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**What's the Bleeding Problem?
Period Poverty, Information Failure
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Abstract

A combination of commercial interests, cultural constraints and illiteracy have shaped the period product markets in the Global South such that disposable pads have gained in popularity but relatively little is known about reusable innovations that could support the goal of eradicating period poverty sustainably and equitably. This work examines how asymmetric information in this market affects consumer choices by drawing on a field experiment and survey with 277 women from low-income households in India. Through a careful consideration of the cultural context and policy backdrop in which decisions on menstrual products and practices are made we draw two key conclusions. First, we find that consumers are effectually denied all agency over choice of period product and are forced to select disposable pads, frequently at aberrant consequences for themselves and their environments. Such 'perverse selection' is manifested as a relational bond with disposables grounded in emotional and habitual cues. This poses a serious challenge to the introduction of reusables. Second, we demonstrate that 'informed choice' is a viable policy tool with potential to steer the menstrual product market in a beneficial direction both for costs to consumers and to their environmental eco-systems.

Key words: period poverty, menstrual hygiene, information failure, relationship theory, informed choice.

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1. Introduction

The study of informational asymmetries in markets and its consequences for consumer decision-making has been of long-standing interest in consumer research (Sharpe 1990; Frenzen and Nakamoto 1993; Corbett and de Groot 2000; Walters and Hershfield 2020). The market for menstrual hygiene products is a textbook example for the study of consumer choice in presence of asymmetric information, but it has remained surprisingly under-researched. The market for period products is significant, serving a large and diverse clientele of over 2 billion girls and women worldwide (UN 2019). Over 85% or 1.7 billion of them live in the Global South. Heavy promotion of disposable period products (pads and tampons) by large corporates has meant that reusable and greener alternatives (compostable pads, reusable pads and menstrual cups) are less well known by consumers and policy makers, especially in the Global South where these products can play a big role in eradicating period poverty. However, imperfection in information flows means most consumers have little choice but to use disposable products. But how entrenched are their preferences? Does giving them complete information about all potential products and their hygienic use have an impact on their consumption decisions? And what about wider implications like that on period equity and environment? This research is the first attempt to empirically investigate these questions and lend a consumer research perspective to the market for menstrual hygiene products and to the global challenge of eliminating period poverty.

Knowledge asymmetries may prevail in a market because of transactional and circumstantial costs associated with sharing full information (Cordelia 2006; Spence 2002; Hutton et al. 1986; Urbany 1986; Barzel 1982). In this study we consider the market for period products where informational asymmetries exist because it has been far more profitable for producers to popularize disposable products which have become established as the “gold standard” (Bobel 2019). Producers of reusable period products, with smaller profit margins and longer duration between consumer repeat purchases, have struggled to match the marketing budgets operated by manufacturers of disposable products (Garikipati 2019). Large companies also pushed for aspirational marketing of sanitary pads in low-income settings by introducing cheaper variants and smaller pack sizes (Mahajan 2019). The inevitable consequence of imbalances in advertising and marketing powers is that disposables are the most recognizable and accessible period products. The situation in the Global South is further exacerbated due to cultural taboos around menstruation that constrain women from seeking information, high prevalence of illiteracy and a policy apparatus that relies on commercial campaigns to inculcate mass awareness about menstrual hygiene management.

Of fundamental interest to consumer research is how consumers cope with such asymmetric information flows in the market. Seminal research in this area suggests that information failure generally leads to sub-optimal decision-making by consumers (Akerlof 1970, Spence 2002;). In the market for menstrual products, incomplete information leaves consumers and policy makers with little choice but to ‘adversely select’ disposables to manage and promote menstrual hygiene. Disposable period products are associated with higher life-cycle costs and present a bigger ecological burden when compared to reusable options (van Eijk et al. 2019; Borunda 2019). These attributes are likely to make reusables far more useful in overcoming the challenge of period poverty in the Global South.

Under the larger banner of ‘how consumers cope with incomplete information’, one prominent stream of research examines consumer’s response to information about new or innovative products (Rogers 1976; Mahajan 1997; Hoyer, et al. 2010). This research examines various determinants of women’s menstrual product choices alongside their response to information on ‘new’ reusable period products, that were hitherto unknown to them. Specifically, we ask if women’s preferences shift in response to complete information about all potential period products, their hygienic use and consequences for waste management. We

carry out a field experiment with 277 women in India to study the differential impact of providing information only against the additional provision of a disposable and a reusable period product for six months.

Previous research suggests that uncertainty associated with evaluating a new product may motivate consumers to act variously. They may consult friends (Berning and Jacoby 1974); look for critic consensus (West and Broniarczyk 1998); rely on intuition or associated knowledge (Broniarczyk and Alba 1994; Moreau, Markman and Lehmann 2001); carefully scrutinize new information (Moreau, Markman and Lehmann 2001; Grant and Tybout 2008). After all this, consumers may still decide to walk away from it, especially if they are already committed to a rival brand or product type (Fournier 1988). This relationship may be stronger if their consumption decisions are out of habit and convenience (Reilly 1982; Murray and Häubl 2007) or/and embedded in emotional cues of anxiety, shame and status (Campbell *et.al.* 2020; Galoni, Carpenter and Rao 2020; Goor, Keinan and Ordabayeva 2020). Consumers used to a certain product may also be complacent about new product learning (Wood and Lynch 2002). The experimental set up and the follow-up qualitative survey allows us to examine the role of these various determinants of women's period product preferences in a dynamic context.

The key contribution of this research is to empirically evidence women's period product choices in face of informational asymmetries and to test the viability of 'informed choice' as a policy instrument to steer the market for period products in a more sustainable direction and thus contribute to ending period poverty in the Global South. Previous seminal research has established that asymmetric information leads to 'adverse selection' by consumers (Löfgren, Persson and Weibull 2002). This research introduces the concept of 'perverse selection' to describe the tenacity of such selection that become embedded in consumer psyche as they relate product choices to their event experiences that are associated with emotional cues of shame and status and refuse to alter these even in face of adversities. Studying women's menstrual product choices in an experimental setting enables us to discern the impact of information alone and in combination with exposure to 'new' reusable products. By examining women's menstrual product choices before and after the field trial we are also able to comment on the role of various factors, including institutional determinants like culture and policy. The findings of this research will be of significance to menstrual hygiene strategies in the Global South.

2. Evolution of the Menstrual Hygiene Product Market

For a large part of human history, menstruation was surrounded by traditional taboos rooted in religious beliefs that considered period blood as "bad", both dirty and shameful (Guterman, Mehta and Gibbs 2007). This narrative mired menstruation in a culture of shame and silence, reducing women to a "bricolage" approach to managing their periods, repurposing all sorts of commonplace items like scraps of fabric, soft bark, hay or sand into pad-or tampon-like objects (Strasser 2014). It was only in 1921 when Kotex disposable pads first hit the American markets that the era of modern period products began (Goldberg 2016). From the beginning, companies pushed the idea that the way to be modern was to use the new disposable products (Vostral 2018). Marketing campaigns heavily leaned into the idea that using disposables freed women from the 'oppressive old ways', making them 'modern and efficient'. Overtime these products became more efficient as variants like tampons, winged-pads, plastic-backing and adhesive strips were added. The profit incentives were considerable as disposables locked women into a cycle of monthly purchases that lasted for several decades. Driven by profits, and the commodification of comfort and convenience, an entirely new market for female hygiene products was created.

As more women entered the workforce, the appeal and ubiquity of disposables grew. The market for disposables was initially limited to the west, but in the 1980s some of the larger

companies recognized the vast potential for expansion into low- and middle-income countries (LMICs) where over 85% of their consumers lived (UN 2019). Companies had to once again create the aspiration for comfort and convenience, but this time for middle-class women in the Global South. Pads were more actively promoted over tampons because of the patriarchal taboos against vaginal insertion that prevails in many cultures (Nappi, Liekens and Brandenburg 2006). With increasing affluence and affordability, these aspirations became a necessity for these women. Given that cultural taboos had left a veritable vacuum of information around menstruation in these countries, it was easy for the companies to position sanitary pads as the only means of hygienically managing periods.

