females (11-16 years)	Baseline	Follow-up at 6 months	Education	N	*Intervention*: Twelve 45-minutes menstrual hygiene education sessions by trained research assistants and teachers *Comparison*: Pre-test and post-test questionnaire scores	Menstrual hygiene knowledge and beliefs; use of sanitary pads; hygiene practices during menstruation
Arora et al. (2013)[30]	Barara District, Ambala, Haryana, India	Longitudinal	200 adolescent females (10-19 years)	Baseline	Follow-up at 2 months	Education	N	*Intervention*: One health education session about menstruation physiology and common myths through lectures and visual aids *Comparison*: Pre-test and post-test scores	Knowledge about the causes and physiology of menstruation, and impact of hot and cold foods on menstruation; Frequency of washing genitalia during menstruation, and use of sanitary pads during menstruation
Crofts and Fisher (2012)[3]	Southern Uganda	Cross-Sectional	134 school girls (13-20 years)	Cross-sectional	Cross-sectional	Receipt of reusable sanitary pads	Y	*Intervention*: Receipt of Afripads or Makapads *Comparison*: Did not receive reusable sanitary pads	Frequency of changing menstrual hygiene products and washing menstrual hygiene products; use of sanitary menstrual hygiene products
Oster and Thorton (2011)[31]	Chtwan District, Nepal	Randomized Control Trial (Individual-Level)	198 adolescent females (mean age~14 years)	Follow-up at 12 months		Receipt of menstrual cup (Mooncup)	Y	*Intervention*: Receipt of Mooncup and instructions on how to use the Mooncup *Comparison*: Did not receive menstrual cups	School attendance during menstruation; school attendance gap during menstruation
Dongre et al. (2007)[32]	Anjo, Wardha District, Maharashtra State, India	Longitudinal	381 adolescent girls (12-19 years)	Baseline	Follow-up at 3 years	Education	N	*Intervention*: Development of educational material based on surveys and focus group discussions with the participants, and dissemination of health information via flip books with menstrual hygiene management messages through community-based monthly meetings *Comparison*: Pre-test and post-test scores, and qualitative trend analyses	Use of sanitary menstrual hygiene products; Use of traditional cloths; frequency of washing menstrual hygiene products
Dorgbetor (2015)[20]	Assin South, Asikuma, Keta, Kpando, Abura Asebu	Longitudinal	120 public schools	Follow-up at 6 months		Education	Y	*Intervention*: Health education through ten 2-hour education sessions that used interactive plays and discussions *Comparison*: Did not receive health education	Menstrual hygiene management knowledge

	Kwamanke se, Ajumako, Gomoa East Districts, Ghana								
El-Lassyand (2013)[33]	Damanhour City, el-Behara Governorate, Egypt	Quasi-Experimental	97 female students (16-19 years)	Baseline	Follow-up at 3 months	Education	N	*Intervention*: Two 30-45 minute health education sessions per week about menstruation and healthy menstrual practices *Comparison*: Pre-test and post-test scores	Menstruation knowledge and menstruation practices including frequency of washing genitalia and changing menstrual hygiene products
Fakhri et al. (2012)[34]	Mazandaran Province, Iran	Quasi-Experimental	698 female students (14-18 years)	Follow-up immediate after completion of intervention		Education	Y	*Intervention*: Ten 2-hour education sessions on adolescence, puberty and menstrual health *Comparison*: Did not receive education	Bathing practices during menstruation
Kidney and Edgell (2013)[4]	Londiani and Kipkelion Districts, Kenya	Longitudinal	4 schools (NR*)	Follow-up at 1 year		Education + receipt of reinforced latrine and washrooms	N	*Intervention*: 10 modules on health and hygiene and 2 modules on economic empowerment, and building of reinforced latrine and washroom structures *Comparison*: Post-module indicators, and qualitative methods	Knowledge about menstrual hygiene; female empowerment; access to water and sanitation facilities to manage menstruation
Mason et al. (2015)[35]	Gem District, Siaya County, Kenya	Randomized Controlled Feasibility	30 primary schools; 101 female students (14-16 years)	Follow-up at 6 months		Education + receipt of menstrual cup (Mooncup) or sanitary pads	Y	*Intervention:* (1) receipt of menstrual hygiene education and receipt of a Mooncup; (2) receipt of menstrual hygiene education and receipt of 2 packs per months of Always sanitary pads *Comparison:* Did not receive menstrual hygiene education or menstrual hygiene products	Use of sanitary products; school attendance during menstruation
Montgomery et al. (2012)[36]	4 Villages in Ghana	Longitudinal	120 school girls (12-18 years)	Follow-up at 5 months		Education + receipt of sanitary napkins	Y	*Intervention*: (1) receipt of 12 sanitary pads per month and puberty education; (2) puberty education *Comparison*: Did not receive sanitary pads or puberty education	School attendance
Naeem, Klawitter, and Aziz (2015)[12]	2 Provinces in Pakistan	Longitudinal	6 governmental girls' high schools (NR)	Follow-up at 9 months		Education + receipt of improved WASH facilities + receipt of menstrual hygiene supplies	N	*Intervention*: Needs assessment, development of menstrual hygiene education materials (information booklets, posters, and stickers for hand washing facilities), formation of WASH clubs, improved WASH facilities, and distribution of menstrual hygiene supplies *Comparison*: Post-intervention focus group discussions	Access to and use of WASH facilities during menstruation; access to menstrual hygiene management materials

