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Research Article

Association between suboptimal health status and academic performance: A cross-sectional study of 1,028 medical students in Punjab, Pakistan

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ABSTRACT
Background: Suboptimal health status (SHS) refers to the transitional period between health and illness, characterized by unexplained symptoms and premature changes in functional status without a known medical diagnosis. Objective: The aim is to examine how often SHS occurs and how lifestyle factors influence both SHS and the academic success of medical students. Methods: A Cross-sectional survey was conducted from February 2024 to September 2024 with first- to fifth-year medical students from four randomly chosen medical colleges in Punjab, Pakistan. The Suboptimal Health Measurement Scale (SHMS V1.0), Pittsburgh Sleep Quality Index (PSQI), and Health-Promoting Lifestyle Scale (HPLS) were used to obtain data. The findings were analyzed using independent t-tests, chi-squared tests, and multivariate logistic regression analyses. Result: Among the 1,028 respondents, 55.4% (570) were classified as healthy and 44.6% (458) as having SHS. Higher levels of physical activity ($p < 0.001$; OR = 0.87; 95%CI = 0.82–0.92), healthier sleep patterns ($p < 0.001$; OR = 0.92; 95%CI = 0.89-0.94), and better dietary habits ($p = 0.003$; OR = 0.95; 95%CI = 0.93-0.97) were negatively associated with SHS. In contrast, increased screen exposure ($p = 0.012$, OR = 1.03; 95%CI = 1.01-1.06), weight loss ($p = 0.001$, OR = 1.07; 95%CI = 1.02-1.11), tobacco use ($p = 0.028$, OR = 1.10; 95%CI = 1.02-1.18), and alcohol consumption ($p < 0.001$, OR = 1.95; 95%CI = 1.74-2.26) were positively associated with SHS. Students with lower academic performance (GPA < 3.0) also demonstrated higher SHS rates. Conclusion: SHS is common among medical students and is associated with unhealthy lifestyle habits and low academic performance.

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academic performance; medical students; physical activity; screen time; sleep quality; suboptimal health status.

Introduction

Suboptimal health status (SHS) is an intermediate state between health and disease, defined by vague health problems, chronic exhaustion, lack of energy, and adaptation ability (Wang, 2024). The symptoms that are common in individuals with SHS are persistent fatigue, depression, emotional variability, and functional somatic syndromes, which result in augmented healthcare utilization. According to a survey conducted by the World Health Organization worldwide, 75% of the general population is at risk of suboptimal health, while less than 5% can be categorized as healthy (Wang et al., 2021). International evidence has shown that university and medical students are especially susceptible to SHS because of burdensome college assignments, mental pressure, lifestyle disturbances, and insomnia (Dragun et al., 2020; Zhang et al., 2019).

Evidence from international studies suggests that SHS is linked to a range of lifestyle behaviors, including poor physical activity, excessive screen time, unhealthy eating habits, and disturbed sleep (Ma et al., 2018; Xu et al., 2020; Wu et al., 2013). The academic performance of a medical student is based

on a four-point GPA system. Lower GPA scores (below 3.0) are often associated with challenges, including adjusting to academic and social environments, excessive time spent on social media, and unhealthy lifestyle behaviors (Elsayed et al., 2022). Large-scale data from China demonstrated that over 11,000 medical students experienced SHS, mainly due to high academic pressure, anxiety, and psychosocial stress (Bi et al., 2014). Previous studies have shown that sleep quality and routine physical activity significantly impact cognitive performance, emotional health, and overall academic adaptation in students (Al-Khani et al., 2019; Ahn & Fedewa, 2011; Hale et al., 2015).

In Pakistan, limited research has been done on suboptimal health status among medical students. Local research indicated that 78.1% of undergraduate medical students reported SHS, with stress and unhealthy lifestyle habits (Rashid et al., 2021). However, this study did not investigate the academic outcomes. Another population-based study highlighted the prevalence of SHS in the general population and its association with lifestyle-related risk factors (Mughal et al., 2024). Similarly, an observational study from Islamabad reported that half of all medical students experienced SHS, highlighting the role of stress as an important factor (Iqbal et al., 2024). No previous study has examined the relationship between the physiological, psychological, and social domains of SHS and health-promoting lifestyle behaviors, as well as academic performance, among medical students. To address this gap, we conducted a multi-institutional cross-sectional survey to determine the relationship between health-promoting lifestyle factors and SHS, and to investigate the association between SHS domains and academic performance, as measured by a four-point GPA system, among medical students in Pakistan. These findings may help educators, parents, healthcare professionals, and policymakers to develop effective student-support strategies.

