Original Article

Eco-Friendliness and Cost-Effectiveness of Reusable Sanitary Pads for Rural Women: A Model for Menstrual Hygiene Management in Low Resource Settings

Noor ul ain Talpur[1], Jamil Ahmed[2*], Suhail Ahmed Bijarani[3], Muhammad Ilyas Siddiqui[4], Partab Puri[5], Shafi Muhammad Wassan[6]

ABSTRACT

Background

Menstrual Hygiene Management (MHM) is fundamental to women's health, well-being, and gender equality. The study aimed to assess the cost-effectiveness and acceptability of reusable sanitary pads among rural women in Pakistan, proposing a scalable model for improving MHM practices in low-income countries.

Methods

A cross-sectional study was conducted using Multi-Stage Cluster sampling to accomplish a sample size of 340 childbearing-age women from the rural areas of Sindh, Pakistan. The data was collected using a standard questionnaire regarding the affordability and accessibility of reusable versus disposable sanitary pads; further information was also gathered from Market surveys for MHM products. The biodegradability of the pads was assessed using a soil burial test. The data was analyzed using SPSS version 27.

Results

Our research found a significant preference for reusable sanitary pads. The biodegradability tests demonstrated that reusable pads had a superior degradation rate (1.88%) to disposable pads (1.59%) over four months. Economic assessments showed a low utilization of commercial pads (12.5%) due to affordability issues, with 87.5% using reusable cloths. Despite 70% awareness of menstrual hygiene, 48% of women showed interest in creating sanitary solutions, underscoring the feasibility of implementing locally sourced, cost-effective products across similar socio-economic landscapes.

Conclusion

The present study underscores the universal applicability of affordable, sustainable MHM solutions in rural communities of low-income countries, advocating for broader implementation of such models to address global menstrual hygiene challenges.

Keywords

Menstrual Hygiene Management; Reusable Sanitary Pads;Rural Empowerment; Eco-Friendly;Cost-Effective; Gender Equality.

INTRODUCTION

Menstrual Hygiene Management (MHM) is recognized as a crucial public health issue that impacts the empowerment, well-being, and dignity of women and girls across the globe. The World Health Organization emphasizes universal access to safe, culturally acceptable, cost-effective menstruation supplies and practices. This need, however, remains unmet for a million people, particularly in low and middle income countries (LMIC), where social stigmas, economic constraints, and environmental concerns surrounding menstruation products

1. Noor ul ain Talpur, Research Scholar, US- Pakistan Center for Advanced Studies in Water, Mehran University of Engineering and Technology, Janmshoro Sindh, Pakistan.
2. Jamil Ahmed, MBBS, MPH, M.Phil, Ph.D. Department of Community Medicine, Rashid Latif Khan University (RLKU), Medical College, Lahore, Pakistan.
3. Suhail Ahmed Bijarani, MBBS, MPH, M.Phil. Department of Community Medicine & Public Health Sciences, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Pakistan
4. Muhammad Ilyas Siddiqui, MBBS, MPH, Department of Community Medicine, Liaquat University of Medical and Health Sciences, LUMHS, Jamshoro, Pakistan
5. Partab Puri, MBBS, MPH. Department of Community Health Sciences, Muhammad Medical College, Ibn-e-Sina University, Mirpur Khas, Pakistan
6. Shafi Muhammad Wassan, MBBS, MPH, Associate Professor (Chairperson), Department of Community Medicine, Ghulam Muhammad Mahar Medical College, Sukkur, Shaheed Mohtarma Benazir Bhutto Medical University Larkana, Pakistan

Correspondence

Jamil Ahmed, MBBS, MPH, M.Phil, Ph.D. Professor, Department of Community Medicine, Rashid Latif Khan University (RLKU), Medical College, Lahore, Pakistan. E-mail: jamil.ahmed@rlkumc.edu.pk
Website: https://rlkumc.edu.pk/

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are more prevalent.[1] These challenges are worsened in rural areas of LMIC, including Pakistan, by suppressing discourse on menstruation hygiene and limiting access to sanitary pads.[2]

The negative environmental effects of disposable feminine hygiene commodities, mostly made of non-biodegradable plastics, have raised the debate about reconsidering menstrual waste management practices. Studies emphasize the need for long-term menstrual hygiene solutions that address health and hygiene problems while minimizing environmental impact.[3] Moreover, the cost of disposable menstrual products exacerbates the situation, forcing many people to use other sanitary practices.[4] This issue highlights the critical need for low-cost, long-term MHM solutions, especially in rural and underserved areas.