Nemade, Anjenaya, and Gujar (2009)[37]	Kalamboli, Navi-Mumbai, Maharashtra, India	Longitudinal	217 adolescent females (NR)	Baseline	Follow-up at 3 months	Education	N	*Intervention*: Community-based health education sessions provided at school using lectures and audio-visual aids *Comparison*: Pre-test and post-test scores	Menstruation knowledge about influence of food on menstruation, whether menstrual blood is impure, and about menstruation during pregnancy
Shah et al. (2013)[38]	South Gujarat Region, India	Longitudinal	164 adolescent girls (12-22 years) (mean age=13.7)	Follow-up at 3 months		Receipt of subsidized falalin cloths and sanitary pads	N	*Intervention*: Accredited social health activists offered subsidized falalin cloths and subsidized sanitary pads to participants *Comparison*: Post-intervention qualitative measures comparing sanitary menstrual hygiene products to traditional unsanitary cloths	Quality of life (based on missing school, skin abrasions due to menstrual hygiene product; stains, leakages, and comfort); use of menstrual hygiene products
Wilson, Reeve, and Pitt (2014)[39]	Nyanza Province, Kenya	Longitudinal	302 female students (NR)	Baseline	Follow-up at 4 weeks	Receipt of materials and training to make reusable sanitary pads	Y	*Intervention*: Training and materials to make reusable sanitary pads plus handouts on how to make and wash the pads *Comparison*: Did not receive the training or materials to make reusable pads	Mean number of days of school missed; frequency of washing reusable pads
Jena et al. (2012)[40]	Rajarajeswaripeta, Vijayawada Municipal Corporation, India	Longitudinal	450 adolescent girls (13-19 years)	Baseline	Follow-up at 3 months	Education	N	*Intervention*: Health education about all aspects of reproductive health, including menstrual hygiene, contraception, STIs, and reproductive tract infections *Comparison*: Pre-test and post-test questionnaires through individual interviews	Reproductive health knowledge; menstrual hygiene behaviors (frequency of bathing, use of sanitary products, frequency of changing sanitary products, and frequency of washing external genitalia)
Kumcagiz and Avci (2011)[41]	Samsun City, Turkey	Longitudinal	408 adolescent school girls (13-18 years)	Baseline	Follow-up at 1 month & at 3 months	Education	N	*Intervention*: Reproductive health education on menstrual hygiene practices for 30-40 minutes *Comparison*: Pre-test and post-test results at 1 month and 3 months following the education sessions	Knowledge about bathing during menstruation, bathing style, genital area hygiene, and use of menstrual hygiene material

*NR Not reported

Study Characteristics

Table 3 summarizes the characteristics including sample size, study setting, study duration, study design, intervention type, and outcomes evaluated for all of the studies included in this review. All studies took place in sub-Saharan Africa (n=6), South Asia (n=8), or the Middle East (n=4). Most of the study settings were in schools with the exception of 2 community-based interventions that assessed the impact of subsidized falalin cloths to manage menstruation in a rural region of India, and the impact of individual reproductive health and menstrual hygiene education sessions in Rajarajeswaripeta, India.[38,40] Additionally, studies varied by design and by urban versus rural settings. The majority of studies were longitudinal (n=13) with one randomized control trial, and a couple of cross-sectional and quasi-experimental studies. The sample size of studies ranged from 97 students in a secondary technical nursing school in Egypt to 1,231 adolescent females in Tehran, Iran.[28,33] The longest study duration was 3 years with most studies having shorter durations between three and six months, and one study assessing the impact of an intervention after 4 weeks.

Interventions were classified into: educational (n=10), where study participants received some form of menstrual hygiene education; receipt of services (n=4), where study participants received menstrual hygiene products and/or water and sanitation hygiene interventions; and receipt of education and services (n=4), where participants received education, and menstrual hygiene products and/or water and sanitation hygiene interventions. The last 2 columns of Table 3 summarize the intervention, comparison measures, and the outcomes evaluated for each study.

Exposures and Outcomes

The exposures varied within each intervention category. Within the educational intervention group some of the education was broad with more of a focus on puberty and with

menstruation as a subtopic, while other studies provided specific menstruation education. One study developed educational materials based on focus group discussions and then disseminated that information.[32] The exposure in two of the studies in the service-based intervention group is the provision of free menstrual hygiene management products, whereas the other interventions include providing subsidized menstrual hygiene products and providing girls with the tools and training to make reusable menstrual hygiene products. In the educational and service-based intervention groups the exposures include providing girls with menstrual hygiene education along with menstrual hygiene products and/or school-based water and sanitation hygiene facilities.

