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Association of Physical Activity and Perceived Stress with Menstrual Cycle Patterns among Female Students at SMA Negeri 15 Palembang: A Cross-Sectional Study

Bunga Anggreini Sari[1*], Fika Minata Wathan[2], Amelia[3], Dewi Mairani[4]

[1,3,4]Diploma IV Medical Laboratory Technology Study Program, Faculty of Health, Kader Bangsa University Palembang, Indonesia

[2]Master of Public Health Study Program, Postgraduate Program, Kader Bangsa University, Palembang, Indonesia

Correspondent author; email : bungaanggreinisari@gmail.com

ABSTRAK

Pola siklus menstruasi merupakan penanda kesehatan reproduksi remaja, dan stres serta aktivitas fisik diduga berkaitan dengannya. Menganalisis hubungan aktivitas fisik dan tingkat stres persepsian dengan siklus menstruasi pada siswi SMA Negeri 15 Palembang. Studi potong lintang pada Januari 2025 terhadap 80 siswi kelas X–XI yang dipilih dengan *stratified random sampling* proporsional. Siklus dihitung dari tanggal menstruasi tiga siklus terakhir yang dilaporkan responden dan diklasifikasikan tidak normal bila terdapat siklus <21 atau >35 hari (klasifikasi operasional, bukan diagnosis klinis). Aktivitas fisik diukur dengan IPAQ-SF dan stres dengan PSS-10. Data dianalisis dengan uji *chi-square* dan regresi logistik ganda. Siklus tidak normal ditemukan pada 34 siswi (42,5%; IK95% 32,3–53,4). Setelah kedua paparan saling disesuaikan, stres persepsian tinggi dibandingkan rendah (aOR 13,91; IK95% 2,53–76,41) dan aktivitas fisik rendah dibandingkan sedang (aOR 3,32; IK95% 1,07–10,30) berhubungan dengan siklus tidak normal, dengan estimasi yang belum presisi. Stres persepsian tinggi dan aktivitas fisik rendah berhubungan dengan siklus menstruasi tidak normal pada siswi yang diteliti. Desain potong lintang tidak memungkinkan inferensi kausal; program sekolah yang memadukan pengelolaan stres dan aktivitas fisik masih perlu dievaluasi.

Keywords: aktivitas fisik; remaja putri; siklus menstruasi; stres persepsian; studi potong lintang

ABSTRACT

Menstrual cycle patterns are a marker of adolescent reproductive health, and stress and physical activity are thought to be related to them. To analyse the association of physical activity and perceived stress with menstrual cycle patterns among female students of SMA Negeri 15 Palembang. A cross-sectional study was conducted in January 2025 among 80 grade X–XI female students selected by proportionate stratified random sampling. Cycle lengths were calculated from self-reported menstrual dates of the last three cycles and classified as abnormal if any cycle was <21 or >35 days (an operational classification, not a clinical diagnosis). Physical activity was measured with the IPAQ-SF and stress with the PSS-10. Data were analysed using the chi-square test and multiple logistic regression. Abnormal cycles were found in 34 students (42.5%; 95% CI 32.3–53.4). With both exposures mutually adjusted, high versus low perceived stress (aOR 13.91; 95% CI 2.53–76.41) and low versus moderate physical activity (aOR 3.32; 95% CI 1.07–10.30) were associated with abnormal cycles, although the estimates were imprecise. High perceived stress and low physical activity were associated with abnormal menstrual cycles among the students studied. The cross-sectional design does not permit causal inference; school programmes combining stress management and physical activity promotion require evaluation.

Keywords : *physical activity; adolescent girls; menstrual cycle; perceived stress; cross-sectional study*

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Introduction

The menstrual cycle is an indicator of the general and reproductive health of adolescent girls and is therefore recommended to be routinely assessed like a vital sign [1]. In the early years after menarche, cycle length still varies, with most adolescent cycles ranging from 21 to 45 days [1,2]. The 2023 international guidelines for polycystic ovary syndrome therefore differentiate irregular cycle lengths based on the length of time since menarche, namely >45 days from 1 to <3 years postmenarche and <21 or >35 days starting 3 years postmenarche [3]. In Indonesia, the proportion of reported menstrual cycle disorders is quite high, for example, 53% in female public health students in Jember [4] and 59.1% in female students at Muhammadiyah 2 High School in Palembang [5]. These figures come from different populations, outcome definitions, and instruments and therefore cannot be directly interpreted as prevalence in high school students in general.