South Asian traditions and societal attitudes significantly affect MHM practices. According to research conducted in countries such as India and Bangladesh, unclean menstrual procedures are extensively employed due to societal constraints and limited access to sanitary goods for period hygiene.[5,6] This issue is aggravated by an absence of open dialogue regarding menstruation, which makes it challenging to communicate factual information and improve access to menstrual hygiene products.[7] Pakistan faces almost similar challenges, with MHM being mostly overlooked despite progress in other domains of women's health.[8]

Recent research has demonstrated the significance of culturally relevant and inclusive MHM awareness programs. However, such projects have poor coverage, especially in rural areas.[9] Environment-friendly menstrual products, such as menstrual cups, reusable sanitary pads, and organic cotton pads, are increasingly considered viable and sustainable options.[9-11] Studies from remote areas such as rural Africa reveal that the high cost of menstrual products prevents girls and women from pursuing higher education or working, indicating the urgent need for low-cost MHM alternatives.[11]

Improvements in menstrual hygiene management and practices, such as developing biodegradable pads and promoting the manufacture of community-based sanitary items, offer practical solutions to improve accessibility and safeguard the environment.[12-13] These initiatives empower women and girls while ensuring ongoing educational and social participation. The aforementioned ideas highlight the ability of both technology improvement and social entrepreneurship to efficiently address the difficulties related to MHM.

The study aims to add to the global discourse on menstrual equity, environmental sustainability, and women's empowerment by offering a scalable MHM solution for areas with limited resources. Transitioning towards reusable sanitary pads offers an environmentally responsible and economically viable solution for rural women, tackling the complex dimensions of MHM challenges in low-income countries.

MATERIALS AND METHODS

Study Design and Participants

A cross-sectional survey was conducted in the Southern village of Sindh, Pakistan, from January through December 2021. The study was conducted in the rural villages of Sindh Province of Pakistan. The sample size was calculated using OpenEPI software at a 95% Confidence interval and a 5% margin of error with the (CI) prevalence of 40% taken from previous studies[13], resulting in a sample size of n=355. However, after leaving 15 refusals, the accomplished sample size was 340, with a response rate of 96%. The sample size for our study was calculated using n = [DEFF*Np (1- p)]/ [(d2/Z21-a/2*(N-1)+p*(1-p)] at 95%CI.

Data Collection and Measurements

We employed the Multi-Stage Cluster sampling technique to recruit participants. We began by selecting ten districts out of the 29 districts in Sindh province to achieve a representative sample size. Subsequently, villages within these districts were chosen. Finally, women of childbearing age (14-45 years) were selected in proportion to the population size of each town.

Affordability & Accessibility to Sanitary Pads

The women in the study already observed the MHM intervention concerning the promotion of reusable sanitary pads by the non-profit organization[14]; however, the acceptance and affordability of disposable vs reusable sanitary pads were unknown. Therefore, the current study assessed the affordability and accessibility of sanitary pads through a household survey of females and a market survey. All the participants who filled out the baseline questionnaire were further investigated regarding affordability, accessibility, and their preference towards the type of sanitary pads (reusable vs. Disposable). The females were asked to fill out information regarding perceptions regarding sanitary pads under use, availability, affordability, use, comfort, etc.