Method

Research Design

This cross-sectional study was conducted from February to September 2024 at two public and two private medical colleges in Punjab, Pakistan. The institutions were selected by simple random sampling from a list of HEC-accredited medical colleges in the province. Within each chosen college, stratified random sampling was used to select students from the first to the final year, ensuring fair representation across academic years and genders.

Participants

A total of 1,028 medical students aged 18-24 years voluntarily participated in this study. The sample size was determined using the Raosoft calculator (confidence interval = 95%, margin of error = 3%), with an additional 10% added to account for incomplete responses. At each campus, one class per academic year was randomly chosen, and all students present on the day of data collection were invited to participate. Participation was voluntary and anonymous. Informed consent was obtained from all respondents prior to the distribution of the survey.

Students were eligible to participate if they were currently enrolled in the MBBS program, between 18 and 24 years of age, and willing to participate. Students with a history of chronic medical illness, any acute health complaints (e.g., fever, infection, or hospitalization) within the previous three months, or with incomplete questionnaires were excluded from the study.

Ethical approval was obtained from the Research Ethics Committee of Riphah International University (Approval no. IIDC/IRC/2021/012/003). All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants, and confidentiality was maintained throughout the data collection and analysis process.

Research Instruments

Data were collected using a self-administered questionnaire consisting of four sections: student characteristics, Health-Promoting Lifestyle Scale (HPLS), sleep quality assessment, and Suboptimal

Health Measurement Scale V1.0 (SHMS V1.0) (Teng et al., 2010). The HPLS was adapted from the "Health Promoting Lifestyle Profile" (HPLP) by Walker (1995) and incorporated items from the Pittsburgh Sleep Quality Index (PSQI) by Buysse (1989). The HPLS consists of 26 items, which are further divided into seven domains: sleep quality (seven items), physical activity (four items), electronic device use (three items), tobacco use (one item), alcohol use (one item), nutritional status (nine items), and weight loss behavior (one item). Each item was rated on a 0–3 Likert scale, with higher scores representing healthier lifestyle practices. Nutritional profile scores ranged from 0 to 27, with lower values indicating poorer dietary habits. The scores for electronic device use ranged from 0 to 11, representing an increase in screen exposure. Tobacco use, alcohol use, and weight loss attempts were coded as binary variables (0 = behavior absent; 1 = behavior present).

The Pittsburgh Sleep Quality Index (PSQI) comprises seven domains: perceived sleep quality, sleep duration, sleep latency, sleep efficiency, sleep disturbances, use of sleep medication, and daytime impairment, which are used to measure sleep quality. Total scores range from 0 to 21, with higher values reflecting poorer sleep. In the present study, the PSQI demonstrated good internal consistency with a Cronbach's alpha of 0.86.

The SHMS V1.0 comprises three key domains: physiological health (consisting of 14 items: physical condition, organ function, body movement, and vigor), psychological health (consisting of 12 items: positive emotion, psychological symptoms, and cognition), and social health (consisting of 9 items: social adjustment, resources, and support) (Zarrabi et al., 2024). Each item is rated on a five-point Likert scale (1 = never to 5 = always). The total scores were transformed into a 0-100 scale, with higher scores representing better health. Cut-off values were set as 68 for physiological, 67 for psychological, and 67 for social dimensions (Teng et al., 2010). Participants scoring below these levels were classified as having a suboptimal health status (SHS).

A pilot test of the questionnaire was conducted on 30 students to assess its clarity and reliability. Cronbach's alpha values for the total scale were 0.89, and for each domain were 0.87, 0.84, and 0.81, respectively. Students reported their GPA from the previous academic year, which served as an indicator of their academic performance. In Pakistan, academic achievement is commonly measured using a four-point GPA scale. GPA was categorized as high performance (≥ 3.0) and low performance (< 3.0).

