The Impact of Menstruation Hygiene Management on Work Absenteeism of Women in Burkina Faso *

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Abstract. Women in developing countries face challenges in terms of managing their menstrual hygiene. They often do not possess the appropriate means, materials, or have access to suitable facilities. Using a newly released dataset for Burkina Faso and propensity score matching, we provide for the first time evidence of the impact of advanced menstrual hygiene management on work attendance. We show that the use of disposable sanitary pads rather than old cloth reduces work absenteeism of women by approximately 24 percentage points. We report the robustness of the results with respect to alternative specifications of the propensity score model and investigate the results for samples stratified by education, wealth, marital status, and religion.

Keywords: Menstrual Hygiene Management, Work Attendance, Period Poverty, Gender Inequality.

JEL: D10, I12, I14, J16, O12.

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1. Introduction

Menstruation affects women's participation in daily life around the world. During their lifetime, women experience about 480 menstrual cycles, albeit with substantial variation at the individual level (NHS, 2018). Menstrual period length also varies but most periods last from 3 to 5 days (Women's Health, 2018). Aggregating averages, women bleed for approximately 2000 days, i.e. 5 years of their lives. Most of the menstrual periods are experienced in working age, and we expect that the influence of menstruation on work participation depends on the quality of the method of menstrual hygiene management (MHM).

Whereas menstruation's adequate management is typically taken for granted in developed countries, it constitutes a serious problem for many women in developing countries. Inadequate MHM is a significant public health concern and substantially impacts women's economic and social well-being (see Sumpter and Torondel, 2013, for a systematic review). In this study, we investigate one potential problem of inadequate MHM, namely its impact on work absenteeism.

Menstrual management methods include the medical suppression of menstruation, eating a balanced diet, and separating menstruating women from particular places or activities. Here, we focus on the most salient menstrual practice, the management of menstrual flow to prevent blood from soiling the clothes and, in particular, on the material used to absorb menstrual blood. In contrast to some related studies, we consider all methods to absorb or catch menstrual blood, be they good or poor (or adequate or inadequate) as menstrual hygiene management methods. The WHO and UNICEF define *adequate* menstrual hygiene management as "women and adolescent girls using a clean menstrual management material to absorb or collect blood that can be changed in privacy as often as necessary for the duration of the menstruation period, using soap and water for washing the body as required, and having access to facilities to dispose of used menstrual management materials." (WHO, 2012).

Women use a variety of materials to absorb or catch menstrual blood. Most women who can afford it use commercially manufactured products, such as disposable sanitary pads. In developing countries, however, many women use traditional methods and homemade products, including new or old cloth, cotton wool, toilet paper, underwear alone, sponges, mattresses, leaves, ash, or nothing (Sumpter and Torondel, 2013; Loughnan et al., 2016; van Eijk et al., 2016). For linguistic ease, we define advanced MHM material as commercially manufactured products that are produced in order to improve hygiene and reduce inconvenience and leaking

(as compared to traditional materials) and that eliminate the need to wash the material. Most women in our sample from Burkina Faso used either "disposable sanitary pads" or "old cloth" to absorb menstrual blood. Although both materials require a safe place to be changed, the reuse of old cloth poses further challenges of cleaning or storing the material. These tasks could be difficult or impossible to perform in subsistence agriculture or informal employment, work environments such as street vendors, without access to a private place to change and clean MHM materials during the workday. Because menstruation remains taboo and women are stigmatized by socio-cultural beliefs that regard menstruation as an impureness (Guterman et al., 2007), women might not be able to clean their MHM materials, particularly in work settings that are open to the public (UNICEF, 2013). Anticipating these difficulties, women may prefer to stay at home during their period.

The most obvious advantage of disposable sanitary pads is hygiene. If reused cloth is not washed and dried correctly or washed with unclean water, it can cause vaginal infections and harmful diseases (Das et al., 2015; Torondel et al., 2018), which may prevent participation in the workforce due to bad health. Another important advantage of sanitary pads, particularly in environments where menstruating women are socially stigmatized, is that their use is less visible, and they are less subject to leakage. Menstruating women are, therefore, less likely identified and subject to humiliation or exclusion from work. We expect the strength of this effect to vary with the women's religion and their religious environment. For example, the Islamic faith regards menstruating women as impure, and men are recommended to avoid women during menstruation (Whelan, 1975; Guterman et al., 2007). Finally, sanitary pads are more convenient to wear and may better allow to perform motion-intensive and physically demanding work. In a sample of Ghanaian adolescent girls exposed to sanitary pads and cloth or toilet rolls as MHM materials, 98% stated that they were less fearful of soiling when using pads, and 95% were less concerned about giving off a scent; 82% commented that pads were more comfortable, and 60% stated as an advantage that pads do not have to be washed (Scott et al., 2009).

Although menstruation affects all women from menarche to menopause, studies on MHM practices and their impact on participation in daily life in developing countries focus on adolescent girls and how MHM affects school attendance. Studies of MHM on work attendance are a neglected issue (Sommer et al., 2016). With respect to school attendance, several studies for African and South Asian countries found that girls miss school during their menstruation and

that menstrual education and/or the provision of advanced MHM material reduced absence. However, most studies did not control for confounders properly, suffered from measurement error, and failed to establish a causal link (see Hennegan et al., 2019, Sumpter and Torondel, 2013, and Kuhlmann et al., 2017 for surveys and explanations regarding these issues). Of the rare studies using a quasi-randomized experimental design, Montgomery et al. (2012, 2016) and Hennegan et al. (2016) reported a significant impact of sanitary pad provision on school attendance in Ghana and Uganda, respectively. In a school-based randomized control trial, Oster and Thornton (2011) find no significant impact of menstrual cup provision in Nepal, potentially because, they argue, for the girls of their sample, menstruation had little impact on school attendance. This observation contrasts with the African studies, which found that girls miss school for several days per month due to menstruation and its inadequate management. In randomized trials conducted in Kenya, Phillips-Howard et al. (2016) found no effect of provision of menstrual cups and sanitary pads on school dropout risk and Benshaul-Tolonenen et al. (2019) found a positive yet non-robust effect of provision of sanitary pads on school absenteeism.