The 18 studies included in this review have wide-ranging measured outcomes, which most likely results from the different types of interventions and from how the impact of each intervention was quantified and measured. For the educational intervention group most of the measured outcomes include use of sanitary menstrual hygiene products following the intervention, knowledge of menstruation and how to adequately manage menstruation, and menstrual hygiene practices like changing menstrual products more frequently and washing genitalia during menstruation. The outcomes of the service-based intervention group ranged from preference of menstrual hygiene products to school attendance rates and quality of life scores following the provision of the products or services. The educational and service intervention group had similar outcomes to the education intervention and service-based intervention groups with the addition of empowerment, and access to and utilization of water and sanitation hygiene facilities as outcomes.

Table 4. Quantitative Impact of Menstrual Hygiene Management Interventions

Author (Year)	Intervention Allocation Method (Intervention Type)	Statistical Analysis	Impact on Knowledge	Impact on Menstrual Hygiene Behavior	Impact on School Attendance
Djalalinia et al. (2012)[28]	Random by school (Education)	Chi-square test and ANOVA		Higher use of sanitary pads in intervention group (p>0.05) Higher levels of bathing during menstruation in intervention group (p>0.05)	
Haque et al. (2014)[29]	Random by school (Education)	McNemar test	31.4% increase in students receiving a high knowledge score on menstruation knowledge and beliefs assessment following the intervention (p<0.05)	22.4% increase in self-reported use of sanitary pads following the intervention (p<0.05) 60.1% increase in self-reported good hygiene practices during menstruation following the intervention (p<0.05)	
Arora et al. (2013)[30]	Random by school (Education)	Paired t-test, and chi square test	Improved scores on question about the causes and physiology of menstruation following the intervention (p<0.05) Improved scores on question about whether hot and cold foods influence menstruation following the intervention (p<0.05)	48% increase in girls reporting washing genitalia during menstruation (p<0.05) 20% increase in girls using sanitary pads during menstruation (p<0.05)	
Oster and Thorton (2011)[31]	Random by individual (Receipt of Service)	Chi-square test and OLS regression			In the control group the probability of school attendance without menstruation and during menstruation is 85.7% and 83%, respectively (p<0.05) The attendance rate in the menstrual cup group had a non-significant difference (p=0.07) during menstruation and without menstruation, compared to the significant difference for the control group (p=0.01), but the gap in attendance between the two groups is not significantly reduced
Dongre et al. (2007)[32]	Convenience (Education)	NR		19.7% increase in reusable sanitary pads (p<0.05) 27.7% decline in use of unsanitary menstrual cloths (p<0.05) Increase in washing cloth with soap and water (among girls still using traditional menstrual cloths)	
Dorgbetor (2015)[20]	Convenience (Education)	NR			65% of girls in the control group report going home once their menses commence at school and do not return to school until the next day, which is higher than the intervention group
El-Lassyand (2013)[33]	Convenience (Education)	Paired t-test, correlation coefficient, McNemar	68% increase in percentage of participants scoring ≥75% on menstrual hygiene knowledge assessment (p<0.05) 0% of participants had poor knowledge scores (<50%) on the post-test (p<0.05)	Improvements in washing genitalia with soap and water (p<0.05) 54.6% of girls reported changing their pad 4 times per day,	

		test		compared to 56.7% changing their pad 2 times per day in the pre-test	
Fakhri et al. (2012)[34]	Convenience (Education)	T-tests and chi square tests		12.3% higher percentage of girls in the intervention group that reported bathing during menstruation compared to the control group ($p<0.05$)	
Montgomery et al. (2012)[36]	Convenience (Education + Receipt of Service)	F-test and t-tests			6 day increase in school attendance per 65 day-term among girls who received pads and education The puberty education intervention (rural mean=89.74 days and periurban mean=90.54 days) and the puberty education plus sanitary pad intervention (mean=91.26 days) had similar impacts on school attendance, and were both higher in comparison to the control group (mean=84.48 days) at the end of the study period At 3 months significant improvements in school attendance among education plus receipt of sanitary pads group ($p<0.001$)
Nemade, Anjenaya, and Gujar (2009)[37]	Convenience (Education)	Chi-square test	79.7% of participants in the pre-test believed that hot and cold foods influence menstruation, compared to in the post-test 92.2% of participants did not believe that ($p<0.05$) Decrease in percentage of participants believing menstrual blood is impure ($p<0.01$)	Increased number of girls washing genitalia with soap and water after changing cloth/sanitary pad ($p<0.05$)	
Shah et al. (2013)[38]	Convenience (Receipt of Service)	T-tests		68% of girls were using sanitary falalin cloths following the intervention compared to 90% of girls using old cloths at baseline	11% of girls using old cloths missed school/work compared to 0% of girls using sanitary pads and 4% of girls using falalin cloths The overall measure of quality of life, which includes measures of missing schools, skin abrasions, feeling unclean, and feeling comfortable, was significantly higher for girls using falalin cloths compared to old cloths ($p<0.00$)
Wilson, Reeve, and Pitt (2014)[39]	Random by school (Receipt of Service)	Covariate adjusted t-tests		100% of girls in the intervention reported washing their reusable pads with soap and water	The mean number of missed days of school remained constant for the intervention group compared to increased number of missed days of school for the control group ($p=0.08$) The mean difference in days of school missed was 1.48 between the control and intervention groups ($p>0.05$), which equates to a 68.8% reduction in absenteeism
Jena et al. (2012)[40]	Random by individual (Education)	Chi-square test	24.5% increase in reproductive health knowledge and awareness ($p<0.05$)		
Kumcagiz and Avci (2011)[41]	Convenience (Education)	Wilcoxon Matched-Pairs Signed-Ranks test	First observation (compared to pre-test): 83.8% increase in knowledge about bathing during menstruation 86.8% increase in knowledge about bathing style 84.1% increase in knowledge about genital area hygiene 25.5% increase in knowledge about use of menstrual hygiene material		