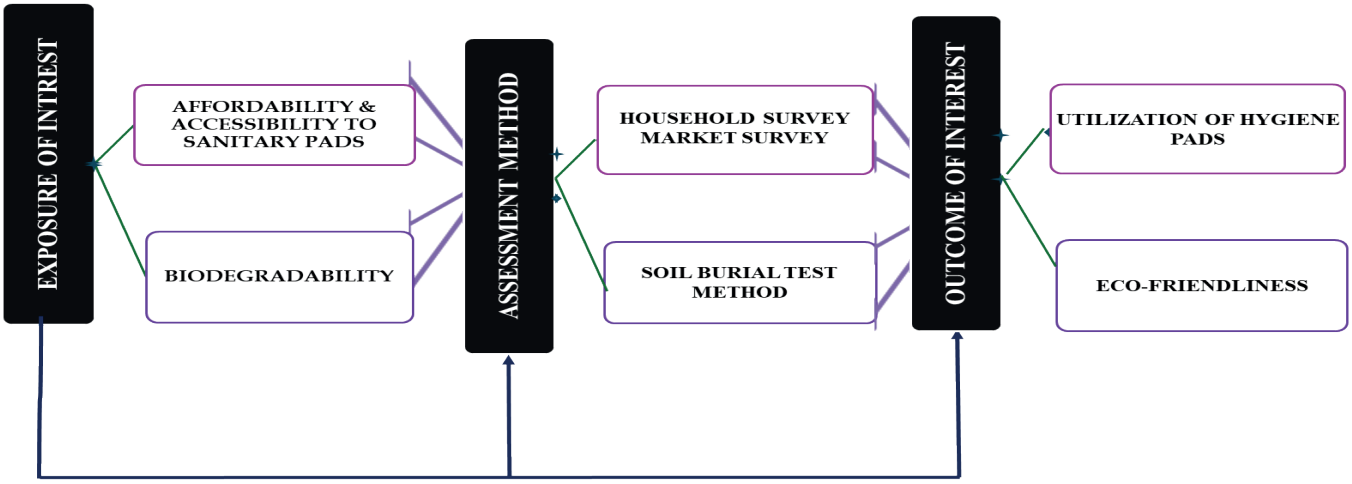

Figure 1. Conceptual Framework

Biodegradability Test for Sanitary Pads

The biodegradation of sanitary pads was performed in a wet soil state as done previously[14]. The lab analysis was done at the Water and Environmental Lab US Pakistan Center for Advanced Studies in Water, Pakistan.

The biodegradability of sanitary pads was evaluated using the soil burial test method. Compost was generated in two containers with wet garden soil, organic waste, and sand in a 2:1:1 ratio, using the approach described previously[14] to facilitate biodegradation. At first, the feminine hygiene items were divided into two layers and dried in an oven at 60°C before thoroughly drying. Subsequently, these dried samples were buried in the prepared soil compost. Every 15 days, the pads were excavated to measure and record their weight. This procedure was repeated over 120 days to obtain comprehensive biodegradation results. To assess the extent of biodegradation, the weight loss percentage was calculated at each 15-day interval using the following equation:

$$Wt\% = Wo\text{-}Wt \times 100\%$$[15]

×100%, where Wt% is the percent of the reduction in weight after the incubation process, Wo is the starting weight of the specimen before drying, and Wt is the final weight of the specimen after drying it upto 60°C [15].

Statistical Analysis

The data was entered and analyzed using Statistical Package for Social Sciences version 27. Descriptive variables such as MHM knowledge and practice, as well as the affordability and accessibility of sanitary pads, were presented in terms of frequency and percentages. The Chi-square test of independence was run to observe the association between reusable vs. Disposable sanitary pads with respect to outcome indicators such as Health and Hygiene practices, utilization of hygiene pads (accessibility and affordability), and eco-friendliness.

Regarding the biodegradability data of sanitary pads, the degradation percentage at various time intervals was the primary variable of interest. The degradation % of sanitary pads was measured at multiple time intervals (15, 30, 45, 60, 75, 90, 105, and 120 days) to assess the biodegradation process of each pad type under a controlled setting. The t-test was used to determine the differences in degradation rates across time points of sanitary pads, considering the within-subject factor of time (days) and the between-subject factor of pad type (reusable vs. disposable).

ETHICAL CLEARENCE

The study was approved by the US-Pakistan Centre for Advanced Studies in Water (USPCASW) Institutional Ethical Review Board, Jamshoro, Pakistan No. USPCASW.IRB-4/12-19. Formal written permission was sought from every participant or guardian (<18 years) before conducting the interview. We confirm that

the study project followed all the local and international ethical guidelines and standards.