Their efforts received a considerable boost in mid-1990s when global concerns around the menstrual health of girls and women from low-income households in LMICs started to take hold (Sommer et al. 2013a). By early 2000, largescale public health campaigns were initiated to encourage women to transition away from the use of traditional cloth, which was considered big, bulky and hence inconvenient but also required washing and direct sunlight drying so were difficult to maintain hygienically. In suggesting an alternative, it was easy to piggyback on the marketing success of private companies that had already created public awareness and aspiration for disposable pads. Use of disposable period products was put forward as an adequate indicator of “menstrual hygiene”, with free or heavily discounted distribution of disposable pads the focus of several policy and third sector initiatives to tackle period poverty among their populations (Joshi, Buit and González-Botero 2015; African Coalition for MHM 2019). These initiatives inadvertently endorsed the prevailing discourse around menstruation that portrayed commercially produced disposable sanitary pads as the “gold standard” (Bobel 2019). In just under twenty years, private companies and government initiatives transformed period product markets in LMICs, where promotion of a single product category unsurprisingly made disposable sanitary pads the most used period product— although wide heterogeneity in usage is reported, even within the same country (Smith et al. 2020).

Use of disposable products is often combined with inappropriate disposal practices, as guidance of waste management is missing, which leads to an escalating burden on the environment (Elledge et al., 2018). As disposables have become popular, concerns around their ecological sustainability has grown both with respect to the waste they generate (van Eijk et al. 2019 provides global estimate of 480 billion soiled pads annually) and the amount of plastic used in their production (Borunda 2019 estimates these would take 800-900 years to decompose). Today, both the industry and the users face a shift from a ‘disposal oriented’ to a ‘circular’ economy. Innovations in period products had kept pace with these concerns resulting in an increase in the range of reliable and sustainable period products available to women. The three main sustainable product lines on offer are reusable pads, compostable pads and menstrual cups. While all products are more ecologically sustainable when compared to disposables, several also had significantly lower life cycle costs making them a much more viable alternative for low-income households in LMICs. For example, menstrual cups, estimated to last up to 10 years have less than 1.5% of the environmental impact of disposables at 10% of the cost (Hait and Powers 2019).

Although the market for these products is expanding, much of this growth has been in the west, echoing the initial phases for disposable pads. But clearly these products promise much for women in poorer regions of the world because they are a much cheaper and environmentally friendly alternative to disposable pads. Largescale trials with such products also suggest that their adoption is likely to support menstrual health objectives in LMICs. For instance, a study from Uganda reports that schoolgirls using reusable pads report less difficulty and disgust with changing and cleaning absorbents and increased absorbent reliability (Hennegan et al. 2016a). A study from western Kenya reports that the provision of disposable pads or menstrual cups reduces the exposure to sexual and reproductive harms among schoolgirls compared with usual

practice (Benshaul-Tolonen et al. 2019). A meta-analysis that included 13 studies on menstrual cups reports that 73% (pooled estimate: $n=1144$; 95% CI 59–84, $I^2=96\%$) of participants wished to continue use of the menstrual cup at study completion (van Eijk, et al 2019).

Despite these developments, information about these products is generally lacking in the Global South both among consumers and policy makers (Garikipati 2019; Hennegan 2019; Mahajan 2019). The sanitary pad revolution in LMICs was led by private companies motivated by profits. Reusable period products that can potentially last for several years don't represent such profit margins and have not enjoyed the largescale marketing campaigns devoted to disposable pads. Informational asymmetries that favor disposables are unlikely to be set right via market forces alone. LMICs interested in pursuing financially and ecologically sustainable menstrual programs must invest in awareness campaigns to overcome the informational deficit around reusable period products and their hygienic use. There is yet no robust evidence to suggest that informing women of period products is a useful strategy, albeit anecdotal evidence reported in Mahajan (2019) are largely favorable. This is the key question of the field experiment which also evidences if exposure to 'new' or hitherto unknown period products shifts established consumption behavior.

3. The India Context

Home to over 20% of world's menstruating girls and women, India represents an important case to study these issues (estimated from Census of India 2011). Like in many LMICs over the last two decades, disposable sanitary pads have dominated the menstrual discourse in India. Sanitary pads were a niche product in India till as late as 1989 when Proctor and Gamble entered the market as a rival to the American giant Johnson and Johnson. By introducing a premium brand called Whisper, P&G created an aspiration for more comfort and convenience among middle-class Indian women. A trade battle ensued with J&J for this segment of the market that saw the introduction of several other luxury pad brands like Carefree and Stayfree in the Indian market. These brands dominated the market till recently when new entrants like Niine changed the game yet again making pads even cheaper and easier to access. Lower-priced products were also made available in small pack sizes to make it even more affordable and large network of pharmacies have been used to reach every corner of the country. New entrants and their marketing strategies have made sanitary pads a truly aspirational product for women everywhere in India.

Early reports on women's lack of access to modern menstrual hygienic products in India also spurred the government into action (Garikipati and Boudot 2017). Free or subsidised distribution of sanitary pads has become one of the core activities of government backed menstrual health initiatives in India. The largest such initiative was the distribution of pads via government schools as part of the erstwhile Menstrual Hygiene Scheme of the Ministry of Health and Family Welfare on the distribution of sanitary pads through government schools (Adukia 2017). Later state-sponsored schemes took over the distribution of pads in schools. A recent example of this is the allocation of Rs. 100 crores by the government of Andhra Pradesh to the distribution of pads to two million adolescent schoolgirls (Jayachandran 2019). The government has also extensively pushed small-scale pad manufacturing units which offer the added advantage of livelihoods creation for women from low-income households making it a socially desirable activity (Muralidharan, Patil and Patnaik 2015). The Indian state's menstrual hygiene strategy has been reduced to the distribution of disposable sanitary.

In face of aspirational marketing by private companies combined with state initiatives, menstrual health and hygiene in India have become synonymous with access to disposable pads. Data suggests that efforts to popularize disposable pads have resulted in a dramatic shift in menstrual practices across India in a short span of time, especially among young girls and

urban populations. A Plan India report from 2010 reports indicated that only 12 percent of India's 355 million menstruating women used sanitary pads. By 2015-16 this figure had gone up to 36% (National Family Health Survey, IIPS 2016). For those in the age group of 15-24 this figure is even higher at 57.6%. For urban regions this is 77.5% and for rural regions it is 48.2%. The remaining populations mainly use traditional cloth with negligible numbers using other materials like hay or sand.

There are two significant considerations that emerge from these statistics. First, while use of sanitary pads has increased phenomenally, there are still large segments of the population that uses traditional cloth or other methods, suggesting that period poverty is still highly prevalent in India. Although traditional cloth can be a hygienic menstrual absorbent, it requires correct usage and maintenance practices. Inability to access adequate washing facilities and cultural inhibitions that stop women from drying cloth in direct sunlight for fear of them being seen by others may render cloth use unhygienic (Torondel et al. 2018; Baker et al 2017; Das et al 2015). Singular focus on sanitary pads poses a real hurdle to meeting the challenge of achieving equity in the provision of menstrual hygiene in a populous country like India. Even with a highly committed state apparatus, monthly purchase and distribution of sanitary pads represent a huge financial and logistical challenge. Second, high pad use among urban women has serious implications for waste disposal systems in India which already struggle to meet the needs of a burgeoning populace (Myles et al. 2018). Evidence also suggests that rural India too lacks recourse for handling increasing volumes of menstrual waste (Lopez 2018).

While efforts to improve awareness and popularize sustainable alternatives in India lack the backing of the state in a big way, there are several local initiatives with limited reach. For example, the initiatives by grassroots organisations like WSSCC, SRF, AKDN reported in Mahajan (2019). Worth mentioning also is a recent small-scale intervention by the Government of Kerala, under which 5000 menstrual cups were distributed to women on voluntary basis (Bechu 2019). The findings of this research will provide robust evidence on the viability of giving women complete information on menstrual alternatives and providing them with reusable products to trial. In that sense, they will have significant consequences on menstrual strategies in India and similar LMICs.