A few studies discuss potential explanations for these ambiguous results. One is that girls were reported to help each other at school, when having their menstruation (UNICEF, 2013), or they were placed under pressure to share MHM material (Scott et al., 2009), hence it is difficult to evaluate a policy intervention's impact without any bias when treatment and control group participants are mixed. Moreover, a women's menstrual cycle is a very sensitive subject and it can lengthen in duration due to starvation or heavy and stressful work. Furthermore, the cycle becomes shorter and more regular with age, whereas cycles tend to be longer and irregular for the first few years after menarche (UNICEF, 2013; Women's Health, 2012). Young school girls may, therefore, not miss many schooldays due to their very long or irregular cycles, and results from experimental studies could be blurred by natural circumstances.

This paper shifts the focus from school to the workplace. There are several reasons why MHM should more strongly impact attendance at work than at school. The workday is typically (substantially) longer than the school day, increasing the probability that MHM material needs to be changed or cleaned. Women working on the fields or street are less likely to find a toilet and access to clean water than school children. Working hard may stress the MHM material more strongly than sitting still in a chair. Finally, working women are likely to be more exposed to other people and, in particular, to men, who may avoid contact and/or humiliate women when

they discover their menstruation. Whereas schoolgirls may also be exposed to period teasing by teenage boys, the problem could be, in principle, more easily eliminated or reduced by having separate classes for boys and girls.

Relatively few studies regarding the effect of menstruation on work attendance in developed countries exist. Ichino and Moretti (2009) observed a 28-day cycle in absence from work for Italian female bank employees below age 45 and argued that this biologically based difference in absence explains a significant part of the gender differential in earnings. Herrmann and Rockoff (2012) argued that the result is not robust and does not apply to female teachers in New York. They also noted differences in 28–days cycles of work absence for men of different ages, casting doubt on the identification of menstruation-caused absence solely from the timing of days missed at work. Herrmann and Rockoff (2013) showed for a representative sample of American women that menstrual problems significantly impact health-related absence from work. These studies did not address how inadequate MHM practices affect work attendance. Intuitively, one could believe that MHM problems are confined to developing countries. However, a public debate exists, arguing that poverty-induced inadequate MHM is also an issue in developed countries (e.g., Abbott, 2018).

In this study, we investigate the impact of MHM practices on work attendance for a nationally representative sample of women aged 15–49 from Burkina Faso. The data were collected from household and female datasets of the Performance Monitoring and Accountability 2020 (PMA2020) project of the Bill and Melinda Gates Institute for Population and Reproductive Health. PMA2020 uses innovative smartphone technology to gather data on family planning and water, sanitation, hygiene, and other health areas in 11 developing countries in Africa and Asia (PMA2020, 2018). The distinctive feature of the dataset for Burkina Faso is that it provides (to the best of our knowledge, for the first time) individual data on absence from work due to menstrual problems and rich information on MHM practices. One major issue of identification – the attribution of days missed at work to menstruation problems and MHM practices – is, thus, solved by data design.

A remaining challenge of identification is that the adoption of good MHM practices is not exogenous. For example, we expected that richer and better–educated women would be more likely to be endowed with the knowledge and financial means to access modern MHM methods. To resolve the endogeneity issue, we used a propensity score matching method to obtain the

causal effect of the used MHM method on work attendance. Propensity score matching has been widely used in different research studies (e.g., Guo et al., 2018, Arndt et al., 2016), and its benefits lie in assessing causal effects in observational studies while yielding the largest reduction in selection and residual bias (e.g., Stuart, 2010; Williamson et al., 2012).[1]

To the best of our knowledge, this is the first study to estimate the causal impact of MHM on women's work absenteeism. Complementing evidence is provided by Czura et al. (2019). The study reported results from a randomized control trial on a sample of female garment workers in Bangladesh. With respect to absenteeism, it was found that women who were offered free sanitary pads had 15 percent fewer absent work days, and women exposed to information sessions had 25 percent fewer absent work days whereas there was no effect on absenteeism for women exposed to both treatments. A repetition of the trial is planned to better understand the mechanism behind these results. One advantage of our non-experimental study is that we used large-scale survey data (compared to low-scale school or firm interventions) with rich information on MHM practices; these data were checked for quality and are nationally representative.

The remainder of the paper is organized as follows. The following section describes the applied methodology and used data set. Section 3 presents and discusses the results from the empirical analysis. The paper ends with a conclusion.

2. Methodology and Data

2.1. **Methodology.** We were interested in estimating the causal impact of advanced menstrual hygiene management on women's work absenteeism. To resolve the endogeneity problem and elicit the causal effect of MHM method on absence from work, we used a matching strategy with the propensity score method. With this method, matched treated and control groups are generated that have similar characteristics. Confounding factors that might impact how individuals are assigned to the treatment versus control group and that would bias the estimate of the treatment effect can, therefore, be taken into account. Matching is done by a propensity score, which is the estimated probability of receiving the treatment given the other characteristics that are observed. The difference in the average outcome between treated and untreated can be

[1]Guo et al. (2018) refer to the problem of small sample intervention study designs, which complicate the interpretation of effects, given that in these study designs only a few potential confounders could be collected for the data, which makes laboratory designs different from observational studies.

interpreted as the causal impact of the treatment variable conditional on selection into treatment due to the observable covariates (Rosenbaum and Rubin, 1983 a).