			Second observation (compared to pre-test): 81% increase in knowledge about bathing during menstruation		
			76.5% increase in knowledge about bathing style		
			77.7% increase in knowledge about genital area hygiene		
			25.5% increase in knowledge about use of menstrual hygiene material		
			Higher overall mean score in first observation compared to pre-test ($p<0.05$)		
			Higher overall mean score in second observation compared to pre-test ($p<0.05$)		

Table 5. Qualitative Impact of Menstrual Hygiene Management Interventions

Author (Year)	Intervention Allocation Method (Intervention Type)	Assessment	Impact on Knowledge	Impact on Menstrual Hygiene Behavior	Impact on School Attendance	Additional Results
Dorgbetor (2015)[20]	Convenience (Education)	Reflect-Connect-Apply Discussion Questions	Indication of improved menstrual hygiene management knowledge among school girls through discussions			Girls appeared more confident and able to discussion menstruation with peers and teachers
						Menstrual hygiene management is not openly discussed in the control schools
Crofts and Fisher (2012)[3]	Random by school (Receipt of Service)	Behavioral themes and qualitative analysis		Girls reported that low-cost sanitary pads allowed for increased frequency of changing menstrual products		Among the girls in the Afripads group, they reported preferring Afripads compared to traditional cloths, but among the more affluent girls reports of washing reusable pads is associated with being "dirty" and among the poorer girls, reports of Afripads being too expensive
						30% of girls in the Makapads group would purchase Makapads, but reports of leakages when using Makapads
Shah et al. (2013)[38]	Convenience (Receipt of Service)	Focus group discussions				Girls report improved quality of life as a result of subsidized falalin cloths
						"We used to have skin abrasions on our inner thighs with the old cloths, but not anymore with the falalin."
Kidney and Edgell (2013)[4]	Convenience (Education + Receipt of Service)	Results framework with indicators for each set of activities	Report of increased knowledge about the female body and menstruation	Report of greater access to adequate water and sanitation facilities to manage menstruation	Report of being able to attend school regularly without having to worry about leakages or embarrassment related to menstruation	Increased female empowerment: "before doing G4G, I didn't think girls mattered, I didn't think I mattered. I thought boys were much better than girls. But now I know that I matter. I know that I am important."

Naeem, Klawitter, and Aziz (2015)[1][2]	Convenience (Education + Receipt of Service)	Focus group discussions and observation checklists		Increased access to menstrual hygiene management materials at school Girls reported increased access to clean toilets, and feeling more comfortable using the toilet to change their menstrual hygiene materials		Girls reported sharing the information booklets with their mothers and sisters
Mason et al. (2015)[3][5]	Random by school (Education + Receipt of Service)	Thematic analysis		Use of sanitary pads to manage menstruation, which girls reported as comfortable to wear	Among girls in the pads group, greater confidence in school: "I just come to school without fearing of leaking" Among the girls who used sanitary napkins and menstrual cups, they reported they no longer experience absenteeism or trouble concentrating in school during menstruation	Report of increased ability to be active during menstruation because the menstrual cup did not fall out: "I'm feeling good because when I put that Mooncup inside, I can do anything"

Effect of Interventions

Overall, the majority of articles included in this systematic review had some form of positive impact on improving menstrual hygiene knowledge, menstrual hygiene practices, and student attendance rates during menstruation (Tables 4 and 5). Among the participants who received menstrual hygiene and reproductive health education, the collective impact of education appears to be increased knowledge and beliefs about menstruation, and improved menstrual hygiene management practices. The comparison of pre-test and post-test scores was predominately used to assess increased knowledge and beliefs, and scores in the studies reviewed increased by about 25-60 percentage points following the educational interventions.[29,33,37,40] Additionally, the practice of adequate menstrual hygiene habits, which includes washing genitalia during menstruation and using sanitary products such as reusable pads, increased by about 20% for most interventions.[29,30,32,33,37] For all of the educational intervention studies that reported p-values, most studies reported significant ($p<0.05$) improvements in menstrual hygiene knowledge, frequency of washing of genitalia during menstruation, and use of sanitary pads during menstruation.[29,30,32,33,37,40,41]