The menstrual cycle is regulated by the hypothalamic–pituitary–ovarian (HPO) axis. Psychological stress activates the hypothalamic–pituitary–adrenal (HPA) axis, and physiological studies have shown an interaction between the HPA axis and the hypothalamic–pituitary–gonadal axis [6]. In humans, clinical guidelines for amenorrhea Functional hypothalamic theory explains that stress, weight loss, and excessive physical exercise, either alone or in combination, can suppress *gonadotropin- releasing pulsations. hormone* (GnRH) and causes chronic anovulation [7]. This relationship may also be bidirectional because the reactivity of the HPA axis to stressors differs according to the phase of the menstrual cycle in adult women [8]. Observational studies in female college students found that high perceived stress was associated with cycle irregularities and other menstrual problems [9,10].

Physical activity is also related to reproductive function. The World Health Organization (WHO) recommends that children and adolescents aged 5–17 years engage in moderate to vigorous intensity physical activity for an average of 60 minutes per day [11]. Low physical activity is associated with adiposity, while obesity in adolescents is associated with menstrual cycle irregularities through changes in insulin, androgens, and *sex hormone-binding globulin* [12]. On the other hand, high-volume exercise without adequate energy intake can lead to low energy availability, which suppresses hypothalamic function [7,13]. Therefore, nutritional status and energy intake may act as confounders or intermediaries in the relationship between physical activity and the menstrual cycle; these two variables were not measured in this study and are therefore considered as limits of interpretation.

Evidence from Indonesia needs to be read per variable. In female students at SMA N 1 Parakan, nutritional status, diet, physical activity, and stress were each associated with menstrual cycle disorders in bivariate analysis [14]. A study in 10th-grade female students at SMAN 12 Depok only assessed stress and found a relationship with the menstrual cycle [15], as did a study of academic stress at SMA Muhammadiyah 2 Palembang [5]. In female students, a multivariate analysis in Jember found a relationship between severe stress and heavy physical activity with cycle disorders [4], while a study in final-year female students at the Faculty of Medicine, Sriwijaya University found no relationship between physical activity and the menstrual cycle [16]. Differences in population (female or male students), instruments (e.g., DASS-42 or *Physical Activity Level*), output definitions, and analysis techniques make the results not completely comparable.

Previous research in high schools in Palembang assessed a single exposure using bivariate analysis on a purposive sample [5]. This study assessed physical activity and stress simultaneously using standardized instruments (IPAQ-SF and PSS-10), randomly selecting respondents in a stratified manner, and estimated the association between each exposure after adjustment in a single model. The primary analytic objective of this study was to assess the association between physical activity and perceived stress levels with irregular menstrual cycles after adjustment for both exposures; the

secondary objective was to describe the proportion of irregular cycles among female students at SMA Negeri 15 Palembang. The research hypothesis was that higher perceived stress and physical activity deviating from the moderate category were associated with higher odds of irregular cycles.

Method

Design, location, and timing. This study was an observational analytical study with a cross-sectional design and reported in accordance with the STROBE guidelines. The study was conducted at SMA Negeri 15 Palembang, Jl. KS Tubun No. 10, Kelurahan 17 Ilir, Kecamatan Ilir Timur I, Palembang City. Data were collected in a single session on January 30, 2025. The time window for each variable was different: cycle history covered the last three cycles before filling (approximately three months, varying between respondents), perceived stress covered the last month, and physical activity covered the last seven days. Therefore, some reported exposures may have occurred after some outcomes, and the temporal sequence between exposure and outcomes cannot be established.