RESULT

The sociodemographics of our study participants from rural areas reveal that a majority (87.5%) identify as housewives, underscoring the community's traditional roles and possible constraints on accessing education or employment. A smaller fraction is involved in formal education (7.5%) or employment (5%), reflecting limited opportunities for women in higher education and careers. The marital status shows most participants (72.5%) are married, adhering to cultural norms valuing early marriage, with unmarried individuals and widows making up 20% and 7.5%, respectively. In our study, the ethnic composition of the participants was predominantly Muslim, accounting for 95.5% of the sample. Non-Muslim participants represented a smaller proportion, constituting 4.5% of the population surveyed. This demographic breakdown reflects the religious diversity among the study participants. Age-wise, the largest segment (32.5%) is aged 30-45, followed by 25% in the 25-30 range and 15% over 45, providing diverse insights into MHM practices across life stages. However, younger age groups (14-18 and 18-20) are less represented at 15%, potentially limiting the applicability of findings to adolescent MHM practices (Table 1).

Table 1. Sociodemographic Characteristics of the Study Participants

Sociodemographic Variables		Frequency (n=340)	Percent (%)
Education/ Occupation	Student	26	7.5
	Employee	17	5
	Housewife	298	87.5
Marital status	Unmarried	68	20
	Married	246	72.5
	Widow	26	7.5
Ethnicity	Muslim	325	95.5
	Non-Muslim	15	4.5
Age group (years)	14-18	34	10
	18-20	17	5
	20-25	42	12.5
	25-30	85	25
	30-45	110	32.5
	45-60	51	15

Table 2 presents a nuanced comparative analysis of women's perceptions, acceptability, and affordability of disposable versus reusable sanitary pads. It reveals that a higher percentage of women (70%) find reusable pads comfortable compared to those who prefer disposable pads (59%). However, a notable proportion experiences discomfort due to irritation and pads moving out of position. Regarding usage per menstrual cycle, a significant majority utilize 3-5 pads (reusable vs. disposable: 70% vs. 55%), where the distribution is more varied. Interestingly, a higher inclination was observed among reusable pad users (83%). Accessibility poses a considerable challenge for reusable pad users, with 74% reporting rare accessibility, whereas disposable pads are more easily accessible (73%). Both groups' satisfaction levels are relatively high, yet disposable pads lead in the 'Satisfied' category (65%). The economic aspect reveals a preference for spending less on menstrual hygiene, with a notable inclination towards reusable pads for their cost-effectiveness and recommendation to friends. This data underscores a complex interplay of comfort, accessibility, satisfaction, and economic considerations influencing women's preferences for menstrual hygiene products. The disposable versus reusable menstrual pads show significant associations ($P<0.05$) with characteristics such as usage frequency, comfort, design interest, accessibility, satisfaction, and recommendations. Particularly, willingness to design, access, and satisfaction levels present highly significant differences ($P<0.001$), emphasizing the strong impact of pad type on women's menstrual hygiene experiences. The data highlights the importance of considering pad choice when promoting sustainable and accessible menstrual solutions.

The market survey revealed that only disposable sanitary pads made of cellulose and plastic (poor or non-biodegradable) were available locally. In contrast, eco-friendlier, cotton-based reusable pads with eight cloth layers and a twill fabric backing were absent in stores, driving women to buy them online or to receive them through NGOs. This situation underscores a significant gap in the availability of sustainable menstrual products, highlighting the need for market diversification to meet the demand for environmentally friendly options. Additionally, while the initial time investment for maintaining reusable pads is higher than the disposable ones, the annual cost analysis reveals that reusable pads are more economical over time (Table 2).

Table 2. Comparison of Women's perceptions of the Acceptability and Cost-Effectiveness of Disposable vs. Reusable Menstrual Pads