The impact of the service-based interventions was not as easily quantified as some of the studies used qualitative methods to assess the impact.[3,38] However, two studies assessed the impact of sanitary menstrual hygiene products on school absenteeism, but both studies had non-significant findings.[31,39] The provision of menstrual cups in Nepal resulted in a non-significant decreased gap in school attendance during menstruation compared to the control group that did not receive menstrual cups.[31] In Kenya when girls received training and materials to make their own reusable pads, the girls missed 1.5 fewer days of school during menstruation. Although the reduction in days missed of school equates to a 68.8% reduction in school absenteeism, the

difference in days missed between the intervention and control groups was not statistically significant.[39] The impact of the other studies included in this category indicated better menstrual hygiene management behaviors, alleviated feelings of being unclean and worrying about leakages, and fewer abrasions from using inadequate products as a result of the provision of adequate menstruation products.[3,38]

The interventions in which girls received both education and the provision of services has a similar range of impact in comparison to the other interventions discussed above. One of the studies reported increased knowledge about menstrual hygiene as a result of 10 educational modules on health and hygiene, which relates to the findings of other studies discussed above.[4] However, the most commonly measured outcome was school attendance. When girls in Ghana received menstrual hygiene education and sanitary napkins, school attendance significantly increased by 6 days per 65-day-term, which equates to a 9% of a girls' school year.[36] In that study, girls who received only menstrual hygiene education had non-significant higher rates of school attendance in comparison to the control group that did not receive any form of education or menstrual hygiene products.[36] In the study in Ghana where all girls received menstrual hygiene education, and then some girls were given menstrual cups or sanitary pads, girls who received sanitary napkins and menstrual cups reported in focus group discussions that they no longer experience school absenteeism during menstruation.[35] Participants also discussed decreased worry about leakages and greater ability to participate in school activities as a result of adequate menstrual hygiene products.[35]

The impact of interventions on female empowerment was limited and difficult to quantify, as most of the assessments were qualitative. However, the only study that assessed the impact of an intervention on female empowerment found that girls reported viewing themselves

as important and valuable as a result of the intervention compared to before when they thought that boys were better than girls.[4] Additionally, a few studies in this review reported increased confidence in going to school and participating in school activities during menstruation, and increased willingness to talk openly about menstruation as a result of educational and service interventions.[20,35,38] Overall, the evidence on the impact of menstrual hygiene management interventions on female empowerment is limited, and therefore it is difficult to generalize the collective impact on female empowerment.

Study Quality and Potential Biases

Among the 18 articles included in this review, study quality is variable and the risk of bias is evident (Tables 6-8), which was determined based on the Cochrane assessing risk of bias tools.[27] First, only 8 of the 18 articles included in the review used random sampling techniques, which suggests that 10 of the studies included in this review have a high risk of bias. Two studies used rudimentary techniques like flipping a coin to determine the type of intervention each school received and interviewing every 10th household to mitigate bias.[40,36] Another way that studies attempted to reduce selection bias was through a pre-test and post-test design. However, this method still does not allow for control of extraneous factors that may interfere with the impact of the intervention. Similarly, balance between intervention and control groups was assessed. Twelve of the 18 studies included in this review had balance, meaning that the same set of participants took both a pre-test and a post-test. One study matched the participants in the intervention and control groups by school type (rural/urban), grade, age, and focus in school, and another matched intervention schools by population density and economic development.[34,42] Additionally, among the studies that had comparison and intervention groups, most studies controlled for contamination by separating the groups by school.[3,28–30,35,39]

The risk of reporting bias is also relatively high in this review, because most of the outcomes were self-reported measures. Nine of the 18 studies included in this review used self-reported outcome measures. Although a couple of articles used validated school records or other less biased sources of information to measure outcomes, all of the articles included in this review had very heterogeneous outcomes, which make it difficult to directly compare and report the collective effect of the interventions. The majority of studies (n=13) reported p-values, so statistical significance of the studies can be collectively examined. However, a description of how the p-values were calculated was often not reported, which makes direct comparison difficult.

When comparing the different intervention categories, the risk of bias differs. For example, most outcomes in the educational intervention category are not objective, because the outcomes were measured using self-reported measures. Also, most studies with educational interventions reported percent change and levels of significance. On the other hand, the majority of interventions in the service-based group (n=3) used randomized sampling techniques, including one study that was a randomized control trial.[31] The service-based intervention group also varied in measurement of the outcomes, as some of the studies used qualitative methods to assess the impact of sanitary menstrual hygiene products, whereas other studies used school attendance records to assess the impact of the intervention on school absenteeism. Among the education and service-based intervention group, all studies were balanced, but only one study used random sampling techniques and only one study had objective measures of effect.[35,42]

A common theme across all studies was the lack of control for confounding factors, which introduces a high probability of other factors influencing the results of the intervention. Also, the length of time and scope of interventions varied greatly, and different quantitative and

qualitative measures of effect were reported, which decreases the extent to which studies in this review can be subjectively compared. Across all studies included in this review, the risk of publication bias is high, because researchers are less likely to publish studies that did not have some form of a positive impact. Therefore, the available peer reviewed journal articles may not be completely representative of the impact of menstrual hygiene management programs in low- and middle-income countries. Also, generalizability of the studies included in this review to the larger population is limited due to the small-scale nature of the interventions, small study sample sizes, and lack of control for covariates.