Data Analysis

All statistical analyses were performed using SPSS version 23.0. Descriptive statistics were used, with continuous variables presented as means and standard deviations and categorical variables reported as frequencies and percentages. For comparison between groups, independent-sample t-tests were applied to assess mean differences in HPLS scores and other continuous measures between healthy students and those with SHS. Categorical variables, such as gender, tobacco use, and academic performance, were assessed using the chi-square (χ^2) test. P values less than 0.05 are considered significant. Logistic regression analysis was used to estimate OR and 95%CIs.

Results and Discussion

Results

Of the 1028 medical students aged between 18 and 24 years (mean = 20.30 ± 1.43 years), 405 (39.4%) were males and 623 (60.6%) were females. A total of 180 students (17.5%) reported tobacco use, and 11 (1.1%) reported habitual alcohol consumption. The majority (72.4%) achieved a high academic performance (GPA ≥ 3.0).

The mean overall health status score was 75.78 ± 8.10, with 570 (55.4%) participants categorized as having a healthy health status, and 458 (44.6%) having a suboptimal health status. The mean physiological, psychological, and social health scores were 80.13 ± 9.7, 77.25 ± 12.9, and 78.54 ± 10.5, respectively. Based on the SHMS V1.0 cut-offs, 30.4% of students showed suboptimal physiological

health, 19.5% had suboptimal psychological health, and 32.6% demonstrated suboptimal social health (Table 1).

Table 1. Characteristics of Medical Students Participating in the Survey (n = 1028)

Participant Variables	n (%) or Mean ± SD
Age (years)	20.30 ± 1.43
Sex distribution	
Male	405 (39.4%)
Female	623 (60.6%)
Dietary intake (range 0-27)	16.38 ± 4.62
Sleep-pattern score (range 0-21)	7.82 ± 2.82
Screen time (range 0-11)	4.20 ± 2.19
Activity level score (range 0-12)	3.88 ± 2.20
Tobacco use	
Yes	180 (17.5%)
No	848 (82.5%)
Alcohol use	
Yes	11 (1.1%)
No	1017 (98.9%)
Attempts at weight reduction	
Yes	571 (55.5%)
No	457 (44.5%)
Overall health (range 0-100)	75.78 ± 8.10
Within healthy range	570 (55.4%)
Suboptimal health	458 (44.6%)
Physiological health domain (range 0-100)	80.13 ± 9.70
Healthy	715 (69.6%)
Suboptimal health	313 (30.4%)
Psychological health domain (range 0-100)	77.25 ± 12.9
Healthy	828 (80.5%)
Suboptimal health	200 (19.5%)
Social health domain (range 0-100)	78.54 ± 10.50
Healthy	693 (67.4%)
Suboptimal health	335 (32.6%)
Academic Performance (GPA)	
High performance (GPA ≥ 3)	744 (72.4%)
Low performance (GPA < 3)	284 (27.6%)

Values are presented as mean ± SD or count (percentage). N, Number, %: Percentage, SD: Standard deviation; GPA: Grade point average.

Table 2 compares health-promoting lifestyle behaviors between students classified as healthy and those with SHS. The overall prevalence of SHS was 44.6% (458/1028). The prevalence of SHS was higher among male (48.4%, 196/405) than female students (42.0%, 262/623). Healthy students had significantly higher mean scores for nutrition status, sleep quality, and physical activity compared with students in the SHS group (17.15 ± 4.3 vs 15.79 ± 4.7, $p < 0.001$; 8.24 ± 2.3 vs 7.31 ± 2.5, $p < 0.001$; 4.37 ± 1.5 vs 3.26 ± 1.6, $p < 0.001$, respectively). In contrast, students with SHS reported significantly higher screen time scores (4.50 ± 2.2 vs 3.96 ± 1.2, $p < 0.001$). Tobacco use and alcohol consumption were more frequent among SHS students ($p < 0.001$ and $p = 0.023$, respectively). Students attempting to lose weight were

also more likely to fall in the SHS group (p = 0.036). Regarding academic achievement, higher achievers (GPA ≥ 3.0) were more common among healthy students, whereas lower achievers (GPA < 3.0) were more common among those with SHS (p < 0.001).