More formally, the propensity score $p(X)$ is defined as the conditional probability of receiving the treatment given the observed characteristics (Rosenbaum and Rubin, 1983 a; Caliendo and Kopeinig, 2008): $p(X) = P(T = 1|X) = E(T|X)$ with X being a vector of the observed covariates and T being the treatment variable (1 or 0). The average effect of treatment on the treated (ATT) is estimated as follows:

$$\begin{aligned} ATT &= E(Y_{1i} - Y_{0i}|T_i = 1) = E[E(Y_{1i} - Y_{0i}|T_i = 1, p(X_i))] \\ &= E[E(Y_{1i}|T_i = 1, p(X_i)) - E(Y_{0i}|T_i = 0, p(X_i))|T_i = 1] \end{aligned} \tag{1}$$

where Y_{1i} and Y_{0i} are the potential outcomes in the treated and control condition. The estimator provides the average impact of the treatment under the assumption of conditional independence and overlap between both groups (Rosenbaum and Rubin, 1983 a).[2]

We use nearest-neighbor matching with replacement, which is the most commonly employed matching method. With this method, the match from the comparison group (j) for a treated individual is chosen so that it has the closest propensity score. An individual observation is left unmatched if it fails to have a propensity score that is within the so called caliper range (δ) from the non-treated individual's one. Formally, let T and C denote the set of treated and control individuals, N the number of treated individuals and Y_i^T and Y_j^C the outcomes of treated and control individuals. Then, $ATT = 1/N \sum_{i \in \delta(i)} (Y_i^T - Y_j^C)$ with $\delta(i) > |p(X_i) - p(X_j)| = \min(|p(X_i) - p(X_j)|)$.

2.2. **Data.** We used data from the Performance Monitoring and Accountability 2020 initiative (PMA2020). The PMA2020 is the first large–scale provision of data on MHM through surveys.[3] The dataset contains representative data for 15–49-year-old women, including several items on MHM. With the release from August 2018, there are now data available for one country, Burkina Faso, that contain information on work absenteeism due to menstruation. The feature that women explicitly declare that work absenteeism was caused by menstrual problems solves

[2]The conditional independence assumption means that the outcomes Y_0 and Y_1 are independent of treatment status, given a set X of observable covariates, formally $(Y_1, Y_0) \perp T|X$. After controlling for X, the assignment of units into treatment is said to follow a random pattern. The overlap condition means that for each value of X, there is a positive probability of being treated or untreated, $0 < P(T = 1|X) < 1$.

[3]Hennegan et al. (2018) provide a study of females menstrual hygiene perception and available sanitation in the household, using PMA2020 data for Nigeria.

an identification problem of related studies in developed countries, which attempted to infer the cause of work absenteeism from the timing of work absence (Ichino and Moretti, 2009; Herrmann and Rockoff, 2012).

The data of Survey Round 5 were collected between November 2017 and January 2018. A two-stage cluster design with urban-rural strata was applied. The Institut National de la Statistique et de la Demographie of Burkina Faso drew a sample of 83 enumeration areas, and from each area, 35 households were randomly selected. Women between 15–49 years were contacted for interviews from these households. The final sample included 2811 households and 3556 females.

We used the subsample of women who stated that they worked outside their home during the last month. Unfortunately, the data set contained no information on women's occupation or the sector to which they supplied their labor. According to the World Development Indicators (WDI) and estimates by the International Labor Organization, in the year 2018, 52.9% of Burkina Faso's women aged 15–65 participated in the labor force. However, according to a national survey from 2018, female labor force participation was 36.2 percent in 2018 (both numbers from World Bank, 2021). Of the women participating in the workforce, 47% worked in services, 33% in industry, and 20% in agriculture (World Bank, 2021). Our treatment group consisted of working women who stated that they had used an advanced MHM method, namely the one-time use of pads. Working women who made use of a traditional MHM method, namely using old cloth only, were defined as the control group. The information was taken from the answer to the question: *"During your last menstrual period, what did you use to collect or absorb your menstrual blood?"* As shown in Appendix Table A.1, these two methods were by far the most prevalent MHM practices in Burkina Faso. The group using only disposable pads contained 1137 women and the group only using old cloth contained 850 women, which together accounted for 80% of the women who provided answers on MHM materials used. The dependent variable 'work absenteeism' was measured by the answer to the question: *"Due to your last menstrual period, were there any work days in the last month that you did not attend?"*. Only the observations for those women who worked outside of home (having a value = 1 for work participation, aside from work at home) entered the regression. The variable 'work missed' is therefore a dummy variable (0, 1) for the outside of home working population of women. This information was available for 818 women who used either sanitary pads or old cloth.[4]

[4]The survey does not address the question of why menstruation resulted in lost work. Aside from reasons directly related to MHM material, such as leakage or inconvenience, work could also be missed due to pain from cramps

We acknowledge that the women's answers may have been incorrect due to recall bias, incomplete reporting, and lying, a feature that our study shares with any interview. In particular, answers on MHM and missing work days may not have been be truthfully reported due to stigma. In a related study, Czura et al. (2019) argued that interviews conducted at firms (as in their study) may represent a lower bound on the true extent of menstrual health related absenteeism. Our interviews were conducted at the women's homes. We have obtained information regarding whether men were listening to the interview, which was the case in less than 0.3 percent of the interviews. The interviews were conducted by female data collectors, referred to as resident enumerators (REs). REs are typically women over the age of 21 who are from or near the respective enumeration areas and hold at least a high school diploma. These features likely reduced the incentive of misreporting. In any case, both misreported MHM use and not truthfully revealed missing workdays would lead to downward bias of the treatment effect. In this sense, the reported coefficient may be interpreted as a lower bound of the "true" effect.[5]

Women using an advanced MHM (Disposable Pad) were matched to women using a traditional MHM (Old Cloth) using the propensity score that was generated from the following observed characteristics: the women's schooling degree (primary education or secondary education), age, age squared, whether they were married, wealth status of the household, whether the household had access to electricity, and a range of dummy variables for administrative regions.[6] Our selection of variables was guided by the objective to minimize the bias between the treated and control group and maximize the overlap of propensity scores across treated and untreated. This approach led to the omission of some variables in the propensity score. In robustness checks we investigated how their addition affected the results.