4. Methods

The analyses reported here use data from a field experiment and qualitative survey carried out with 277 women from ten low-income areas in Hyderabad, the capital city of Telangana, India. The study design included repeat cross-sectional surveys over six months to quantify the effects of providing women with complete information of period products compared with combining knowledge provision with reusable cloth pad or disposable pads on women's preferences for menstrual materials and practices. Baseline was carried out from July to September 2017; distribution of menstrual materials was completed by October 2017 and follow-up was from April to May 2018. This project was funded by a GCRF grant 2016/17 (Ref No. 141131). Ethics was approved and overseen by Safa in Hyderabad, India (Ref: Safa0317R) and the University of Liverpool in Liverpool, UK (Ref: RETH000734).

4.1. Study objectives

This research examines a variety of questions related to the beliefs, consumption behaviour and disposable practices of menstruating women. We use an experimental set up to explore the effects on these after exposure to three separate conditions: when women are offered complete information on all menstrual alternatives (including hygienic use and disposal); when they are offered reusable cloth-pads and information; and when they are offered disposable pads and information. We test two main hypotheses:

H1: Social norms around periods and commodification of menstrual hygiene by popularizing a single product category has influenced beliefs, awareness and consumption preferences of menstruating women.

H2: Knowledge of alternative period products and opportunity to trial these influence women's preferences for reusable menstrual products.

In analyzing the findings, we explore several issues around women period product preferences like: how do women with limited affordability weave in their aspirations to use a modern menstrual product with meagre family budgets? What other idiosyncratic and institutional determinants impact women's period product decisions, use and disposal? Where do women acquire their knowledge of period products and how accurate is their information?

4.2. Study location and partner organisations

Field work was intended to be carried out in low-income settings of a large and growing urban city as we wanted to explore associated MHM issues in challenging urban settings, like affordability, public policy penetration and disposal. The core research team had previous experience with working in Hyderabad, and had access to a wide-network of NGOs and research organisations. Hence Hyderabad was selected as the study location. We then went through the profile of several NGOs and selected Safa and KGNMT because of their strong community presence and experience of working with women from low-income areas and had the capacity to be trained for the field experiment. Additional information about these partner organisations and their role in the study is provided in Appendix A, Text Box A1.

4.3. Participant selection, sampling and randomization

In consultation with partner NGOs, ten areas were identified to achieve a mix of geographical spread, access to amenities and other considerations like safety of enumerators, accessibility etc. From each of the study sites, a random sample of 50 households was created. From this list, we removed households that were known to reside in the area only intermittently and households that had no women in the age group 18-45 years of age. Using stratified random sampling, the remaining women were allocated to one of the three study conditions using the ratio of 4 women to product plus information condition for every 1 woman to the information only condition. No significant differences were found among conditions on location at the area level. The CONSORT diagram in Fig 1. depicts the flow diagram of the study, including enrolment and random allocation.

4.4. Interventions

All study participants received complete information on the entire range of menstrual alternatives along with their hygienic use and correct disposal. For the two product conditions, participants also received sufficient menstrual products for six months. To achieve community acceptance, the products used in the trial had to be selected carefully and with the involvement of the NGOs. A careful selection exercise was undertaken which assessed two products as viable for the community trial: a pad that required burial to compost ('Disposable' condition) and a reusable cloth-pad with an anti-microbial top layer ('Reusable' condition). The selection process and additional information about the products are detailed in in Appendix A, Box A2.

Thus, we have the three study arms: information + disposable pad (Disposable condition); information + reusable cloth-pad (Reusable condition); and information only + usual practice (Inform-only condition). After allocation to study conditions, baseline was completed, and menstrual materials distributed to Disposable and Reusable arms. All interactions were administered by pairs of women, one of whom was an employee of the partner NGOs. Most individual interviews were carried out in respondent's home, but where women preferred it, these were done in partner NGOs' office.

4.5. Overview of study conditions

There were three study conditions: (1) Disposable arm provided with disposable pads and complete information on the full range of menstrual alternatives, their hygienic use and correct disposal; (2) Reusable arm was given cloth-pads and information on menstrual products; and (3) Inform-only arm, continued with usual practice and received same information. The current study analyses the time points directly before for all conditions (baseline), and after the women completed six months of product use (follow-up). Follow-up is used for comparisons between disposable pads to reusable cloth-pads to inform-only. Fig. 1 provides the flow diagram of the study, including the timing of the interventions and follow-up relevant to the analysis. These were done in partner NGOs' office.

4.6. Data capture

Women participated in one-to-one interviews at household level that lasted approximately one hour each at baseline and at follow-up. We used structured questionnaires that were piloted beforehand during the planning phases to ensure that it was culturally appropriate and relevant to the purpose of this study. The baseline questionnaire generated socio-demographic and menstrual health related variables. At both baseline and follow-up, respondents were asked about their preferred menstrual product and their willingness to adopt alternative products and associated menstrual practices. We also included questions on current menstrual beliefs, awareness and disposal practices. There was also room for some open-ended answers which constitute the qualitative analysis. All measures used in this study are self-reported by respondents during interviews and have not been validated externally. Detailed information about the study measures is provided in Appendix A, Box A3.1 and A3.2.

4.6.1. Primary and secondary outcomes

The primary outcome is a measure of women's preference for reusable menstrual products. This outcome measure was chosen as the main aim of the study to understand the effect of exposing women to alternatives to disposable pads on their preference for menstrual products. We also included three secondary outcomes: women's willingness to adapt menstrual practices in terms of use and disposal; a measure of women's awareness of products beyond traditional cloth and disposable pads; and a measure of women's beliefs about menstruation and menstrual products, including their beliefs about the need for drying cloth in direct sunlight. These outcomes were chosen because in combination they encompassed women's attitudes towards menstrual materials and practices that are more sustainable than using disposable pads.

Note that the outcomes of this study only measured change in beliefs, attitudes, knowledge and preferences, not actual behavioural change which is potentially more difficult to achieve, particularly in LMICs (e.g., Paul-Ebhohimhen et al. 2008; Leventhal et al. 2016). Hence, we expected that the hypotheses would hold for the primary outcome and for those secondary outcomes that are not reliant on knowledge alone as women were offered identical information on menstrual materials across conditions.

4.6.2. Covariates

We include a range of socio-demographic and menstrual hygiene related variables as covariates: age, marital status, education level, employment status, head of household, caste, access to private toilet and menstrual product used at baseline. These covariates and their measurements are detailed further in Appendix A, Box A3.2.

4.7. Sample size

Stratified random sampling was used in this pilot to allocate women to one of the three study conditions: Disposable ($n = 200$), Reusable ($n = 200$) and control Inform-only ($n = 50$). As the main aim of the study was to quantify the effects of exposure to reusable alternatives to

disposable pads, the control was kept smaller than the two arms providing menstrual products. Information on the range of menstrual materials was provided to women across all three conditions. Sample size calculations assumed a 30% increase in preference for sustainable menstrual materials after exposure to sustainable alternatives thus increasing it from 50% to 65%, requiring a total population of 386 (193 per arm), providing 85% power with 0.05 alpha. Based on these calculations, we found that the sample size would be adequate.

4.8. Statistical methods

We tested the hypotheses first by comparing the magnitude of difference between exposures to reusable conditions (Reusable + Inform-only) vs. the Disposable pad condition by calculating the effect size using Cohen's term d . We also use Difference in Difference (DID) Ordinary Least-Squares Regression estimations and F -tests for equality. We began by conducting DID regressions for the outcome variables with and without covariates. We then examined the R^2 values to choose the models with the best-fit that explained the largest amount of variance for interpretation and further analysis. In each case, we found that the models with covariates explained more of the variance in the data and provided a better fit.

We investigated the magnitude, direction and significance of the effects for all outcomes from the best-fit models that include covariates to evaluate the effectiveness of sustainable conditions (Reusable + Inform-only) versus Disposable pad condition. We first consider each of the conditions separately and then combined the sustainable conditions. The results remain robust across the two specifications, so we examined the magnitude and direction of the coefficients for the sustainable interventions \times time interactions (follow-up), which, combined with F -tests for equality, allowed us to compare the effects of each intervention against another. Findings were interpreted to be significant when $p \leq 0.05$ for all outcomes.