Table 2. Health-Promoting Lifestyle Scale according to Health Status (n = 1028)

Participants Variables	Health-Promoting Lifestyle Scale Scores		P-value
	Healthy (n = 570)	SHS (n = 458)	
Age (years)	21.38 ± 3.10	20.30 ± 3.43	0.63
Sex distribution			0.394
Female	347 (60.9%)	262 (57.2%)	
Male	223 (39.1%)	196 (42.8%)	
Dietary intake score	17.15 ± 4.3	15.79 ± 4.7	<0.001
Sleep-pattern	8.24 ± 2.3	7.31 ± 2.5	<0.001
Screen time	3.96 ± 1.2	4.50 ± 2.2	<0.001
Activity level score	4.37 ± 1.5	3.26 ± 1.6	<0.001
Tobacco-use			<0.001
Yes	94 (16.5%)	108 (23.6%)	
No	476 (83.5%)	350 (76.4%)	
Alcohol-use			0.023
Yes	05 (0.88%)	09 (1.97%)	
No	565 (99.1%)	449 (98.0%)	
Attempts at weight reduction			0.036
Yes	195 (34.2%)	164 (35.8%)	
No	375 (65.8%)	294 (64.2%)	
GPA			<0.001
High (GPA ≥ 3)	427 (57.4%)	317 (42.6%)	
Low (GPA < 3)	197 (34.6%)	261 (57.4%)	

Continuous data presented as Mean±Standard deviation, and categorical data presented as Number (percentage).

Multiple logistic regression analysis was used to examine the relationship between SHS and health-promoting lifestyle factors (Table 3). Seven dimensions were included: dietary intake, screen time, physical activity, weight loss efforts, sleep quality, and use of tobacco and alcohol. Screen time was significantly and positively related to SHS (OR, 1.03; 95% CI = 1.01-1.06; p = 0.012). use of alcohol (OR = 1.95; 95% CI = 1.74-2.26; p < 0.001), use of tobacco (OR = 1.10; 95% CI = 1.02-1.18; p = 0.028), and attempts to lose weight (OR = 1.07; 95% CI = 1.02-1.11; p = 0.001) were also positively associated with poor health.

In contrast, higher activity level (OR = 0.87; 95%CI = 0.82–0.92, p < 0.001), better sleep cycle (OR = 0.92; 95%CI = 0.89-0.94, p < 0.001), along with good dietary intake (OR = 0.95; 95%CI = 0.93-0.97, p = 0.003) were negatively and significantly associated with lower odds of SHS. Overall, medical students with healthier lifestyle behaviors exhibited a significantly lower risk of poor health.

Table 3. Analysis of Suboptimal Health Status among Medical Students using Logistic Regression Analysis

Participants Variables	P value	OR	95% CI for OR	
			Lower	Upper
Dietary intake score	0.003	0.95	0.93	0.97
Sleep-pattern	<0.001	0.92	0.89	0.94
Screen time	0.012	1.03	1.01	1.06
Activity level score	<0.001	0.87	0.82	0.92
Tobacco-use	0.028	1.10	1.02	1.18
Alcohol-use	<0.001	1.95	1.74	2.26
Attempts at weight reduction	0.001	1.07	1.02	1.11

OR: odds ratio; CI: Confidence interval.