Population and sample. The population was all female students in grades 10 and 11 of SMA Negeri 15 Palembang in the 2024/2025 academic year. The sample size was determined using the Slovin formula with a 10% error rate, resulting in 80 respondents. This calculation was intended to ensure the accuracy of the proportion estimate and not to calculate the power for regression analysis; this limitation is discussed in the discussion section. The sample was selected using *a stratified random sampling technique. Random sampling* by grade level with proportional allocation, using the list of female students from each grade level as the sample frame, resulted in 41 female students in grade X and 39 female students in grade XI. With proportional allocation, the probability of selection between strata is essentially the same, so the estimates are not weighted. Inclusion criteria were having experienced menarche at least two years previously, being able to remember or have a record of the first day of menstruation for the last three cycles, and being willing to participate with parental consent. Exclusion criteria were currently using hormonal medication , having a history of endocrine disorder diagnosis reported by respondents (e.g., polycystic ovary syndrome or thyroid disorder), and incomplete questionnaire completion. The absence of a history of diagnosis does not guarantee the absence of endocrine disorders. Data from 80 respondents with completed questionnaires were analyzed.

Menstrual cycle (output). Respondents recorded the first day of their last three menstrual cycles sequentially based on memory or personal records. The length of each cycle was calculated as the number of days from the first day of one menstrual period to the day before the first day of the next menstrual period. The unit of analysis was the respondent: cycles were categorized as normal if all cycles lasted 21–35 days and abnormal if at least one cycle was >35 days (long cycle) or <21 days (short cycle). The 21–35 day cutoff was used for comparability with previous Indonesian studies [4,14]; this cutoff aligns with international guidelines for adolescents ≥3 years postmenarche, but is stricter than the >45 day cutoff for adolescents 1 to <3 years postmenarche [1,3]. Time since menarche was not analyzed as a separate variable, so sensitivity analysis by gynecological age was not possible. This classification is an operational classification based on respondent self-report and not a clinical diagnosis of menstrual disorders.

Physical activity (exposure). Physical activity was measured by *the International Physical Activity Questionnaire – Short The Indonesian version of the IPAQ-SF form* [17], which asks for the frequency (days) and duration (minutes per day) of vigorous activity, moderate activity, and walking during the past seven days [18]. Processing and categorization followed the IPAQ guidelines [19]: MET values of 8.0 for vigorous activity, 4.0 for moderate activity, and 3.3 for walking; activities less than 10 minutes were not counted and the duration per activity type above 180 minutes per day was truncated to 180 minutes. The high

category was assigned if vigorous activity was ≥3 days with a total of ≥1,500 MET-minutes/week or a combination of activities ≥7 days with a total of ≥3,000 MET-minutes/week; the moderate category was if vigorous activity was ≥3 days with a minimum of 20 minutes/day, moderate activity or walking was ≥5 days with a minimum of 30 minutes/day, or a combination of ≥5 days with a total of ≥600 MET-minutes/week; The rest are categorized as low. The IPAQ guidelines are intended for ages 15–69 years, thus aligning with the respondents' age range. The moderate category according to the IPAQ algorithm is not identical to the WHO recommendation of 60 minutes of moderate to vigorous activity per day [11].

Perceived stress (exposure). Stress levels are measured by *Perceived Stress* The Indonesian version of the PSS-10 [20], which asks about feelings and thoughts over the past month on a scale of 0–4. Positive items (items 4, 5, 7, and 8) are reversed before being summed, resulting in a total score ranging from 0–40. Scores are categorized as *low (0–13), moderate (14–26), and high (27–40)* perceived stress. The developers of the PSS state that it is not a diagnostic tool and does not have diagnostic cutoff scores [22]; therefore, the categories are operational categories commonly used for description and not degrees of clinical distress. Evidence for the validity of the Indonesian version comes from samples of university students and workers, not specifically school adolescents [21].

Data collection. The questionnaires were completed directly by the students in class, with the researcher's guidance, for approximately 20 minutes. Before completing the questionnaires, the researcher explained how to record the first day of menstruation to reduce errors and recall bias.

Research ethics. This study has obtained ethical approval from the Health Research Ethics Commission and permission from the school. Written consent was obtained from parents/guardians and assent *was* obtained from each student after explanation of the purpose, procedures, and right to refuse or withdraw without academic consequences. The questionnaire was anonymous; each respondent was assigned a code, identity data was stored separately from the analysis data, and responses were accessible only to the research team.