The most interesting aspects from the summary statistics are shown in Table 1. Of the women using Disposable Pads, approximately 46% worked compared to 34% of the women using Old

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or infections, which in turn could be indirectly related to MHM material. In principle, women could also affect work absenteeism by strategic intake of oral contraceptives (Lakehomer et al., 2013). If this were the case, a downward bias of the estimated treatment effect would result. A study by Ranehill et al. (2017) provided evidence that contraceptives do not affect economic preferences such as risk taking, willingness to compete and altruism, suggesting that preferences are an unlikely channel through which MHM affects work absenteeism.

[5]In order to check for recall bias we stratified the sample by the reported timing of the last period (less than or equal to two/three/four weeks ago) and found no systematic differences in the reported work missed. This indicates that recall bias may be negligible.

[6]In the PMA2020, wealth is a generated variable by the data providers. It reflects households' assets (livestock as well as electrical equipment, internet, and car or motorcycle, etc.), building materials (condition and material of floor, roof and walls), water sources, and sanitation facilities. We considered the low and middle tercile of wealth in the propensity score model.

Table 1: Descriptive Statistics on MHM use, Female and Household Characteristics

	Disposable Pad	Old Cloth	t-test
No school degree	21.3	76.1	28.9
Primary school	21.7	15.2	-3.7
Secondary school	49.2	8.6	-21.3
Tertiary school	7.7	0.1	-8.3
Low wealth	5.5	40.1	20.9
Middle wealth	9.9	36.9	15.3
High wealth	84.5	22.9	-34.9
Urban	81.9	23.5	-32.1
Work participation	46.5	34.1	-5.6
Missed work	14.9	19.7	1.8

Notes: The table shows the percentage shares of women who either use disposable sanitary pads or old cloth as MHM material with respect to their schooling degree and other characteristics and whether they missed work due to menstruation in the last month. The t-test provides the test on equality of means. The statistics are based on 1987 observations for work participation, wealth and urban, 1985 observations for schooling, and 818 observations for work absenteeism.

Cloth. These numbers from PMA2020 are based on the question of whether the women worked outside home during the last month. They are not directly comparable with those on female labor force participation according to WDI, particularly, if there is substantial temporary and seasonal work outside home. Women using Disposable Pads were on average better educated and members of richer households; about 22% had a primary school degree and 57% had a secondary or higher education. Among the women who used only Old Cloth for their MHM, 76% had no school degree attained at all, about 15% had primary education, and about 9% had a secondary school degree or higher. Of the Disposable Pad users, 83% were urban versus 23% for Old Cloth users. Wealth was similarly unequally distributed. Of the Disposable Pad users, 15% were from the low or middle wealth tertile versus 77% of the Old Cloth users. Similar differences were observed when we conditioned the sample on working women (women who stated that they worked outside home in the previous month); see Table A.4 in the Appendix. The substantial differences in the characteristics of users of modern versus traditional MHM methods and their potential influence on participation in the workforce call for a rebalancing strategy in order to make causal inferences.

Table A.2 in the Appendix shows the full summary statistics. We confine our analysis of MHM effects on absenteeism to the 818 women who worked outside the home (and used either sanitary pads or old cloth). Note that this restriction is not only intuitively reasonable, but also eliminates the concern that estimates could be biased by backward causation from MHM to work participation. Approximately 18 percent of the women had no school degree, 20 percent only a primary degree and about 50 percent a secondary degree. Women were on average 28

years old and 62 percent of them were married. About 60 percent of the women were Muslim and almost 30 percent Christian. About 40 percent of the women lived in cities. Table A.2 shows that the treatment and control group were rather heterogeneous in almost all aspects. In particular, a higher share of users of disposable pads was younger, better educated, and a member of richer households with access to electricity and piped water.[7]

3. Results

In a first step, we estimated the propensity score for the sample using a Probit model. The propensity score is the probability of receiving the treatment (Disposable Pads) conditional on the specified observable characteristics. The dependent variable is our treatment variable, which is a dummy of MHM use, with use of Disposable Pads (1) and use of Old Cloth (0). The results from this regression are shown in Table 2. To alleviate the interpretation of coefficients, we also provide the results from estimates of average marginal effects with the same regressors. Married women and women from the low and middle wealth tertile were less likely to use Disposable Pads whereas women who had received primary and secondary education were more likely to use Disposable Pads. Age exerted a weakly non-linear influence on MHM use.[8]

As benchmark method we used matching with the nearest neighbor with replacement. Because the common support of treatment and control group covers the entire range of observations, we had no unmatched individuals. To assess the matching quality, we present results from balancing tests in Table 3. The bias in observables between treated and untreated women was reduced to a large degree. The t-values show that, particularly for our main variables of interest, (schooling and wealth), the similarity in observables (equality in means) of treated and control can not be rejected after matching.[9] Further test results of the quality of matching are reported in Table 5. The pseudo-R^2 was substantially reduced in the matched sample (from 0.387 to 0.034), indicating that the observable characteristics were no longer predictive for determining the treatment group. Table 5 further shows that the mean median bias for the overall matching process was significantly reduced, and Rubin's R was within the range of good matching quality.[10]

[7]Results from using composite survey weights as given within the PMA2020 dataset are reported in Table A.3. We refer to these results later, in the final paragraph of the Results Section.

[8]We lost one observation due to matching because some of the matched covariates were unavailable for one woman of the sample.

[9]Further tests across blocks of the propensity score revealed that the balancing property is satisfied for all control variables.

[10]Rubin's R gives the ratio between the treated and matched non-treated variance of the propensity score. R should lie between 0.5 and 2 for the samples to be considered sufficiently balanced.