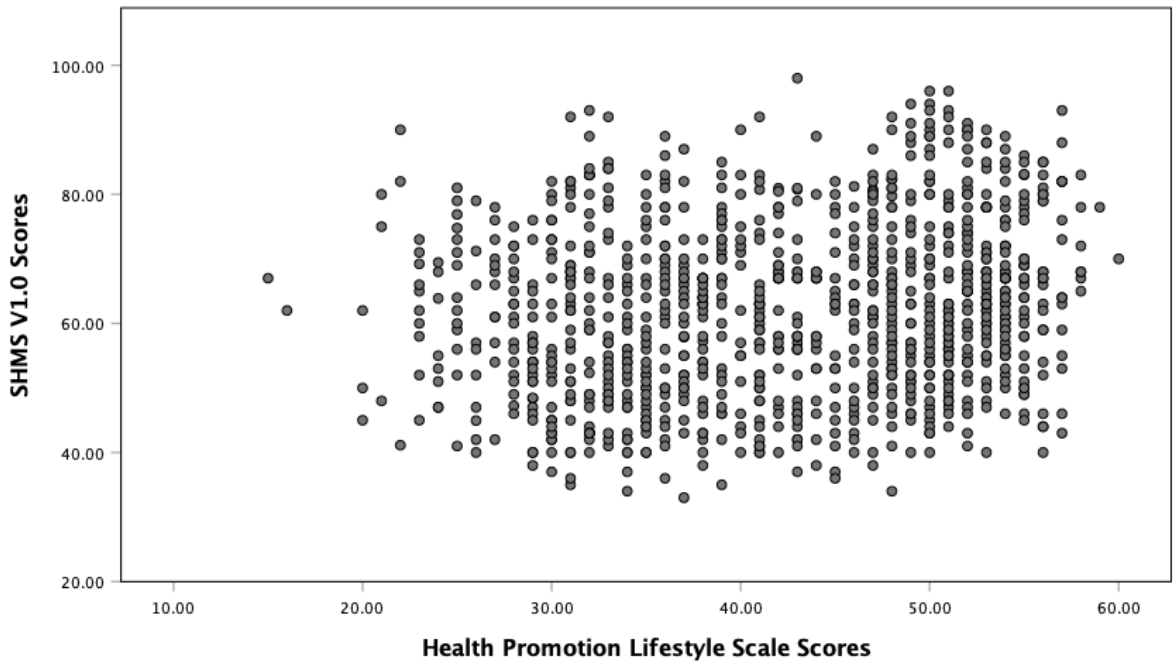

Figure 1. Scatter diagram of the Health Promoting Lifestyle Scale and the Suboptimal Health Measurement Scale (SHMS) V1.0

Table 4. Factors Influencing Academic Outcomes in Medical Students (n = 1028)

Variables	Good Academic performance N=744 (%)	Poor Academic performance N =284 (%)	p-value	OR	95% CI	
					Lower	Upper
Physiological health domain						
Healthy	606 (81.5%)	111 (39.1%)		1.00	Ref.	
SHS	138 (18.5%)	173 (60.9%)	<0.001	8.49	5.93	12.15
Psychological health domain						
Healthy	623 (83.7%)	205 (72.2%)		1.00	Ref.	
SHS	121 (16.3%)	79 (27.8%)	0.07	1.50	0.96	2.34
Social health domain						
Healthy	510 (68.5%)	183 (64.4%)		1.00	Ref.	
SHS	234 (31.4%)	101 (35.5%)	0.83	1.05	0.74	1.50

CI: Confidence interval, OR: Odds ratio, SHS: Suboptimal health status.

Scatter plots of the health-promoting lifestyle scale and health status scores are shown in the Figure 1. The graph demonstrates a statistically significant positive connection ($r = 0.179$, $p < 0.001$) between the SHMS V1.0 and HPLS scores.

Regarding academic performance, a significant association was found between physiological health status and GPA ($p < 0.001$), while a weaker association was observed with psychological health ($p = 0.07$). Most students with GPAs below 3.0 (60.9%) expressed suboptimal physiological health, whereas 81.5% of students with GPAs above 3.0 were classified as physiologically healthy (Table 4).

Discussion

The findings suggest that lifestyle factors, including physical activity, screen time, and sleep patterns, are strongly associated with suboptimal health status among medical students in Punjab. This is consistent with the results of previous international studies (Xu et al., 2011; Ma et al., 2018). Our findings show that SHS was frequently observed (44.6%) and was strongly associated with several modifiable behaviors, particularly physical inactivity, poor sleep quality, unhealthy diet, increased screen exposure, and tobacco and alcohol use. Although the cross-sectional design precludes any causal interpretation, the overall pattern of associations is consistent with studies that highlight the role of lifestyle factors in perceived physical and psychological well-being among university students.