Characteristic	Reusable Pad (n= 163) N (%)	Disposable Pad (n= 177) N (%)	P-value
How many sanitary pads are used per cycle 3-5 6-10 More than 10	 114 (70%) 42 (26%) 7 (4%)	 97 (55%) 66 (37%) 14 (8%)	0.0114
Are you comfortable with the sanitary pads you are using? Comfortable Moderately Comfortable Uncomfortable	 114 (70%) 18 (11%) 31 (19%)	 104 (59%) 16 (9%) 57 (32%)	0.0213
If uncomfortable, please select causes of discomfort Leak Cause Irritation Did not stay in place Poor absorbent	 9 (5%) 11 (7%) 7 (4%) 9 (5%)	 0% 34 (19%) 5 (3%) 14 (8%)	0.312
Would you be able to design sanitary pads if you are given training? Yes No	 117 (72%) 46 (28%)	 60 (34%) 117 (66%)	0.001
How would you describe your access to sanitary pads? Easily accessible Somewhat accessible Rarely accessible	 16 (10%) 26 ((16%) 121 (74%)	 129 (73%) 48 (27%) 0%	0.001
Level of satisfaction with using sanitary pads Satisfied Strongly satisfied Neutral Unsatisfied Strongly unsatisfied	 86 (53%) 42 (26%) 18 (11%) 16 (10%) 0%	 115 (65%) 23 (13%) 4 (2%) 16 (9%) 19 (11%)	0.001
How much will you spend on sanitary pads [in Pakistani Rupees (PKR)]? Less than 200/month 200-400/month 500-700/month More than 1000 Prefer cloth Not affordable	 72 (44%) 29 (18%) 0% 0% 29 (18%) 33 (20%)	 39 (22%) 83 (47%) 50 (28%) 0% 5 (3%) 0%	0.021
Which type of sanitary pads do you recommend to your friends Reusable Disposable Traditional cloth	 135 (83%) 18 (11%) 10 (6%)	 35 (20%) 137 (78%) 5 (3%)	0.001

Analyzing the biodegradability of reusable versus disposable sanitary pads over 120 days, the data exhibits a trend where reusable pads start degrading quicker, initially registering higher biodegradability (0.54) than disposable pads (0.37). However, the degradation of disposable pads remains constant in the early stage (first 45 days) and then accelerates rapidly after 60 days, overtaking the biodegradability of reusable pads. By the end of the observed period, reusable pads reach a higher biodegradability value of 1.82. In contrast, disposable pads conclude at 1.59, indicating that, despite the slower start, reusable pads ultimately achieve more significant degradation within the measured timeframe, as shown in Figure 2.

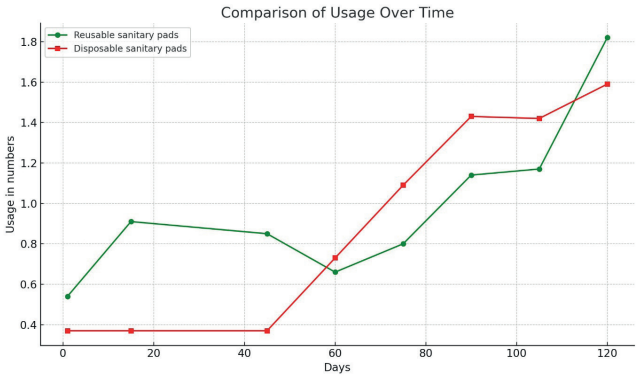

Figure 2. Comparison of the biodegradability of reusable sanitary pads with disposable

Figure 2 depicts the biodegradability of reusable and disposable sanitary pads over time. You can observe how each type of pad's biodegradability metric changes over 120 days. The reusable sanitary pads start with a higher biodegradability value, fluctuating and increasing significantly. In contrast, the disposable pads begin with a lower value, remain constant initially, and then rise steadily from day 60 onwards, surpassing the reusable pads between days 60 and 75 and continuing to increase until day 120.

DISCUSSION

The findings from this study underscore a marked preference for reusable sanitary pads among rural women in Pakistan, highlighting not only their cost-effectiveness and eco-friendliness but also their broader acceptability. This inclination towards reusable sanitary products is consistent with global movements toward more environmentally friendly menstrual hygiene management (MHM) practices, highlighting the pressing need to replace non-biodegradable disposable items, which contribute significantly to environmental pollution.[16-18] Furthermore, the economic benefits of reusable pads are obvious, challenging the current dependence on less sustainable alternatives due to perceived cost limitations.[4,11]

Our study's findings revealed that 95% of rural Pakistani women perceive menstruation as a natural biological process, outperforming earlier regional studies in which knowledge levels differed significantly.[13,19] Education identified as a significant factor in improving MHM, with anatomical knowledge gaps and reliance on informal information sources emphasizing the need for comprehensive educational initiatives.[7,9] The level of basic understanding demonstrates the communities' potential readiness to adopt more sustainable menstrual hygiene management (MHM) practices.