Data analysis. Univariate analysis presents frequencies and percentages; the 95% CI of the proportion of abnormal cycles was calculated using Wilson's method. Bivariate analysis used Pearson's *chi-square test* (df = 2) with complete cross-tabulation and *odds ratio. Crude ratio* (OR) and 95% CI; all expected frequencies were >5. The outcome was coded as 1 for abnormal cycles and 0 for normal cycles. Both exposures met the bivariate selection criterion of $p < 0.25$ and were entered simultaneously (*enter method*) into a multiple logistic regression as *dummy variables* with moderate physical activity and low perceived stress as comparison categories. Age and time since menarche were not included in the model, so *adjusted odds The aOR ratio* (aOR) only reflects the reciprocal adjustment between the two exposures. Model fit was assessed using a *likelihood test. ratio* (omnibus) to the constant model and Nagelkerke R^2 as pseudo-R^2. With 34 events and four exposure coefficients, the number of events per parameter is approximately 8.5, so the estimates are potentially unstable, especially in small categories. The significance limit is $p < 0.05$. The analysis was performed with IBM SPSS Statistics.

Results and Discussion

Respondent characteristics. A total of 80 female students were analyzed. The largest group was 16 years old (41.3%), experienced menarche at age 12–13 (65.0%), had moderate physical activity (43.8%), and had moderate perceived stress (55.0%). A total of 34 female students (42.5%; 95% CI 32.3–53.4) had irregular menstrual cycles, consisting of 22 (27.5%) with long cycles and 12 (15.0%) with short cycles; both subcategories were independent of each other in this data (Table 1).

Table 1. Respondent characteristics (n = 80)

Characteristics	n	%
Age (years)		
15	14	17.5
16	33	41.3
17	27	33.8
18	6	7.5
Class		
X	41	51.3
XI	39	48.8
Age of menarche (years)		
<12	11	13.8
12–13	52	65.0
≥14	17	21.3
Menstrual cycle		
Normal (entire cycle 21–35 days)	46	57.5
Abnormal: long cycle (>35 days)	22	27.5
Abnormal: short cycle (<21 days)	12	15.0
Physical activity (IPAQ-SF)		
Low	31	38.8
Currently	35	43.8
Tall	14	17.5
Perceived stress (PSS-10)		
Low (0–13)	18	22.5
Medium (14–26)	44	55.0
Height (27–40)	18	22.5

Source: primary data, 2025. Percentages may be slightly above 100% due to rounding. Cycle classifications are based on respondent reports, not clinical diagnoses.

Bivariate analysis. Physical activity was associated with menstrual cycle ($\chi2 = 7.43$; df = 2; p = 0.024). The proportion of abnormal cycles was highest in low activity (18/31; 58.1%), followed by high activity (7/14; 50.0%), and lowest in moderate activity (9/35; 25.7%). Perceived stress was also associated with menstrual cycle ($\chi2 = 14.35$; df = 2; p < 0.001), with the proportion of abnormal cycles being 16.7% (3/18) in low stress, 38.6% (17/44) in moderate stress, and 77.8% (14/18) in high stress (Table 2; Figure 1). The *chi-square test* is global in nature and does not indicate that each pair of categories is significantly different.

Table 2. Cross-tabulation of physical activity and perceived stress with menstrual cycle

Variables	Abnormal n (%)	Normal n (%)	Rough OR (IK95%)
Physical activity			
Low	18 (58.1)	13 (41.9)	4.00 (1.41–11.33)
Currently	9 (25.7)	26 (74.3)	Comparator
Tall	7 (50.0)	7 (50.0)	2.89 (0.79–10.53)
			$\chi^2 = 7.43$; df = 2; p = 0.024
Perceived stress			
Low	3 (16.7)	15 (83.3)	Comparator
Currently	17 (38.6)	27 (61.4)	3.15 (0.79–12.52)
Tall	14 (77.8)	4 (22.2)	17.50 (3.31–92.48)
			$\chi^2 = 14.35$; df = 2; p < 0.001

Source: primary data, 2025. Percentages are calculated per row. Pearson chi-square test ; all expected frequencies are >5. Crude OR and 95% CI are calculated using Woolf's method from cross-tabulations.