All analyses were intent-to-treat, meaning that all women randomized into a study condition were analyzed as part of that condition, regardless of whether or not they used the menstrual product they were given as part of their intervention condition.

5. Results

5.1. Study flow and follow-up attrition

Fig. 1 illustrates the flow diagram of the study. Of the 453 women enrolled, the topic of research and resource constraints meant that just 293 (64.67%) completed the consent process and baseline. Of the 293, 277 (95.56%) were evaluated at six months follow-up and there was no significant difference on the proportion of women evaluated by condition. Of the 131 women consenting in the Disposable condition 127 completed the six months follow-up (96.95%), Reusable condition also included 127 of the 133 who participated (95.49%) and Inform-only included 26 of 29 who participated (89.65%). At analysis, three interviews were excluded as they were incomplete owing to women leaving interviews mid-way. Women lost to follow-up and analysis did not differ significantly on covariates or outcomes as measured at baseline.

5.2. Covariates and outcomes at baseline

Table 1 provides baseline scores on covariates and outcomes, including women's socio-demographic characteristics. At baseline, women in the full sample were an average of 28 years old ($SD = 7.53$). Most women had some education, with a mean score of 1.58, indicating on average they had attended high school ($SD = 1.14$). Approximately 20% women were in paid employment ($SD = 41\%$) and lived in households typically headed by their husbands or parents with average score of 1.12 ($SD = 0.68$). Seventeen percent were from backward castes, which indicated fewer restrictions on women's autonomy and mobility in these households ($SD = 0.54$). Sixty percent of women had access to a private toilet ($SD = 49\%$) while remaining used

communal facilities. At baseline, around 78% women stated using disposable pads as their only or main menstrual protection (SD = 42%). Few cloth users innately preferred using cloth, most did so due to reasons of affordability. Cloth users were all were over 40 years of age, suggesting that this practice is dying out. Many were mothers to daughters who used pads.

Levene's F-test for equality of variance is used to check for the effectiveness of the randomization strategy. We found differences across conditions only on the covariate that measured head of household, suggesting that women with greater decision-making agency are somewhat over represented in the Reusable condition than Disposable (but not Inform-only). With respect to outcomes, the only difference we found is that women in the Inform-only group are more willing to adapt menstrual practices than the two product arms.

Two further results on outcomes at baseline are worth noting. First, we found that awareness of menstrual materials other than cloth and disposable pads was negligible among women. Twenty-six research participants (9.75%) knew that sanitary pads could be made of compostable materials (cotton, banana pulp), but none of them had heard of menstrual cups, reusable cloth-pads, or tampons.

Second, we found that women's beliefs on menstruation and menstrual materials at baseline reflected cultural taboos and misinformation. The mean score on beliefs was 1.36 of a possible 3, meaning less than 50% of what women knew about menstruation and products was correct.

Evidence from qualitative interviews suggests that gaps in knowledge and information may be driven at fundamental levels by existing social norms which contribute to a culture of silence around menstruation, hindering women from talking about it openly or seeking information. Women participating in the study frequently used words like "*galeez*" (impure) and "*sharmanak*" (shameful) when referring to menstruation. Exposure to urban living and education seem to have little impact on this. In fact, menstruation was largely outside the purview of formal education and women could only rely on their closest networks for knowledge on it which increased the circulation of misinformation. One study participant, who had completed college education, claimed that she knew cloth was inferior to disposable pads because "*My aunt's friend became infertile because of it and she told us*" (age, 23).

The emotions of shame and embarrassment often led to unhygienic and unsustainable menstrual practices. For example, drying washed cloth openly under direct sunlight was frowned upon. Around half the study participants who used cloth, reported drying cloth indoors, sometimes hidden under other a mattress or inside a closed cupboard. This was considered as the "*saahi*" (correct/respectful) thing to do. Women also adopted disposal practices that would allow them to "hide their shame" from men in the household. Many chose to throw them in the stream that flowed next to the houses. Participants in their late twenties told us: "*We have a huge river behind us, the pad will just flow away with it.*" "*I wrap it [used pad] in a plastic bag, before throwing it in the river, how can I throw it just like that?*"

Survey data suggests that commercial adverts and public hygiene campaigns also had a significant influence on knowledge, tastes and preference. All research participants had seen several adverts for disposable sanitary pads, but none had seen one for any other product. Government sponsored promotion of pads are regularly played on radio, TV and in cinemas. In qualitative interviews women described preference for pads using aspirational language cues like 'modern' 'city' and associated pad usage with 'status'. Several phrases like, "*pad is best*", "*it is modern*", "*I am a city girl*", and "[using cloth is like] *stepping into the dark ages*" were used when expressing these opinions. One young woman (age 19), whose mother used cloth due to the cost of pads, expressed the view that she will go without food but not without pads.

Our data and qualitative survey show that women's menstrual beliefs and misinformation were, to some extent, the result of the culture of silence around menstruation. Women's attitudes towards period products and their preferences were undeniably influenced by

commercial and state campaigns that popularized disposable pads at the expense of information on other alternatives. These results support the main study hypothesis 1.

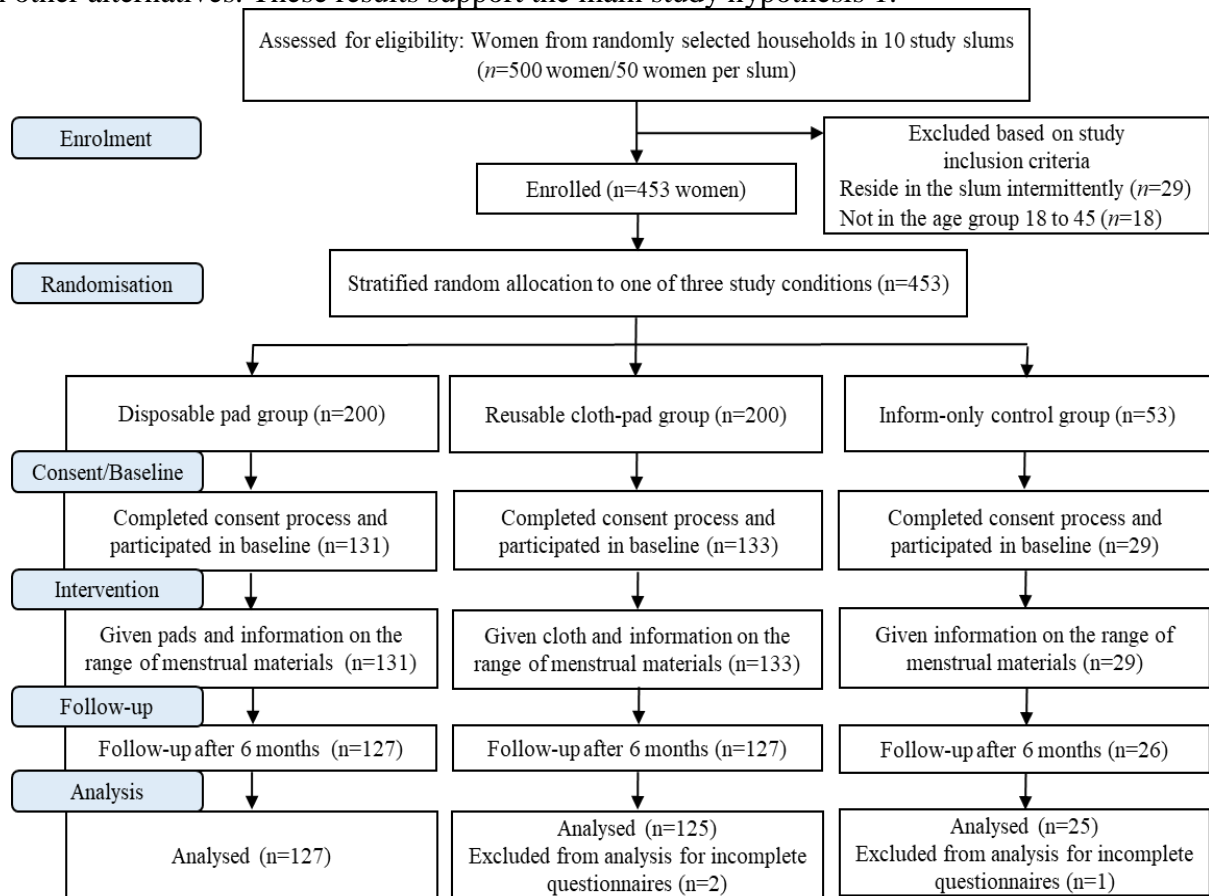


Fig. 1. CONSORT diagram detailing study flow of all relevant aspects and conditions.