Table 2: Determinants of MHM Materials Usage (Disposable Pads vs. Old Cloth)

	Probit Model	Average Marginal Effects
Female characteristics		
Primary schooling	0.5263***	0.1166***
	(0.122)	(0.0273)
Secondary schooling	1.2907***	0.2859***
	(0.1372)	(0.0385)
Age	0.1201***	0.0266***
	(0.0469)	(0.0103)
Age squared	-0.002***	-0.0004***
	(0.0007)	(0.0002)
Married	-0.2735*	-0.0606
	(0.1560)	(0.0378)
Household characteristics		
Wealth low	-1.7286***	-0.3828***
	(0.3440)	(0.0578)
Wealth middle	-1.4393***	-0.3188***
	(0.2083)	(0.0308)
Electricity	-0.1161	-0.0257
	(0.1052)	(0.0237)
Region Centre-Nord	-0.8865***	-0.1963***
	(0.1647)	(0.0365)
Region Centre-Sud	1.2175***	0.2696***
	(0.1722)	(0.0379)
Region Plateau-Central	-0.4543***	-0.1006***
	(0.1170)	(0.0249)
Region Nord	-0.2647*	-0.0586*
	(0.1506)	(0.0334)
Region Sahel	-0.3386*	-0.075
	(0.2042)	(0.047)
Obs.	817	
Log likelihood	-325.29	
Pseudo R^2	0.3872	

Notes: The table shows the results from a Probit model for estimating the impact of covariates on MHM usage (Disposable Sanitary Pad versus Old Cloth). The third column displays the average marginal effects from a Probit model with the same regressors. Standard errors are clustered at regional level. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, * denotes significance at the 10 percent level.

We further found overlap and common support at all levels of the propensity score for the treated and untreated group.

Table 4 shows the main result – the average treatment effect on the treated (ATT). The mean incidence of work absenteeism of women who used Disposable Pads was 23.86 percentage points lower than for women in the control group of the sample. These results show that the use of advanced MHM materials has a statistically significant impact on work absenteeism due to menstruation, which is also economically significant. This finding implies an economically significant impact on aggregate labor supply as well as on individual wellbeing of the women

Table 3: Balancing Tests

Variable	Unmatched / Matched	Mean: Treated	Mean: Control	%Bias	%Reduct Bias	t-test: t	t-test: $p > \|t\|$
School primary	U	0.280	0.163	28.6		3.80	0.000
	M	0.280	0.258	5.5	80.7	0.83	0.405
School secondary	U	0.362	0.052	82.7		10.36	0.000
	M	0.362	0.354	2.0	97.6	0.26	0.798
Age	U	29.5	32.6	-34.3		-4.75	0.000
	M	29.5	29.8	-3.4	90.2	-0.59	0.554
Age squared	U	942.8	1146.5	-36.3		-5.05	0.000
	M	942.8	949.8	-1.3	96.6	-0.23	0.821
Married	U	0.494	0.754	-55.7		-7.45	0.000
	M	0.494	0.659	-35.3	36.6	-5.49	0.000
Wealth low	U	0.045	0.374	-88.0		-13.46	0.000
	M	0.045	0.061	-4.1	95.4	-1.10	0.272
Wealth middle	U	0.080	0.329	-64.9		-9.61	0.000
	M	0.080	0.059	5.4	91.6	1.33	0.182
Electricity	U	0.752	0.401	75.8		10.55	0.000
	M	0.752	0.761	-2.0	97.3	-0.36	0.720
Region Centre-Nord	U	0.004	0.048	-28.2		-4.45	0.000
	M	0.004	0.004	0.0	100.0	0.00	1.000
Region Centre-Sud	U	0.032	0.017	9.6		1.26	0.209
	M	0.032	0.027	3.7	61.9	0.55	0.585
Region Plateau-Central	U	0.021	0.069	-23.5		-3.48	0.001
	M	0.021	0.006	7.3	68.7	2.16	0.031
Region Nord	U	0.027	0.090	-27.3		-4.05	0.000
	M	0.027	0.006	9.0	67.2	2.70	0.007
Region Sahel	U	0.006	0.059	-30.4		-4.76	0.000
	M	0.006	0.008	-1.1	96.4	-0.38	0.705

Notes: The table shows tests for balancing between the treatment and the control group across different control variables. The mean between treated and control group, the bias and bias reduction as well as results from a t-test for the difference in means is displayed.

and their families. The effect translates into up to 23 days of work missed per year due to the use of old cloth as MHM material.[11]

[11]For our calculation of the upper bound, we take a 365-day year of potential working days, 14 menstrual cycles per year and absence of 7 days due to the menstrual period: $(14 \cdot 7)/365) \cdot 0.238 \cdot 365$. A more conservative estimate based on 12 menstrual cycles per year and 3 days absence due to menstrual period would imply 8.6 work days missed per year. Our data contains only information regarding whether women worked in the previous month. If some women worked only temporarily, the number of work days lost would be further reduced.

Table 4: Treatment Effect of Disposable Sanitary Pad Use on Work Absenteeism

(1)	(2)	(3)	(4)	(5)
ATT $n = 1$	ATT $n = 2$	ATT $n = 1$, $cal = 0.05$	ATT Mahalanobis	ATT noreplace
-0.2386**	-0.2250**	-0.2273**	-0.2289**	-0.184***
(0.1150)	(0.0909)	(0.1162)	(0.0981)	(0.083)

Notes: The table displays the average treatment of using disposable sanitary pads vs. old cloth on work absenteeism using different estimation methods. Standard errors are displayed in parentheses and have been adjusted for the ATT according to Abadie and Imbens (2006) in columns 1-4; column 5 shows the ATT without replacement obtained from Stata's attnd routine used in the sensitivity analysis of Table 7; n stands for the number of nearest neighbors used for the estimation; *cal* stands for the caliper used. *** denotes significance at the 1 percent level, ** denotes significance at the 5 percent level, * denotes significance at the 10 percent level.

As a robustness check, we also report the results for alternative matching parameters. As shown in columns 2 and 3 of Table 4, the results hardly change when the number of nearest neighbors is increased to 2 or the caliper is reduced to 0.05. In column 4, we report results from the Mahalanobis matching.[12] The estimate is close to the same size and precision of the benchmark ATT estimate. For comparison, Table 4 shows in column 5 the results from propensity score matching without replacement. The point estimate is somewhat smaller, indicating that it is more difficult to find perfect matches without replacement. The standard errors of the routine (Stata's attnd command), however, assume no heteroskedasticity and may, thus, be unreliable (Abadie and Imbens, 2016). We provide the result in column 5 because the sensitivity checks reported in Table 7 below are inevitably based on matching without replacement.