Discussion

The results of this review indicate that menstrual hygiene management interventions increase menstruation knowledge and beliefs, and improve menstrual hygiene behaviors. Although the results indicate that interventions appear to decrease the number of missed days of school during menstruation, there is not enough statistically significant evidence or high quality studies (Tables 6-8) available to suggest that menstrual hygiene management interventions increase school attendance rates. Of the different intervention groups, the educational interventions appeared to have the greatest impact on improving knowledge and menstrual hygiene behaviors. The service-based interventions had varied impact, as the impact of the interventions on school attendance was not statistically significant. The collective impact of educational and service interventions suggests that multipronged interventions will most likely have the greatest statistical impact on decreasing rates of school absenteeism during menstruation. The combined interventions also indicate that providing girls with education about menstruation and tools to manage menstruation has the potential to have longer-term impact on female empowerment, but additional research is necessary.

Although the studies included in this review represent a wide range of interventions and study settings, study limitations are also evident. One of the most common limitations is the study time frame, which is often the result of study funding and feasibility. The studies ranged in duration from 4 weeks to 3 years, which most likely restricts the impact on intermediate and long-term outcomes like school attendance and female empowerment. Many of the studies included in this review also had interventions with small sample sizes, which restrains the generalizability of the results to other groups of adolescent girls and other settings.[32,33,36,38] Additionally, studies that utilized pre-tests and post-tests to assess knowledge are based on self-reported measures, which are subject to reporting biases.[29,34]

Another limitation was the difficulty of quantifying and measuring behavior change through qualitative assessments, because some of the studies in this review used focus group discussions to assess the impact of the intervention. One study discussed how peer influence and fear to speak about personal experiences may influence focus group discussions and responses.[35] Also, menstruation is a taboo topic in many cultures, so some of the behavior surrounding menstruation in the assessment of interventions may be skewed or underreported.[39] Lastly, although multipronged interventions with menstrual hygiene and female empowerment education, water and sanitation support, and provision of menstrual hygiene products suggest the possibility for wide-spread impact, the sustainability of that type of program can be challenging especially in terms of funding and support from schools, non-governmental organizations, and other agencies involved.[4]

This review also has some limitations due to the types of studies included and excluded in the analysis. First, because all studies except for systematic reviews and descriptive studies were included in this review, some of the studies lacked randomization in how the intervention

and control groups were determined. Therefore, the risk of reporting bias is higher and it is more difficult to interpret and generalize the impact of the interventions. The types of outcomes and interventions included in this review were heterogeneous, which became challenging during the process of comparing and synthesizing the results. However, I attempted to mitigate this factor by categorizing interventions into three mutually exclusive groups. A lot of research on menstrual hygiene occurs in conjunction with reproductive tract infections, which was outside of the scope of this review, but by excluding articles with the prevalence of infections as the outcome, the measure of effect of menstrual hygiene programs may be partially lost. Additionally, because this review focused on community and school-based interventions, a few articles on the impact of larger-scale interventions were excluded, but those articles may provide insight into the effectiveness of larger-scale initiatives.

Some of the strengths of this review include the application of the PRISMA checklist to guide the systematic review process and the use of the Covidence site to manage and sort through the articles for this review. While including a wide range of studies by intervention and outcome is a limitation, it is also a strength as this review includes a diverse array of evidence on the impact of menstrual hygiene programs. Additionally, because of the recent increase in menstrual hygiene management interest, all of the studies included in this review were conducted within the last ten years, which eliminates some of the variation in menstrual hygiene products available, and tools used in both study design and study implementation.

In comparison to the two other systematic reviews I identified on the impact menstrual hygiene management programs, this review reports some of the similar findings.[21,22] Although the focus of the systematic review by Sumpter and Torondel was on reproductive tract infections, they also reported on the impact of menstrual hygiene education programs on school attendance

rates.[21] Hennegan and Montgomery also focus on the impact of menstrual hygiene management programs on psychosocial wellbeing in their review.[22] However, both published reviews are similar in reporting a non-significant positive impact of interventions on school attendance during menstruation, which matches with the findings of this review.[21,22] While Sumpter and Torondel reported that quantitative data on the number of missed days of school during menstruation is missing, this review cites quantitative evidence for menstrual hygiene interventions increasing school attendance during menstruation.[21,31,36] However, research on the impact of menstrual hygiene management programs on school attendance is still very limited, and there is a need for more qualitative and quantitative data on this topic.