Table 1.

Baseline scores on covariates and outcome and analysis of variance among conditions

Study variable	Scores for the full sample and intervention conditions				ANOVA P-value
	Full sample	Disposable	Reusable	Inform-only	
<i>Covariates</i>					
Age (years)	28.01 (7.53)	28.39 ^a (6.92)	27.94 ^a (8.09)	26.48 ^a (7.70)	0.505
Education level	1.58 (1.14)	1.56 ^a (1.04)	1.62 ^a (1.20)	1.52 ^a (1.39)	0.865
Employed	0.21 (0.41)	0.20 ^a (0.40)	0.22 ^a (0.41)	0.28 ^a (0.46)	0.649
Head of household	1.13 (0.68)	1.04 ^a (0.62)	1.22 ^b (0.75)	1.12 ^{ab} (0.60)	0.121
Backward caste	0.17 (0.54)	0.18 ^a (0.68)	0.14 ^a (0.34)	0.32 ^b (0.48)	0.289
Private toilet	0.60 (0.49)	0.65 ^a (0.48)	0.58 ^a (0.50)	0.52 ^a (0.51)	0.359
Pad users ⁺	0.78 (0.41)	0.78 ^a (0.42)	0.77 ^a (0.42)	0.84 ^a (0.37)	0.732
<i>Primary outcome</i>					
Preference for sustainable materials	0.43 (0.74)	0.42 ^a (0.73)	0.46 ^a (0.77)	0.32 ^a (0.63)	0.691
<i>Secondary outcomes</i>					
Willing to adapt menstrual practices	0.55 (0.50)	0.53 ^a (0.50)	0.54 ^a (0.50)	0.76 ^b (0.44)	0.091
Awareness of alternatives	0.09 (0.29)	0.08 ^a (0.27)	0.10 ^a (0.31)	0.12 ^a (0.33)	0.709
Beliefs about periods & products	1.36 (0.66)	1.40 ^a (0.70)	1.34 ^a (0.63)	1.24 ^a (0.64)	0.470
Number of observations	277	127	125	25	

Note. Scores are presented as Mean (Standard Deviation). Number of observations are given in the last row.

Abbreviations. ANOVA = Analysis of variance.

^{a,b} Values with the same superscripts in the same row are not significantly different at $p \leq 0.05$ for ANOVA and post-hoc tests; different superscripts indicate that the Means are significantly different.

+ 64.26% ($n = 178$) study participants report using disposable pads only; 13.72% ($n = 38$) report using disposable pads mainly but also cloth and 22.02% ($n = 61$) report using cloth only. All disposable pad users have been combined.

5.3. Analyzing product interventions

Table 2 provides follow-up scores on how women responded to the product conditions. While nearly all the women used the distributed products, approximately 38% ($n = 48$) in Disposable arm and 21% ($n = 26$) in the Reusable arm used it with their usual menstrual protection. We found significant differences across conditions on all the responses measuring perceptions of distributed products. Perception of convenience to use and comfort were better in the Disposable arm, whereas the Reusable arm scored better on reducing menstrual waste.

Table 2

Scores on use and perception of products distributed in the product conditions (PI and CI).

Variable of interest	Disposable	Reusable	<i>t</i> -test
Used the product distributed	0.98 (0.13)	1.00 (0.00)	1.409
Used in combination with other menstrual materials	0.38 (0.49)	0.21 (0.41)	-3.007**
Convenience and comfort of use	0.86 (0.35)	0.54 (0.50)	-5.912***
Helps reduce menstrual waste	0.36 (0.48)	0.62 (0.49)	4.150***
Number of observations	127	125	

Notes. Scores are presented as Mean (Standard Deviation).

Inference. * Indicates difference between Means is significant at 0.10 level, ** at 0.05 level and *** at 0.01 level.

5.4. Analyzing outcomes

Table 3 presents that post-intervention scores on the primary and secondary outcomes across conditions and the effect size of sustainable conditions (Reusable + Inform-only) vs. Disposable condition for all outcomes. We found differences across conditions on all the outcomes at follow-up, suggesting that study conditions worked as intended. Prominently, women in sustainable conditions (Reusable and Inform-only) were more likely to express a preference for reusable menstrual materials (Cohen's d : 0.42, $p = 0.009$) and were more willing to adapt associated menstrual practices at follow-up (Cohen's d : 0.39, $p = 0.021$) than women in Disposable condition.

Further, we conduct the DID regression analysis and examination of R^2 values indicated that in all the cases, the model including study covariates explained more of the variance in the data than the model without covariates. Hence, for the remaining of the analyses, we use models that included covariates for all primary and secondary outcomes. Full regressions models, including results on covariates, are presented in Appendix B, Table B1.

Table 4 presents the relevant summary effect sizes when adjusted for covariates, i.e., DID coefficient and significance level for each of the sustainable intervention's effect versus Disposable, which is the intervention \times time interactions from the regression models. We also present comparisons with significance levels among effect sizes from F-tests for equality.

There was clear support for the main hypothesis 2 that exposure to the sustainable interventions (Reusable and Inform-only), have a positive influence on women's preference for reusable menstrual products that were hitherto unknown to them (β : 0.23, $p = 0.049$ and β : 0.55, $p = 0.013$ respectively). The result is robust to combining the two conditions (Reusable + Inform-only) and comparing with Disposable condition (β : 0.28, $p = 0.020$). Testimonials by research participants suggested that, despite the taboos associated with vaginal insertion, they are willing to experiment with products like menstrual cups. Exemplifying this attitude was the statement by one of them who told us, "*I feel I could use a menstrual cup.*" (age 38)

Results on secondary outcomes offer further support for hypothesis 2. Reusable condition had a positive influence on women's willingness to adapt sustainable menstrual practices (β : 0.17, $p = 0.049$) and that this result remains robust when combined with Inform-only group (β :

0.18, $p = 0.046$). With respect to other secondary outcomes, we found no difference across conditions with respect to awareness of menstrual absorbents, but that Reusable had a greater positive effect on women's beliefs about menstrual materials than Disposable ($\beta: 0.20, p = 0.048$) and results remains robust when combined with Inform-only group ($\beta: 0.20, p = 0.047$). Several women in the expressed an interest in learning more about alternatives to pads, especially about menstrual cups, as little was known about these, and gave suggestions on how information could be shared: *Someone should tell us no? Such group discussions, teachers, government ... they can put posters.*" (age 34)

Table 3

Follow-up scores on outcomes, post-hoc difference tests and effect size (Reusable and Inform-only vs. Disposable condition).

Study variable	Scores for the full sample and intervention conditions				Cohen's term d^*	p -value
	All	Disposable	Reusable	Inform		
<i>Primary outcomes</i>						
Preference for sustainable materials	0.67 (0.85)	0.51 ^a (0.78)	0.78 ^b (0.87)	0.96 ^b (0.93)	0.42	0.009
<i>Secondary outcomes</i>						
Willing to adapt menstrual practices	0.96 (0.67)	0.85 ^a (0.66)	1.02 ^b (0.68)	1.20 ^b (0.64)	0.39	0.021
Awareness of alternatives	1.26 (0.58)	1.22 ^a (0.52)	1.30 ^a (0.65)	1.32 ^a (0.56)	0.16	0.520
Beliefs about periods & products	2.19 (0.62)	2.13 ^a (0.67)	2.26 ^b (0.57)	2.20 ^{ab} (0.58)	0.16	0.246
Number of observations	277	127	125	25		

Note. Scores are presented as Mean (Standard Deviation). Number of observations are given in the last row.