In Table 5 we show the robustness of the results when further variables are added to the propensity score model. The method is based on nearest neighbor matching with replacement, with one nearest neighbor, and Abadie-Imbens correction, as in column (1) of Table 4, which is reiterated in Table 5 as benchmark model. When urban, Muslim religion, or access to piped water were added to the model, the mean bias increased somewhat but the estimated treatment effect varied only insignificantly from the benchmark result. When all additional variables were added simultaneously, the point estimate reduced to 0.19, and Rubin's R indicated that the variances between the treated and matched non-treated became mildly unbalanced. Finally, we show results for a broadly defined control group, consisting of women who used any traditional

[12]For Mahalanobis matching individuals are matched according to a distance metric, rather than (the closest) propensity score. Mahalanobis distance is equal to $D_{mn} = \sqrt{(X_m - X_n)' V^{-1} (X_m - X_n)}$ with X a vector of explanatory factors and V is the variance covariance matrix of X. A unit from the treatment group is then matched with a unit from the untreated group that has the lowest Mahalanobis distance.

method (and assigning missing values to the few women who mixed sanitary pads with traditional methods). Here, we observed a smaller treatment effect. The reason is perhaps that treatment and control group were less clearly delimited against each other. Most of the women who are now additionally in the control group used new cloth as their MHM method. One could argue that new cloth has some of the characteristics of a modern method, namely that the material has not been used previously and is, therefore, potentially cleaner. The treatment effect, however, still differed insignificantly from the benchmark results, as indicated by the overlapping 95% confidence intervals.[13]

Table 5: Sensitivity Analysis of Bias and Treatment Effect of Advanced MHM on Work Absenteeism

	Pseudo R^2	Mean Bias	Rubin's R	ATT	Std. Error
Benchmark	0.034	6.2	1.51	-0.239	0.115
& Urban	0.034	7.4	1.46	-0.211	0.097
& Muslim	0.063	9.1	1.45	-0.232	0.115
& Piped water	0.047	7.5	1.20	-0.243	0.108
& All	0.041	7.6	2.00	-0.188	0.092
pad once vs. any trad. method	0.018	4.6	1.54	-0.124	0.060

The table displays bias indicators, treatment effect, and standard errors when further confounders are added to the benchmark specification. In the last row all additional confounders are added together. Standard errors have been adjusted for the ATT according to Abadie and Imbens (2006); benchmark replicates the benchmark results from Tables 3 and 4.

A perhaps more interesting exercise is to use the richness of information in the data set to explore the average treatment effect in subsamples stratified by female characteristics. It should be kept in mind, however, that these exercises have less statistical power due to the reduced sample size. The results are presented in Table 6. The first block stratifies the sample by religion. Of the women in our sample, 92 percent were either Muslim or Christian. The results show that there was a strong significant impact of disposable pad use for the group of Muslim women, whereas the effect was insignificant for Christian women. The socio-cultural beliefs of Islam are likely responsible for Muslim women benefitting more from effective MHM (by avoiding soiling or displaying other side effects in public). If under-reporting of menstruation-related absence from work was an issue because of associated stigma, we would expect it to be higher among Muslim women. Because underreporting would imply a downward bias of the treatment effect (in absolute terms), the large effect for Muslim women could be regarded as a lower bound of the true treatment effect.

[13]Applying the same method to assess economic significance as for the benchmark result, the point estimate suggests that up to 12 days of work are missed per year due to the use of any traditional method instead of sanitary pads.

Table 6: Heterogenous Effects of Disposable Sanitary Pad Use on Work Absenteeism

Stratification by religion				
	Treatment	Control	Difference	t-Stat
Muslim	0.139	0.434	-0.295***	-2.95
Christian	0.145	0.009	0.136	1.52
Stratification by wealth				
	Treatment	Control	Difference	t-Stat
Low wealth tertile	0.235	0.118	0.118	0.66
High wealth tertile	0.145	0.446	-0.301***	-2.63
Stratification by urban-rural setting				
	Treatment	Control	Difference	t-Stat
Urban	0.143	0.388	-0.245***	-2.29
Rural	0.194	0.284	-0.09	-0.84
Stratification by highest schooling level				
	Treatment	Control	Difference	t-Stat
Primary educ.	0.197	0.190	0.007	0.09
Secondary educ.	0.114	0.865	-0.751***	-2.34
Stratification by marital status				
	Treatment	Control	Difference	t-Stat
Married	0.107	0.241	-0.134*	-1.86
Unmarried	0.191	0.524	-0.333**	-1.97

Notes: The table displays the average treatment effects of the treated stratified by religion, wealth group, residence, marital status, and education.

The next block entries of Table 6 provide the results for samples stratified by wealth, location of residence, and education. We found no significant effect of sanitary pad use on work absenteeism for women with only primary education, from the low wealth tercile, and with rural residence. In contrast, we observed a positive treatment effect for women with secondary education, from the high wealth tercile, and with urban residence. These results indicate that an effective MHM method is particularly important for women who likely work in higher positions in a modern work environment.

The last block in Table 6 shows the results stratified by marital status. We found a mildly significant treatment effect for both groups and a much higher point estimate for unmarried women. Because we considered only women who worked outside home during the last month and due to the fact that the question on MHM use focuses on the last period and the question on work missed on the last month, a direct channel of fertility on MHM use and work missed is unlikely the explanation for the difference in the size of the effect. We can only conclude that married women apparently live in social environments, in which MHM use has a smaller impact on absenteeism from work.