Overall, more research on the impact of menstrual hygiene management programs is necessary. The evidence on the challenges of menstrual hygiene is abundant, which demonstrates a need to address school absenteeism and female disempowerment linked with menstruation. However, the evidence on effective, replicable, and sustainable menstrual hygiene management programs is limited and often interventions are implemented on a smaller scale, so generalizability of the impact is not possible. Although all of the studies included in this review include interventions in low- and middle-income countries, published literature is not available on the impact of interventions in the most vulnerable and poorest countries in the African, South Asian, and Middle Eastern regions of the world. Therefore, diversity in the types of interventions, study designs, study settings, and study durations is necessary to better inform the question of whether menstrual hygiene management programs can help to increase school attendance and female empowerment.

Conclusion

Although the results of this review indicate that high quality evidence on the impact of menstrual hygiene management interventions is lacking, some recommendations for future menstrual hygiene management programs and policies can be provided. First, school-based educational programs appear to provide the greatest number of girls with menstrual hygiene education, especially in communities where menstruation is a taboo topic to discuss at home.[28,30] Educational programs should conduct needs assessments before developing materials.[32] Other recommendations include: incorporating interactive techniques like plays, as those activities are fun and can help to abate some of the taboos surrounding menstruation; involving teachers to educate students, provide support to students, and promote sufficient menstrual hygiene management in schools; and including information about managing dysmenorrhea, because that often serves as a barrier to school attendance during menstruation.[20,28]

A second set of recommendations is the need for longer and more intensive interventions to get at the root causes of why girls are missing school and the barriers to adequately managing menstruation. For example, giving out free or heavily subsidized disposable sanitary pads does not target the underlying factors of poverty and place of residence.[3] On the other hand, low-cost sanitary pad businesses are more sustainable, and producing low-cost sanitary pads in the intervention country can create employment and empowerment opportunities.[3] Additionally, there is a need for increased access to private and clean WASH facilities to ensure that girls have secure places for menstrual hygiene management at school and at home.[4,39] Overall, multipronged interventions can help to improve knowledge, menstrual hygiene practices, school attendance, and female empowerment. It is important to also look at other factors that are contributing to school attendance and menstrual hygiene management challenges.[4] Interventions

must be cost-effective, culturally sensitive, and accepted by adolescent girls; therefore, developing interventions should involve schoolgirls, teachers, parents, and education department officials.[41]

Often research on menstrual hygiene management-related interventions may not be completely randomized due to ethical factors, but future research on the impact of interventions should strive to use randomized sampling techniques, have balanced intervention and control groups, control for intervention contamination, report any lost to follow-up participants, assess measures of effect objectively, and report p-values and how the p-values were calculated. In conclusion, this review provides insight not only on how interventions can improve menstrual hygiene management among girls and increase school attendance during menstruation, but also on how more research is necessary especially in terms of assessing the sustainability and longevity of menstrual hygiene management interventions.

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Appendix

Table 6. Assessment of Quality and Bias in Educational Interventions												
	Groups						Follow-up			Analysis		
Author Year	Arms	Sample	Random[A]	Balance[B]	Representative[C]	Control for Contamination[D]	Objective[E]	LTFU[F]	Identical[G]	Effect Size[H]	Confidence Interval[I]	p-value[J]
Djalalinia et al.[28] 2012	3	1231[b]	Y	Y[e]	N	Y[h]	N[i]	Y	Y	N	N	Y
Haque et al.[29] 2014	1[a]	416	N	Y[f]	N	Y[h]	N[i]	Y[n]	Y	Y[p]	N	Y
Arora et al.[30] 2013	1[a]	200	Y	Y[e]	Y	Y[h]	N[i]	Y[n]	Y	Y[q]	Y	Y
Dongre et al.[32] 2007	1[a]	383	Y	Y[e]	N	N/A[a]	N[i] /Y[j]	Y	Y	Y[p]	N	Y
Dorgbetor[20] 2015	2	60:60 (schools)	N	N	N	N	N[k]	N	Y	Y	N	N[t]
El-Lassyand[33] 2013	1[a]	97	N	Y[e]	N	N/A[a]	Y[l]	Y[n]	Y	Y[r]	Y	Y
Fakhri et al.[34] 2012	2	349:349 (control: intervention)	N[c]	Y[g]	N	Y[h]	N[i]	Y[n]	Y	Y	N	Y
Nemade, Anjenaya, and Gujar[37] 2009	1[a]	217	N	Y[e]	N	N/A[a]	N[i]	Y[o]	Y	Y[s]	N	Y
Jena et al.[40] 2012	1[a]	450	Y[d]	Y[e]	N	N/A[a]	Y[m]	Y	Y	Y	N	Y
Kumcagiz and Avci[41] 2011	1[a]	408	N	Y[e]	N	N/A[a]	N[i]	Y[n]	Y	Y	N	Y