* Effect sizes (unadjusted for covariates) are computed using Cohen's term d (Carson 2012).

^{a,b} Values with the same superscripts in each row are not significantly different at $p \leq 0.05$ for ANOVA and post-hoc tests; different superscripts indicate that the Means are significantly different.

Table 4.

Summary of Difference in Difference coefficients for Reusable and Inform-only vs. Disposable condition (intervention \times time interaction) and F-tests for equality among interventions.

	Intervention conditions		
	Reusable	Inform-only	Reusable + Inform-only
<i>Primary outcomes</i>			
Preference for sustainable materials	0.23*	0.55**	0.28**
<i>Secondary outcomes</i>			
Willing to adapt menstrual practices	0.17*	0.12	0.18*
Awareness of alternatives	0.05	0.06	0.05
Beliefs about periods & products	0.20*	0.24	0.20*

Note. Positive coefficients indicate that the intervention was more effective compared to the condition in which pads and information were offered to women.

^{a,b} Values with the same superscripts in each row are not significantly different at $p \leq 0.05$ for all outcomes; values with different superscripts differ significantly. For all outcomes: ** $p < 0.01$, * $p \leq 0.05$

6. Discussion

What do the findings of this research imply for menstrual hygiene programs in India and similar LMICs, especially in terms of the prognosis for introducing sustainable menstrual products amongst its urban populace as a way of ending period poverty and furthering period equity? This question is even more relevant now as COVID-19 exposes the vulnerabilities of global supply chains, with shortages in sanitary pad supplies emerging as a particular concern around the world (BBC 2020; Golberg 2020; Plan International 2020; Tora 2020;).

The main observation at baseline is that disposable pads are now the main period product in urban India, even amongst low-income households. Nearly 78% of research participants report using disposable pads either as the only protection or main menstrual protection. This is comparable with estimates from the National Family Health Survey (IIPS 2016) and other surveys with women in similar context (Garikipati and Boudot 2017). Most who used traditional cloth did so due to lack of affordability rather than innate preference. This ties in with the result of a high preference for disposable pads among research participants at baseline.

Many of the research participants associated menstruation with emotional cues of ‘shame’ and ‘stigma’ and were keen to ‘hide’ this bodily function from others. A study on Australian women reports similar attitudes of ‘stigmatization’ (Seear 2009) and other studies have reported similar findings for India (Garikipati and Boudot 2017; Sivakami et al. 2019). What women understood about menstruation was influenced by anecdotes exchanged in their close social circles and formal education or other sources of information had little role to play. Similar findings are reported for Scottish women by Santer, Wyke and Warner (2018).

Associating periods with ‘shame’ and ‘stigma’ was manifested in stigmatizing the use of traditional cloth and made women value disposable pads as a product that could be conveniently used and discarded, in many cases straight into the flowing waters next to the residential area, and hence saved them from the ‘humiliation’ of having periods. Several younger users were even prepared to sacrifice essential consumption to continue using sanitary pads. Studying menstrual practices among wealthier women in India, Meenakshi (2020) also finds that strong taboo prevents them from transitioning to reusable sanitary protection, even though they have a desire to make environmentally friendly choices. For low-income households, buying disposable pads every month represented a considerable commitment and, in some instances, required real sacrifices. Some older participants went without pads to ensure that their daughters could continue using these. For many younger women using disposable pads was a symbol of ‘modernity’ and of ‘being from the city’; not simply a matter of convenience and habit but something that defined their ‘identity’ and ‘status’ that they could not do without even if meant sacrifices elsewhere. Similar instances have been reported by other studies from other parts of the world, like from rural Kenya, where school girls are reported to have exchanged sexual favors for disposable pads (Oruko et al., 2015).

We find that research participants had little knowledge of reusable hygienic alternatives like menstrual cups or commercial cloth-pads that are easier to wash and dry and have the potential to support menstrual hygiene at significantly lower cost over product lifetime. Commercial advertisement that popularized disposable pads had taken over the period product space that was difficult (if not impossible) to infiltrate for producers of reusable products who had much smaller profit margins. Asymmetric information in this market was also found to influence public messaging on menstrual hygiene, which too promoted disposable pads.

We argue that these findings suggest that consumers of period products have a ‘relational bond’ with disposable pads that are embedded in emotional cues of ‘shame’ and ‘embarrassment’ that are manifestations of the cultural taboos surrounding menstruation. This has semblances with Fournier’s (1998) ‘relationship theory’, which proposes that consumers form relationships with products that conform to their contextual values and beliefs. Our results also find support in other studies in consumer research, like Campbell *et.al.* (2020) and Galoni, Carpenter and Rao (2020) who locate that consumer’s relationship with products may be based in emotions of anxiety and shame, especially where consumption decisions are made in a stressful context.

Overtime, women have become habituated to the convenience of using and discarding pads in the most accessible ways possible. Research suggests that consumer’s relationship with products may be stronger if consumers are habituated to the product (Reilly 1982) and these consumption decisions are embedded in convenience (Murray and Häubl 2007). Further, we

find that younger women are likely to associate pads with status, which may make them unwilling to consider reusable alternatives. Goor, Keinan and Ordabayeva (2020) also identify status as a reason for consumers to get attached to a product, where a change is perceived as inferior or lowering standards.

The relational bond women developed with disposable pads grounded in cultural, emotional and habitual cues can be thought of as the ‘adverse selection’ they make in the context of missing information on other viable and potentially better period alternatives in terms of costs to consumer and their eco-systems. We propose that a meaningful way of considering consumer choices of period products in low-income countries in the presence of cultural taboos and information asymmetries is to frame them as ‘perverse selection’ – which describes consumption decisions that result in aberrant outcomes for consumers, their households and their environmental eco-systems. In the absence of full information, the consumers of period products were obliged to cultivate preferences such that the cultural roots of their inclinations became tenacious and embedded in their consumer psyche via commercial and state campaigns that popularized a single product category. Consumers relate product choices to their event experiences that are associated with emotional cues of shame and status and see no ‘real’ alternative to their choice even in face of serious hardships like insufficient family incomes to meet basic consumption needs and causing untold damage to their environmental eco-systems. The choice that consumers make can then be regarded as a ‘perverse choice’ thrust on them by way of lack of information on alternatives to a single product category.

These results indicate a serious market and public policy failure in bringing to consumer’s attention the full range of menstrual products (including their hygienic use and appropriate disposal), so they have a wider product base from which to make an informed choice. Policy focus on disposable pads alone denies menstruators access to information on alternative menstrual absorbents, essentially impeding their ability to choose effectually. This is reflected in the choice women make when asked about their most preferred period product at baseline. Women express their choice between disposable pads and traditional cloth only, most expressing a preference for pads. This information bias needs correcting. Informing women’s choice of menstrual material is not only likely to uphold their right to informed choice but also reduce the financial and environmental burden of menstrual management in LMICs.

Overall, the post-intervention results suggest that exposing consumers to information on the range of period products and giving them an opportunity to trial these has the potential to reverse consumer’s ‘perverse selection’ and steer the period products markets towards sustainability, both for consumer costs and their eco-systems. Informing women of various alternatives is likely to influence their choices to a similar extent as providing them with sustainable alternatives to disposable pads. While women from Inform-only condition were somewhat more willing to experiment with period products than other conditions, women in the Reusable and Inform-only groups exhibited similar preferences at follow-up.

Results on secondary outcome regarding willingness to adapt menstrual practices support the primary outcome, in that women in the Inform-only and Reusable conditions were seen to be significantly more willing to adopt sustainable menstrual materials and waste management practices than Disposable condition. Further, the results show that women’s knowledge of alternative materials improved across all conditions by an average of two points, suggesting there are substantial knowledge gains to be had from providing women with complete information on all period products.