We further conducted tests to assess the robustness of the ATT estimate as proposed by the econometrics literature. Although it is important to determine whether the conditional independence assumption is fulfilled, it is, however, impossible to directly test for confoundedness by unobservable factors. Since Rosenbaum and Rubin (1983 b), the literature has suggested several ways to nevertheless assess the sensitivity of an ATT estimator to unobserved confounders. Here, we follow the method of Nannicini (2007) and Ichino et al. (2008). This method assumes that the conditional independence assumption is not satisfied given the observables, but it would be satisfied if an additional simulated variable could be observed, and it compares the estimates with and without matching on the simulated variable. The confounder is evaluated for how likely it is to occur and whether it is a problem if it was not included in the regression. The method is based on matching without replacement. To the best of our knowledge, a sensitivity analysis for matching with replacement is not available.

In Table 7, parameter d captures the outcome effect of a simulated variable in the absence of treatment, and s is the effect of the simulated variable on selection into treatment. Our baseline estimate is given in the case of unconfoundedness ($d = 0$ and $s = 0$). We simulated different effects upon outcome and selection into treatment by increasing d in 0.1 steps as well as by decreasing d, and we simulated the behavior of potential confounders that behave similarly to actually observed confounders, as suggested in Nannicini (2007).

The results in Table 7 show that to explain a significant deviation of the matching estimator from the baseline estimate caused by an unobserved confounding factor, a confounder needs to have an enormous positive effect upon selection into treatment or on the untreated outcome. For particularly concerning confounding factors with large values of d and s (so-called 'killer confounders', see the case of $s = 0.6$ and $d = 0.5$), the confounder would have to increase the probability of selection into treatment by a factor greater than 21 and the probability that the outcome is greater than the mean by a factor greater than 18. The results are less robust when the simulated confounder is negatively correlated with the outcome variable. As d becomes more negative (and s more positive), the simulated ATT declines and converges towards zero. Because the magnitude of the simulated confounders is difficult to assess in terms of the actual observed confounders, we also provide results for simulated confounders that behave as observed covariates. An unobserved confounder behaving like Muslim religion would be mildly negatively correlated with the treatment and the outcome. It would imply the estimation of a somewhat

higher treatment effect. An unobserved confounder behaving like secondary education would be mildly negatively correlated with the outcome and very strongly positively correlated with selection into treatment. It would imply a substantially reduced treatment effect. This outcome is consistent with our analysis showing that secondary education exerts a large selection effect.

Table 7: Sensitivity for Unobserved Confounders

		ATT	Std. error	Outcome effect	Selection effect
Effect on untreated outcome	Effect on treatment assignment				
Simulated confounding factor					
$d = 0$	$s = 0$	-0.184	0.083	1.00	1.00
$d = 0.1$	$s = 0.28$	-0.161	0.081	1.71	3.95
$d = 0.2$	$s = 0.36$	-0.165	0.104	2.64	5.84
$d = 0.3$	$s = 0.44$	-0.211	0.102	4.08	8.39
$d = 0.4$	$s = 0.52$	-0.276	0.104	7.23	12.88
$d = 0.5$	$s = 0.60$	-0.388	0.120	18.16	21.27
$d = -0.05$	$s = 0.21$	-0.139	0.093	0.83	3.04
$d = -0.1$	$s = 0.22$	-0.132	0.099	0.72	2.94
$d = -0.2$	$s = 0.24$	-0.112	0.107	0.46	3.16
$d = -0.3$	$s = 0.26$	-0.062	0.110	0.27	3.47
Simulated confounding factor: dummy variable for Muslim religion					
$d = -0.02$	$s = -0.04$	-0.215	0.046	0.96	0.82
Simulated confounding factor: dummy variable for secondary education					
$d = -0.02$	$s = 0.35$	-0.095	0.121	0.808	11.8

Notes: The top part of Table 7 displays the sensitivity analysis of the matching estimator for different settings of confounders based on the method from Nannicini (2007). The probability that a confounding factor is existent while an individual receives the treatment and has an outcome equal to one, and the probability that a confounding factor is existent while an individual receives the treatment and has an outcome equal to zero were each held at the level 0.8. The bottom part of the table shows the outcome for a simulation of a potential confounder with similar characteristics as Muslim religious affiliation or secondary schooling. 100 bootstrap replications were run for the iterations.

The descriptive statistics from Table A.3 in the Appendix show that there were more women with lower education, lower wealth and higher incidence of living in rural areas in the overall population than in the survey sample. The literature has not yet developed a consensus view about how to address survey weighting for matching estimators. We conducted an exercise following the suggestions by DuGoff et al. (2013). We estimated the average treatment effect of the treated running a regression on the matched sample using a composite measure of weights, dealing on the one hand with the two-way cluster-stratification of the survey sample, and on the other hand incorporating the weight of the estimate of the propensity score. For this purpose, we used the weights for matches between the treated and untreated that resulted from our baseline propensity score matching regression (the weight is 1 for observations from the treated group and for the control group it is the number of observations from the treated group that the observation is a match for) and adjusted it for survey weights, that is, we multiplied it

by the inverse of the weight for the enumeration area, the weight for the household, and the weight for the female respondent (as provided by PMA2020). Using primary and secondary education, age and age squared, marital status, middle wealth tercile, electricity, and a set of regional dummies in the propensity score model, we obtained an ATT of -0.2608 (and standard error of 0.0763) of MHM material usage for female work absenteeism. When we extended the weight by multiplying it with the propensity score, as suggested by DuGoff et al. (2013), the ATT became -0.3029 (with standard error of 0.0721). These estimates do not differ significantly from the benchmark ATT in Table 4. Because these estimates are close to our sample ATT, it makes us confident that the estimates from the survey sample allow for robust inferences at the population level.

4. Conclusion

Menstrual hygiene management constitutes a challenge for women, particularly in developing countries. Recent research has delivered ambiguous evidence about the causal impact of MHM practices for women's schooling outcomes, especially absenteeism from school. The non-significant impact that has been found by some experiments in single countries is in stark contrast to the voices raised by women and girls from developing countries, as well as several international institutions that point to a need for MHM materials and facilities for the poorest and most deprived. In this study we shifted the focus from school to the workplace and used a newly released dataset and propensity score matching to provide the first causal evidence of the impact of MHM on work attendance. Women in Burkina Faso who used advanced MHM practices (disposable sanitary pads) in contrast to old cloth reduced their probability of missing work-days due to their menstrual period by about 24 percentage points. This difference constitutes an economically significant impact on aggregate labor supply as well as on the individual wellbeing of the women and their families. These days of absence could imply a substantial loss of income for the household and an increased risk for the women's permanent employment. The results indicate a large problem of social exclusion of women due to menstruation and its management with homemade methods.