[A]Were random sampling techniques used? [B]Were the comparison group characteristics provided and are they balanced? [C]Is the study sample representative of the general population? [D]Was there control for contamination between the comparison and intervention groups? [E]Were objective outcome measures used? [F]Was the number of lost to follow-up (LTFU) provided [G]Was the follow-up in each arm identical? [H]Is the measure of effect reported? [I]Was the 95% confidence interval reported? [J]Were p-value(s) provided? [a]Before and after study [b]Number of participants in each arm not reported; total number of participants [c]Quasi experimental [d]Every 10th household was interviewed [e]Same students interviewed: pre/post-test [f]Validated through ANOVA tests [g]Balanced via matching of control and intervention groups [h]Control and intervention groups at different schools [i]Self-assessment test/questionnaire [j]Qualitative trend analysis [k]Based on focus group discussions [l]Based on literature [m]All participants were directly interviewed by trained interviewers [n]Not explicitly stated, but total numbers indicate no participants were LTFU [o]Not explicit, but there was LTFU [p]Percent change values and p-values provided [q]Mean pre/post-test scores [r]Paired t-test, correlation, and McNemar test [s]Chi-squared [t]Qualitative assessment

Table 7. Assessment of Quality and Bias in Service-Based Interventions												
	Groups						Follow-up			Analysis		
Author Year	**Arms**	**Sample**	**Random[A]**	**Balance[B]**	**Representative[C]**	**Control for Contamination[D]**	**Objective[E]**	**LTFU[F]**	**Identical[G]**	**Effect Size[H]**	**Confidence Interval[I]**	**p-value[J]**
Crofts and Fisher[3] 2012	2	134[b]	Y	N	N	Y[e]	N[f]	N	Y	N	N	N[i]
Oster and Thorton[31] 2011	2	101:98 (control: treatment)	Y	Y[c]	N	Y	Y[g]/ N[h]	N[j]	Y	Y	N	Y
Shah et al.[38] 2013	2[a]	148:136:68 (total: falalin cloths: sanitary pads)	N	N[d]	N	N	N[h,i]	N	Y	Y	N	Y
Wilson, Reeve, and Pitt[39] 2014	2	159:143 (control: intervention)	Y	Y	N	Y[e]	N[h]	Y[k]	Y	Y[l]	Y	Y

[A]Were random sampling techniques used? [B]Were the comparison group characteristics provided and are they balanced? [C]Is the study sample representative of the general population? [D]Was there control for contamination between the comparison and intervention groups? [E]Were objective outcome measures used? [F]Was the number of lost to follow-up (LTFU) provided [G]Was the follow-up in each arm identical? [H]Is the measure of effect reported? [I]Was the 95% confidence interval reported? [J]Were p-value(s) provided?
[a]Overlap of participants between the 2 intervention groups [b]Number of participants in each arm not reported; total number of participants [c]Balanced in all categories except for menses at baseline, so analysis was restricted to those that already started menstruating [d]Overlap of intervention groups, but fewer participants in sanitary pad intervention group [e]Control and intervention groups at different schools [f]Focus group discussions [g]School attendance via official school records [h]Self-reported assessment [i]Qualitative assessment [j]Not explicitly stated, but total numbers indicate no participants were LTFU [k]One school completely LTFU because of a holiday break [l]t-test statistics reported

Table 8. Assessment of Quality and Bias in Educational and Service-Based Interventions												
	Groups						Follow-up			Analysis		
Author Year	Arms	Sample	Random[A]	Balance[B]	Representative[C]	Control for Contamination[D]	Objective[E]	LTFU[F]	Identical[G]	Effect Size[H]	Confidence Interval[I]	p-value[J]
Kidney and Edgell[4] 2013	1[a]	4 (schools)	N	Y[d]	N	N/A[e]	N	N	Y	N	N	N[l]
Mason et al.[35] 2015	3	101[b]	Y	Y	N	Y[f]	N[g]	Y	Y	N	N	N[l]
Montgomery et al.[36] 2012	3	35:25:60 (control: education-only: education and service combined)	N[c]	Y	N	N	Y[h]	Y[i]	Y	Y[j]	N[k]	Y
Naeem, Klawitter, and Aziz[12] 2015	1	6 (schools)	N	Y[d]	N	N/A[e]	N[g]	N	Y	N	N	N[l]

[A]Were random sampling techniques used? [B]Were the comparison group characteristics provided and are they balanced? [C]Is the study sample representative of the general population? [D]Was there control for contamination between the comparison and intervention groups? [E]Were objective outcome measures used? [F]Was the number of lost to follow-up (LTFU) provided [G]Was the follow-up in each arm identical? [H]Is the measure of effect reported? [I]Was the 95% confidence interval reported? [J]Were p-value(s) provided? [a]Before and after study [b]Number of participants in each arm not reported; total number of participants [c]Flipped coin to assign school to one of three intervention options [d]Same students interviewed: pre/post-test [e]No comparison group [f]Control and intervention groups at different schools [g]Focus group discussions [h]School attendance records from teachers validated by researchers [i]Not explicitly stated, but total numbers indicate no participants were LTFU [j]t-test statistics and standard deviations reported [k]Means and standard deviations reported [l]Qualitative assessment