The final secondary outcome – beliefs regarding menstrual materials – was the most difficult to change from baseline. Culturally, menstruation is associated with taboos, especially with respect to restriction on girls and women and the information provided by the study seem to have had little impact on these beliefs. Across South Asia, menstruation invokes strong cultural taboos, where restrictions are placed on menstruating girls and women, including separation of

touching, eating, drinking and sharing facilities (Garikipati and Boudot 2017; Sivakami et al. 2019). A study by van Eijk et al. 2016 in fact suggests that despite an increase in education, knowledge of menstrual health in general and among women has remained low with no evidence of change in the past two decades. Interestingly, however, despite having access to the same information on menstrual materials, women in the Disposable condition were significantly more likely to hold the belief that disposable pad is superior to other period products. Offering women disposable pads may have simply reinforced their original belief that '*pad is best*' causing them to ignore the information given about alternative menstrual materials, as also reflected in their preferences at follow-up. Previous research into consumer behavior throws light the possible underpinning determinants of this results. For instance, Wood and Lynch 2002 find that consumers who are satisfied with the product they use are unwilling to invest time in learning about new products and Robert (1981); Moreau, Markman and Lehmann (2001); and Grant and Tybout (2008) find that uncertainty associated with new products might contribute to consumer reluctance.

Overall, there is a need that the menstrual hygiene policy in India and other LMICs moves beyond promoting and subsidizing disposable pads and recognizes the need for informed choice. Informed choice should not only include awareness on the range of menstrual materials available but also on educating girls and women on their hygienic use and appropriate disposal. For instance, one of the issues with cloth usage has been lack of direct sun light drying, which is likely to render it unhygienic. Much of the perceived inferiority of cloth is likely to be related to its improper usage (Torondel et al., (2018) Das et al 2015; Baker et al 2017). State funding campaigns for the popularization of disposable pads have inadvertently fueled this perception.

6.1. Limitations

This study has two main limitations: first, the follow-up sample sizes are small, especially for the Inform-only condition and second, the challenges of conducting menstrual product interventions in India have meant compromising on the variety of period products that could be used in the field experiment.

6.1.1. Sample size

The final sample analyzed in the three study conditions were: Disposable ($n = 127$); Reusable ($n = 125$) and Inform-only ($n = 25$). Post-hoc sample size calculations suggest that for an increase of 53% in preference for sustainable menstrual materials after exposure to reusable alternatives, i.e., from 51% in the Disposable condition to 78% in the Reusable condition, the sample provides 99.6% power with 0.05 alpha. Similarly, we can draw comparisons between Disposable and Inform-only groups with 100% power and 0.05 alpha. However, when comparing Reusable and Inform-only conditions, the actual power is just 58.5%, mainly because these two groups have similar post-intervention results (and distinct to the Disposable group). Note that while the results are important, small sample sizes means caution in interpretation is necessary. A full-scale population-level trial is necessary to comprehensively examine the finding that offering women full information on all period products positively influences their preferences for sustainable period products and practices.

6.1.2. Challenges of conducting menstrual product interventions in India

The study was originally planned to introduce menstrual cups as one of the period products in the field. However, menstrual cups were met with considerable opposition from local IRB and from partner organizations and community-leaders due to the requirement for vaginal insertion. After considerable deliberation, the study design was altered to include only non-insertion

menstrual products. This greatly delayed the study which had cascading implications on time and finances. Study was also delayed at baseline due to the time spent in obtaining consent from participants because of the research topic was considered taboo. These delays also hindered the ability to make multiple visits to recruit all the women enrolled. This experience suggests that, without mass awareness campaigns, current cultural beliefs are likely to impede the adoption of menstrual products that require insertion in India.

7. Concluding Comments

The last 15 years have been an exciting time for innovations in period products, where new and sustainable innovations have continued to emerge. Some of these products have the potential to end period poverty more sustainably and equitably than disposables. Information about these products, however, has not cascaded down to consumers and policy makers as rapidly, especially in LMICs where openly talking about menstruation remains a taboo and the only information on period products comes from private advertising that is dominated by the manufacturers of disposable pads. In this backdrop, policy makers also continued to back public interventions that promoted disposable pads. If women have information about and access to just disposable pads, then the demand for this alone will continue to increase – but this is not informed choice. Lack of correct and complete information on alternative period products has led to market failure where the market has failed to respond to the latent needs of consumers for low cost and environmentally sustainable products. The preference for disposable pads then emerges as a ‘perverse selection’ where consumers are forced into selecting disposable pads with frequently aberrant consequences for family budgets and for their environmental eco-systems.

Despite the general caution attached to studies with small sample sizes, our results suggest that as a policy tool, informed choice has the potential to reverse this ‘perverse selection’ and steer the period product market in a sustainable direction, both for consumer costs and their environments. If given comprehensive information on all available menstrual products, women are likely to make a choice that considers not only costs to themselves and their health but also costs to the environment. Increase in demand for a range of products, including reusable alternatives, is likely to incentivise the markets into improving availability and access to these. Wider product choice is likely to support menstrual hygiene management even amongst low-income households, while giving consumers the agency to effectually manage their menstrual needs. Breaking down the cultural taboos and silence around menstruation is a likely prerequisite to ensure that full and correct information on menstrual alternatives can reach women so that a variety of stakeholders can participate to bring down the veil of misinformation – including women’s close social contacts (mothers, family members and community influencers), health care providers (frontline workers, community frontline workers and health care professionals) and government programmes (use of promotional advertising and tangible interventions like product distribution). Given serious market failure and the economic imbalances between producers of various period products, is likely that we will require policy-driven messaging, at the minimum to support awareness of alternative choices, but where possible to also include proactive subsidy and promotion of sustainable alternatives. This can also enable LMICs overcome period poverty in a way that is sustainable and equitable such that the ultimate goal of ‘period equity’ can be realized – where every woman, irrespective of her socio-economic background has the agency to hygienically and sustainably manage her periods.

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Appendices

Appendix A: Detailing Estimates, Methods and Measurement

Text Box A1

Facilitating NGOs

- **Safa** is a grassroots social venture. It mainly works with women from ethnic minorities, living in slums in Hyderabad, Telangana. It focuses on education and income generation activities as the ultimate drivers of socioeconomic empowerment. Safa provides its women members with livelihood trainings such as tailoring and embroidery, as well as entrepreneurship opportunities through the sales of its members' handmade products including bags, soft toys, carpets and others. Safa supported the ethics, pilot and planning phases and facilitated the study in six slums. Website: <http://www.safaindia.org/> (accessed on 3.04.2021).

- **KGNMT (Kasturba Gandhi National Memorial Trust)** is a national NGO with 23 branches all over the country. While the Trust mission is to improve the lives of the country's most needy women and children, each branch has some autonomy in deciding their specific remit. Its branch in Hyderabad provides residential and livelihood support to women who have been victims of crimes like trafficking and domestic violence and supports socioeconomic empowerment of women in local slums. KGNMT supported the pilot and planning phases and facilitated the study in four slums. Website: <http://kgnmthyd.org/> (accessed on 3.04.2021).

Text Box A2

Selection process for the sustainable alternatives to disposable pads used in the study interventions

Selection Process: We began by developing a list of menstrual products. Two points were considered: First, in response to the concerns raised by Ethics committee which were also voiced by the NGO partners regarding insertion products, we excluded all products requiring vaginal insertion. Second, given that the remit of the project was the study of sustainable menstrual hygiene management, we decided to include only products available in India and to include only those disposable pads that claimed biodegradability. From the list prepared, we managed to procure 15 products. On voluntary basis, ten women residing within KGNMT, who were not part of the final study, were recruited to trial the products. Each of them was given three products to sample. After the completion of at least one menstrual cycle, they were asked to rank each product on three measures:

1. "How comfortable is it to wear?"
2. "How convenient is it to change?"
3. "How well it washes? OR How easy is it to follow the manufacturer recommended decomposing procedure?"

To better understand the ranking, we also carried out informal discussions with the women. The results of this exercise were presented at a project meeting on 11th April, 2017 in Hyderabad, with representatives from partner NGO, where the final selection was made.

The following products were selected for distribution in the two product conditions:

1. Anandi pad, manufactured by Akkar Innovations was selected for the Disposable condition. Anandi pad is averred to be India's first disposable 100% biodegradable pads that disintegrates into natural elements in a compost environment in 90 to 180 days depending on environmental considerations. Website: <https://aakarinnovations.com/anandi/> (accessed on 16.09.2019).