Conversely, just 22% of study participants correctly recognized the anatomy of menstruation, which is problematic. This number is much lower than the results of a recent study in Bangladesh, where almost 40% of women demonstrated correct anatomical knowledge.[5] Our study's preference for reusable sanitary pads, with 70% of females finding them comfortable, is consistent with the global shift toward sustainable menstrual hygiene management practice.[10]

In a later study, the women's preference contradicts dramatically a study from India, in which only approximately half of women indicated pleasure with reusable alternatives.[17] Socioeconomic studies demonstrate poor utilization of sanitary products (12.5%) due to parallel affordability data from Sub-Saharan Africa, emphasizing financial constraints as a universal barrier to acquiring hygienic products.[11]

In our study, the women's interest in designing their hygienic product, with 70% indicating willingness, suggests a substantial change toward self-sufficiency in MHM practices. This statistic is far higher than that of previous surveys, such as one study from Nepal, where just 30% of women showed interest in similar initiatives.[18] The demonstrated willingness of participants to build their sanitary product, if given proper training, highlights the possibility of leveraging women as crucial agents of change in the MHM landscape. This is consistent with broader aims of gender equality and empowerment[1,8], emphasizing the necessity of incorporating women in developing innovative and sustainable MHM solutions.[19-20]

Our study's market survey revealed a lack of local availability of reusable pads, mirroring challenges reported in other low-income settings and emphasizing the need for enhanced supply chains and market access to sustainable MHM products.[12,14] Furthermore, the superior biodegradability rate of reusable pads demonstrated in our study supports the environmental rationale for their adoption, aligning with recent research advocating for the environmental benefits of reusable over disposable pads.[3,15,21] The biodegradability assessment of sanitary pads contributes to the discourse on the environmental impact of MHM products. Reusable pads demonstrated a superior degradation rate compared to disposable pads[15], highlighting their environmental advantage and supporting the case for their broader adoption. This finding is particularly relevant to global environmental concerns and the push for sustainable development.[3,10]

Study Limitation

We acknowledge a few limitations in our study. The reliance on self-reported data may introduce bias, and the focus on rural areas of Sindh may limit the generalizability of findings to other regions or urban settings. Furthermore, the research did not examine the environmental impact of reusable sanitary pads throughout their lives, including water usage and cleaning procedures. Prospective research recommended expanding the focus on MHM educational programs to include detailed anatomical and reproductive health knowledge and techniques for countering cultural stereotypes. The study should also look into community-led projects that help women design their reusable feminine products locally, which can benefit local economies and empower women. At the same time, stakeholders should engage in legislative lobbying to promote the availability and affordability of sustainable MHM products, especially among underserved communities.

CONCLUSION

The present study's findings revealed that reusable feminine hygiene products are viable and cost-effective options for rural women who frequently use unsanitary fabric due to budgetary constraints and social norms. We recommend improving the design and quality of these locally manufactured pads to ensure they are culturally acceptable and efficient in reducing genitourinary diseases. Our study findings underscore the universal applicability of affordable, sustainable MHM solutions in rural communities of low-income countries, advocating for broader implementation of such models to address global menstrual hygiene challenges.

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AUTHORS' CONTRIBUTION

Conceptualization: Noor ul ain Talpur, Jamil Ahmed, Suhail Ahmed Bijarani

Data curation: Noor ul ain Talpur, Jamil Ahmed, Muhammad Ilyas Siddiqui, Partab Puri, Shafi Muhammad Wassan

Formal analysis: Noor ul ain Talpur, Jamil Ahmed, Suhail Ahmed Bijarani
Investigation: Muhammad Ilyas Siddiqui

Methodology: Noor ul ain Talpur, Jamil Ahmed, Suhail Ahmed Bijarani, Partab Puri, Shafi Muhammad Wassan
Project administration: Suhail Ahmed Bijarani

Supervision: Jamil Ahmed

Validation: Partab Puri, Shafi Muhammad Wassan

Writing–original draft Noor ul ain Talpur, Jamil Ahmed

Writing–review & editing: Noor ul ain Talpur, Jamil Ahmed, Suhail Ahmed Bijarani, Muhammad Ilyas Siddiqui, Partab Puri, Shafi Muhammad Wassan

COMPETING INTERESTS

The authors reported no potential conflict of interest.

DATA AVAILABILITY STATEMENT

Data will be made available on request by contacting the corresponding author.

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