In this study, we focused on one aspect of menstrual hygiene management, namely the use of absorbent materials for menstrual blood. We did not assess the impact of access to water, soap, and facilities to change MHM materials. These areas are left for further research. We

expect these issues to explain the remaining variation in work absenteeism of women due to menstruation, aside from and in addition to the impact of MHM materials. Our research would not have been possible without the PMA2020 data set of the Bill and Melinda Gates Institute for Population and Reproductive Health, which provided for the first time rich data on MHM practices and their influence on women's work attendance due to menstruation.

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Appendix

Table A.1: Detailed MHM usage and educational level in Burkina Faso

	Never	Primary	Secondary 1st cycle	Secondary 2nd cycle	Tertiary
Cotton wool	14	9	24	5	2
Cotton wool, diaper	1				
Cotton wool, undies	1				
Diaper	12	11	15	4	1
Diaper undies	1				
New cloth	42	8	10		
New cloth, diaper, undies	1				
New cloth, old cloth	13	3		1	
New cloth, undies	8				
Old cloth	646	129	71	2	1
Old cloth, cotton wool	1	1	2	1	
Old cloth, cotton wool, undies		1			
Old cloth, diaper	2				
Old cloth, other	6	1			
Old cloth, undies	45	6	1		
Pad multi	4	3	2	1	1
Pad once, pad multi					1
Pad multi, new cloth	1				
Pad once, pad multi, old cloth				1	
Pad, old cloth	3				
Pad once, other				1	
Pad once	242	247	387	172	88
Pad once, cotton wool			1		
Pad once, new cloth	5	5			
Pad once, diaper			1	1	
Pad once, new cloth, old cloth	1				
Pad once, tampons, toilet paper, undies			1		
Pad once, new cloth, undies	1		1		
Pad once, toilet paper			2		
Pad once, old cloth	20	17	12	1	
Pad once, old cloth, undies	1				
Pad once, old cloth, cotton wool			1		
Pad once, undies	3				
Pad once, tampons			3		3
Undies	108	16	15		
Pad once, undies			4		
Tampons			1		2
Observations ($Total = 2482$)	1182	457	554	190	99

Notes: The Table shows the number of women who used a certain type of MHM material. Women were given the chance to self-report which method they used and they were allowed to name several items. The results are displayed according to educational level.
Source: Data from PMA2020.

Table A.2: Summary Statistics

	Disposable Pad		Old Cloth	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
participation in work outside home	0.465	0.499	0.341	0.474
work missed	0.149	0.357	0.197	0.399
no school degree	0.213	0.410	0.761	0.427
primary school	0.217	0.413	0.152	0.359
secondary school	0.492	0.500	0.086	0.281
tertiary school	0.077	0.267	0.001	0.034
low wealth tertile	0.055	0.229	0.401	0.490
middle wealth tertile	0.099	0.299	0.369	0.483
high wealth tertile	0.845	0.362	0.229	0.421
electricity	0.736	0.441	0.360	0.480
married	0.387	0.487	0.745	0.436
age	25.7	8.5	30.6	10.0
age squared	732.2	495.0	1038.4	620.8
region Centre-Nord	0.017	0.128	0.101	0.302
region Centre-Sud	0.033	0.180	0.016	0.127
region Plateau-Central	0.029	0.168	0.040	0.196
region Nord	0.032	0.175	0.146	0.353
region Sahel	0.003	0.051	0.067	0.250
Muslim	0.560	0.497	0.661	0.474
Christian	0.424	0.494	0.231	0.421
urban	0.820	0.385	0.235	0.424
access to piped water	0.766	0.424	0.219	0.414

Notes: The Table shows descriptive statistics for women who either use disposable sanitary pads or old cloth as MHM material in regard to various variables.
Source: Authors' computations based on data from PMA2020.

Table A.3: Summary Statistics overall

	Survey Sample		Overall Population
Variable	Mean	Std. Dev.	Mean
work missed	0.1663	0.3725	0.1857
no school degree	0.4474	0.4973	0.5351
primary school	0.1894	0.3919	0.2719
secondary school	0.3184	0.466	0.1856
tertiary school	0.0448	0.207	0.0074
low wealth tertile	0.2033	0.4026	0.3014
middle wealth tertile	0.2149	0.4109	0.2785
high wealth tertile	0.5818	0.4934	0.4201
electricity	0.5750	0.4945	0.555
married	0.5400	0.4985	0.7160
age	27.8	9.5	30.1
Muslim	0.6029	0.4894	0.5877
Christian	0.3419	0.4745	0.2892
urban	0.5697	0.4952	0.0734
access to piped water	0.5317	0.4991	0.3395

Notes: The Table shows descriptive statistics for women for the PMA2020 survey sample as well as recalculated values for the population level using PMA2020 survey weights as a composite weight measure of enumeration area, household, female and propensity score.
Source: Authors' computations based on data from PMA2020.

Table A.4: MHM and Characteristics of Working Women

	Disposable Pad	Old Cloth	T-Test
no school degree	28.5	78.6	15.6
primary school	28.1	16.2	-3.8
secondary school	36.1	5.2	-10.3
tertiary school	7.3	0.0	-4.7
low wealth	4.5	37.5	13.5
middle wealth	7.9	32.7	9.5
high wealth	87.5	29.6	-20.8
urban	87.3	30.3	-20.3
missed work	14.9	19.7	1.75

Notes: The Table shows the percentage shares of women who either use disposable sanitary pads or old cloth as MHM material with respect to specific characteristics conditioned on that they stated that they worked during the last month. The T-Test provides the test on equality of means. Based on 817 Observations.