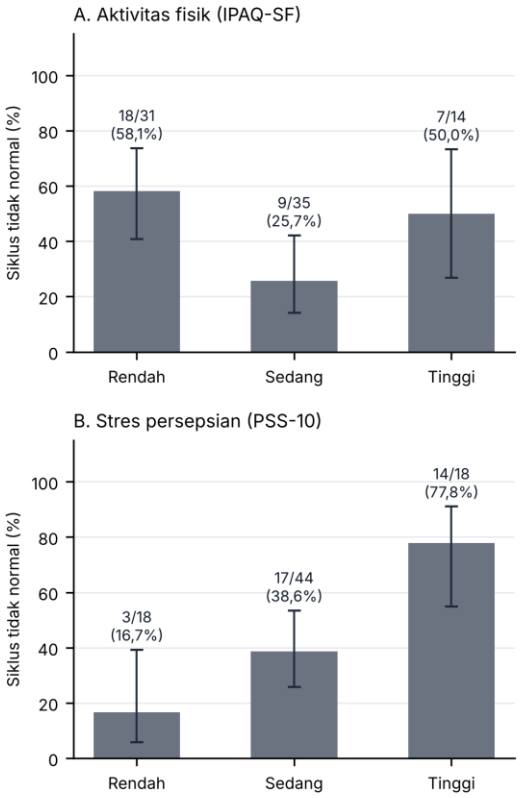

Figure 1. Proportion of abnormal menstrual cycles according to physical activity (A) and perceived stress (B). Bars show crude proportions with 95% CI (Wilson); labels indicate n abnormal cycles/N categories.

Multivariate analysis. In the model containing both exposures (n = 80; 34 events), high versus low perceived stress (aOR 13.91; 95% CI 2.53–76.41) and low versus moderate physical activity (aOR 3.32; 95% CI 1.07–10.30) were associated with irregular cycles. Estimates for high versus moderate activity (aOR 2.29; 95% CI 0.53–

9.80) and moderate versus low stress (aOR 2.54; 95% CI 0.60–10.76) were not significant and imprecise (Table 3). *Likelihood tests The ratio* model to the constant model yielded $\chi^2 = 19.74$ (df = 4; p < 0.001) with Nagelkerke $R^2 = 0.294$.

Table 3. Results of multiple logistic regression of physical activity and perceived stress with abnormal menstrual cycles (n = 80; 34 events)

Variables	aOR	IK95%	p
Physical activity (comparator: moderate)			
Low	3.32	1.07–10.30	0.037
Tall	2.29	0.53–9.80	0.265
Perceived stress (comparator: low)			
Currently	2.54	0.60–10.76	0.204
Tall	13.91	2.53–76.41	0.002

Source: primary data, 2025. Outcome: 1 = abnormal cycle, 0 = normal. aOR is only adjusted for other variables in the table. Likelihood test ratio model: $\chi^2 = 19.74$; df = 4; $p < 0.001$; Nagelkerke $R^2 = 0.294$ (pseudo-R^2).

Nearly half of the female students in this sample (42.5%) had cycles outside the 21–35 day range, with long cycles being the most common pattern. This figure is lower than the 53% among female students in Jember [4] and the 59.1% among female students at SMA Muhammadiyah 2 Palembang [5], but differences in age, definition of the disorder (e.g., the inclusion of amenorrhea in the Jember study), recall period, and sampling technique make this comparison only descriptive. Some respondents may have been only 2 to <3 years postmenarche; in this group, cycles of 36–45 days are still a common variation [1,3], so the proportion of long cycles in this study may be higher than the proportion based on criteria adjusted for gynecological age .

perceived stress is associated with irregular cycles. The odds of irregular cycles in female students with high perceived stress were approximately 13.91 times the odds in female students with low stress (95% CI 2.53–76.41). This value is a prevalence odds ratio, not a risk ratio; because the outcome is quite frequent (42.5%), the OR would appear larger than the prevalence ratio. Roughly, the proportion of irregular cycles was 77.8% in high stress compared to 16.7% in low stress. The very wide confidence interval due to the small number of respondents per category (n = 18) indicates that the magnitude of the association cannot be determined with precision, although the direction is consistent. This finding is consistent with studies on high school female students in Parakan, Depok, and Palembang [5,14,15] and studies on female students [9,10]. Lutviani et al. reported an OR of 15.3 for high stress compared to no stress in female students, but using the DASS-42 instrument and adjusting for nutritional status and physical activity, the magnitudes cannot be directly compared [4]. A biological explanation proposed in the literature is that activation of the HPA axis may suppress GnRH pulsations and ovulation [6,7]; hormone levels and ovulation were not measured, so this mechanism remains conjectural. The reverse is also possible, with irregular cycles and menstrual complaints increasing stress, and a bidirectional interaction between the HPA axis and the menstrual cycle has been reported [8].