2. Safepad, a reusable cloth pad manufactured by RealRelief was selected for the Reusable condition. Safepad is understood to be designed with a permanently bonded antimicrobial technology that helps reduce vaginal infections caused by *Candida albicans* and other pathogens. Website: <http://www.realreliefway.com/en-us/life-saving-products/health/safepad™/safepad™> (accessed on 16.09.2019).

Text Box A3.1

Measurement details for outcome variables

Primary Outcome: Preference for menstrual materials

1. Preference for sustainable menstrual absorbents: We developed this outcome using women's response to the following question: "Can you please tell us what menstrual material you prefer most? In answering this question, please think only of your preference and not of other factors like price and availability. You can choose a single menstrual material or if you like, you can choose a combination of materials you prefer". Women who chose a reusable or compostable material (like, homemade cloth-pad; commercial cloth-pad; menstrual cup; compostable pad) received two points, those who chose sustainable products in combination with disposables (like, pad; tampons) received one point and those who chose only disposable pads were given no points. The preference for sustainable score ranged from 0-2, with higher score indicating greater preference for sustainable materials.

Secondary Outcomes: Attitude to change, awareness and beliefs

1. Willing to adapt menstrual practices: This measures women's willingness to adopt sustainable practices in two areas: use and waste management. Responses were noted on three questions:

- "Would you be willing to try a new sustainable menstrual product?"
- "Would you be willing to pay for the safe waste disposal of your menstrual absorbent?"
- "Would you be willing to dig a pit for burial of compostable menstrual product?"

A woman received one point if she answered "yes" to the use question and one point for answering "yes" to either of the disposal questions. Thus, the willingness to adapt score ranges from 0-2, with higher score indicating greater willingness to adapt practices.

2. Aware of alternatives to cloth and pad: This measures women's awareness of the range of menstrual materials beyond traditional cloth and disposable pad. Women were asked to name or describe all the menstrual material they were aware of. For each menstrual material they named or described other than traditional cloth or disposable pad they were given one point. The knowledge of menstrual products scores ranges from 0 to 4, with higher scores indicating greater knowledge of menstrual materials beyond cloth and pad.

3. Beliefs about periods & products: Beliefs about menstruation and menstrual products is measured using the responses women gave to three questions:

- "Should girls and women continue with their normal activities during their menses?"
- "Does menstrual cloth need direct sunlight drying after wash?"
- "If correctly used, can cloth provide equally good menstrual protection as a disposable pad?"

A woman received one point for each question she answered "yes". Thus, the possible range of scores are 0-3, with higher score indicating more accurate beliefs about menstrual materials.

Text Box A3.2

Measurement details for covariates

Covariates:

1. Age: Age is measured in the number of years completed

2. Education level: Women were asked about their level of education and this was later divided into five categories: no education; secondary school; did not finish high school; high school; college; graduate. Therefore, education scores range from 0 to 5, with greater score indicating greater education levels.

3. Employed: This variable indicates woman's employment status. This covariate is dichotomous, with 1 indicating that she is employed and 0 indicating that she isn't.

4. Head of household: Women were asked about who headed their household. This variable is scored based on the assumption that woman's ability to bargain for a specific outcome is likely to be influenced by who heads the households in the following ascending order: in-laws other than husband; husband; parents and self. Thus head of household scores range from 0 to 3, with greater scores indicating greater bargaining power.

5. Backward caste: This variable indicates social status of woman's household. This is a dichotomous covariate, with 1 indicating that the household belongs to a backward caste and 0 indicating that it does not.

6. Private toilet: This variable indicates whether the woman has access to a private toilet. A dichotomous covariate, with 1 indicating that she has access to a private toilet and 0 indicating that she does not.

7. Pad users: Women were asked what menstrual material they used. This covariate is dichotomous, with 1 indicating that she used pad and 0 indicating she used cloth. Note that 38 women (13.72%) reported using a combination of pad and cloth. Pad was used during heavy days and cloth during lighter days, indicating that pad was their main menstrual material. Therefore they were considered as pad users. This group is also similar to pad users on all covariates except age (combination users are significantly older than only pad users), but are different to cloth users on a number of covariates. Results available on request.

Appendix B: Supplementary Results Tables

Table B1.

Difference in Difference Ordinary Least Squares Regression Results Including Covariates (Reusable and Inform-only vs. Disposable)

	Primary outcome		Secondary outcomes		
	Preference for sustainable materials	for	Willingness to adapt menstrual practices	Awareness of alternatives to cloth and pad	Beliefs about menstrual materials
Reusable	0.031 (0.090)		0.025 (0.072)	0.024 (0.058)	-0.049 (0.076)
Inform-only	-0.032 (0.156)		0.253* (0.125)	0.029 (0.101)	-0.096 (0.131)
Time	0.094 (0.089)		0.323*** (0.071)	1.142*** (0.057)	0.724*** (0.075)
Reusable × Time	0.226* (0.110)		0.170* (0.079)	0.050 (0.081)	0.196* (0.096)
Inform-only × Time	0.546** (0.210)		0.117 (0.176)	0.058 (0.141)	0.236 (0.185)
Age (years)	0.004 (0.004)		0.008** (0.003)	0.005* (0.003)	0.014*** (0.004)
Education level	0.030 (0.029)		0.005 (0.023)	-0.029 (0.018)	0.019 (0.024)
Employed	-0.110 (0.079)		-0.104 (0.063)	-0.012 (0.051)	-0.139* (0.067)
Head of household	-0.019 (0.046)		-0.049 (0.037)	0.058* (0.028)	0.006 (0.039)
Backward caste	-0.015 (0.057)		-0.047 (0.046)	0.049 (0.037)	0.134** (0.048)
Private toilet	-0.050 (0.065)		0.023 (0.053)	0.012 (0.042)	0.136* (0.055)
Pad users	-0.888*** (0.082)		0.282*** (0.066)	0.176*** (0.053)	-0.470*** (0.069)
Constant	1.016*** (0.171)		0.133 (0.137)	-0.216* (0.110)	1.245*** (0.144)
Observations	554		554	554	554
R ²	0.243		0.194	0.632	0.398

Note. Standard errors in parentheses.

Abbreviations. ANOVA = Analysis of variance. PI = Pad and Information. CI = Cloth and Information. OI = Only Information.

*** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$

Table B2.

Difference in Difference Ordinary Least Squares Regression Results Including Covariates (Reusable + Inform-only vs. Disposable)

	Primary outcome	Secondary outcomes		
	Preference for sustainable materials	Willingness to adapt menstrual practices	Awareness of alternatives to cloth and pad	Beliefs about menstrual materials
Reusable + Inform-only	0.020 (0.086)	0.063 (0.069)	0.025 (0.055)	-0.057 (0.072)
Time	0.094 (0.089)	0.323*** (0.071)	1.142*** (0.057)	0.724*** (0.075)
Reusable + Inform-only × Time	0.279** (0.121)	0.157* (0.072)	0.052 (0.078)	0.202* (0.100)
Age (years)	0.004 (0.004)	0.008* (0.003)	0.004 (0.003)	0.014*** (0.004)
Education level	0.029 (0.029)	0.003 (0.023)	-0.029 (0.018)	0.020 (0.024)
Employed	-0.107 (0.079)	-0.097 (0.064)	-0.012 (0.051)	-0.140* (0.067)
Head of household	-0.021 (0.046)	-0.053 (0.037)	0.057* (0.028)	0.007 (0.039)
Backward caste	0.020 (0.057)	-0.038 (0.046)	0.049 (0.037)	0.133** (0.048)
Private toilet	-0.052 (0.065)	0.017 (0.053)	0.012 (0.042)	0.137** (0.055)
Pad users ⁺	-0.883*** (0.082)	0.293*** (0.066)	0.176*** (0.053)	-0.471*** (0.053)
Constant	1.022*** (0.171)	0.145 (0.137)	-0.216* (0.110)	1.243*** (0.144)
Observations	554	554	554	554
R ²	0.239	0.186	0.623	0.398

Note. Standard errors in parentheses.

Abbreviations. ANOVA = Analysis of variance. PI = Pad and Information. CI = Cloth and Information. OI = Only Information.

*** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$