The proportion of irregular cycles according to physical activity was highest in the low category, lowest in the moderate category, and again higher in the high category. This pattern is descriptive because nonlinear relationships were not formally tested. After adjusting for stress, low activity compared with moderate was associated with higher odds of irregular cycles (aOR 3.32; 95% CI 1.07–10.30), while the estimate for high activity (aOR 2.29; 95% CI 0.53–9.80) still fit within a wide range of possibilities, ranging from no association to a substantial association; these results are not proof of an absence of association. The literature links low activity with adiposity and insulin resistance associated with cycle irregularity [12], and high-volume activity with low energy availability [7,13]. However, body fat, insulin resistance, androgens, and energy intake were not measured, and a high IPAQ category is not synonymous with excessive exercise, so these explanations cannot be confirmed in this sample.

These physical activity findings are in line with research in Parakan [14], but differ from research on medical students at Sriwijaya University which found no relationship [16] and research in Jember which actually found

a relationship between heavy activity and light activity as a comparison [4]. These differences may be related to the age of the respondents, the instruments (IPAQ-SF, *Physical Activity Level*, or other questionnaires), comparison categories, and distribution of activity categories. The moderate category in this study only represents the lowest gross proportion in the sample and serves as a comparison category; this study does not test the optimal dose of activity or the effectiveness of the WHO recommendation of 60 minutes per day [11]. In addition, the WHO recommendation for ages 5–17 years differs from the adult recommendation that applies to the six 18-year-old respondents.

Practically, these findings can serve as the basis for program proposals that still need to be evaluated, rather than providing evidence of the intervention's effectiveness. Schools, in collaboration with community health centers, can provide education on menstrual health and stress management, facilitate students' self-recording of their menstrual cycles with guaranteed confidentiality, provide access to counseling, and provide referrals to health professionals for students with persistent irregular cycles or other complaints [1]. Such recording or screening is not the same as diagnosing menstrual disorders, and the program's effects on cycle patterns need to be assessed using a prospective design.

This study has several limitations. First, the cross-sectional design and different measurement windows (seven days for physical activity, one month for stress, and approximately three months for cycles) do not allow for establishing temporal order, and reverse causality cannot be ruled out. Second, menstrual dates were obtained from respondents' recall or records; recall errors could lead to misclassification of outcomes and, if they differ by stress level, could inflate or minimize associations. Third, the requirement to recall the dates of the last three cycles could introduce selection bias, for example, excluding students with very long cycles or those who did not menstruate during that period, thus underestimating the proportion of long cycles. Fourth, using a cutoff of >35 days without accounting for gynecological age could have classified some physiological cycles as abnormal; the direction of this influence on the association is uncertain. Fifth, the model only adjusted for the two exposures; nutritional status, energy intake, sleep quality, age, and gynecological age were not controlled for, so confounders Residuals are still possible. Sixth, the small sample size, with approximately 8.5 events per parameter, results in imprecise estimates. Seventh, the study was conducted in a single school, and the Indonesian version of the PSS-10 has not been validated specifically for school-aged adolescents, so generalizability is limited

Conclusion

Of the 80 female students at State Senior High School 15 Palembang studied, 42.5% reported menstrual cycles outside the 21–35-day range. After adjusting for both exposures, high perceived stress (compared to low) and low physical activity (compared to moderate) were associated with higher odds of irregular cycles, with estimates that are imprecise. This relationship is associative and does not yet demonstrate causality.

Recommendations. For schools and community health centers, education on menstrual health and stress management, promotion of physical activity, confidential cycle recording, and access to counseling and referrals can be considered as programs with clear evaluation indicators. For future research, prospective cycle recording over several cycles with measurements of stress and physical activity aligned with each cycle, measurement of gynecological age, nutritional status, energy intake, and sleep quality as pre-specified confounders, a calculated sample size for analytical purposes, and the involvement of more than one school are recommended.

Thank-you note

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Conflict of Interest

The author declares no conflict of interest in this research.

Data Availability

Anonymized data, instruments, and analytical outputs that support the findings of this study are available from the corresponding author upon reasonable request and may be submitted to the editor for verification.

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