Physical activity had the strongest association. Students with lower physical activity levels had significantly higher odds of SHS (OR = 0.87; 95% CI = 0.82–0.92; $p < 0.001$), indicating that more active students reported better health outcomes. Similar patterns have been observed in previous studies (Tamminen et al., 2020; Wu et al., 2013). Ma et al. (2018) have also reported that the more active students scored a better overall health profile. Our results are further supported by Muhammad et al. (2021), who observed that healthier students generally showed lower SHS scores. In contrast, students engaging in activities such as smoking, alcohol consumption, excessive screen time, unhealthy diets, and low physical activity were more likely to have poor health.

This study found a significant link between excessive screen time and SHS. Students who spent more time on screens were more likely to fall into the SHS category (OR = 1.03; 95% CI = 1.01–1.06; $p = 0.012$). Ahn & Fedewa (2011) also demonstrated that prolonged screen time can disrupt sleep patterns and reduce time spent on physical activity. In our findings, a significant number of students experiencing SHS reported longer screen-time duration (4.50 ± 2.2) than their healthier fellows (3.96 ± 1.2; $p < 0.001$). These findings support the hypothesis that digital exposure is a significant risk factor for lifestyle changes.

Sleep quality showed a similarly strong pattern. Participants with poor sleep were more likely to be in the SHS group (OR = 0.92; 95% CI = 0.89–0.94; $p < 0.001$). Healthy students had better sleep quality scores (8.24 ± 2.3) than the SHS group (7.31 ± 2.5; $p < 0.001$). This observation aligns with previous research, which has shown that poor sleep can lead to mood disturbances, decreased concentration, and fatigue (Gu et al., 2015; Xue et al., 2020; Al-Khani et al., 2019).

Nutritional habits are closely associated with SHS. Students with poor dietary habits had a considerably increased risk of suboptimal health (OR = 0.95; 95% CI = 0.93–0.97; $p = 0.003$), which supports earlier findings that nutrition is a significant health-related factor (Chen et al., 2017; Mamurov et al., 2020). Weight loss attempts were also associated with SHS (OR = 1.07; 95% CI = 1.02–1.11; $p = 0.001$). Many students, particularly females, reported engaging in restrictive practices, such as severe dieting, fasting, or using slimming products.

There was a significant correlation between substance-related behaviors. Tobacco use was more common among students with SHS (OR = 1.10; 95% CI = 1.02–1.18; $p = 0.028$). Although alcohol intake was uncommon in the sample, it was strongly related to SHS and statistically significant (OR = 1.95; 95% CI = 1.74–2.26; $p < 0.001$). These findings align with the behavioral patterns reported in the literature from other Asian settings (Ma et al., 2018; Mughal et al., 2024).

One of the main objectives of this study was to assess the relationship between the SHS and academic performance. Students with poorer physiological health showed higher odds of achieving a GPA < 3 (OR = 8.49; 95% CI = 5.93–12.15; p < 0.001). This finding is consistent with Byun's (2024) results, which noted that students with unhealthy lifestyle patterns are more likely to perform poorly in school. However, the direction of this association is unclear, as reduced health may lower academic performance or academic failure may lead students toward SHS risk-enhancing behaviors. However, longitudinal studies are required to clarify these mechanisms.

Several potential confounders were not assessed, including socioeconomic status, family stress, academic pressure, and history of chronic illness. These variables may influence lifestyle behaviors and perceived health, leading to residual confounding factors. All data were self-reported, which created recall and social desirability biases, especially in the case of tobacco and alcohol use. The low prevalence of alcohol consumption may also affect the stability of the odds ratio. Additionally, due to the selection of students from the four medical colleges, intercampus clustering effects may have influenced the results.

This study had several limitations. First, due to the cross-sectional design, the findings cannot establish causality between SHS and lifestyle factors. Longitudinal studies are required to determine the direction of these relationships. Second, the sample consisted only of medical students, which may limit the overall applicability of the results to other student groups. Third, all variables, such as health profile and lifestyle behaviors, were based on self-reported questionnaires, which may be affected by recall or social desirability bias and cannot replace clinical assessments. Future studies using objective measures and diagnostic interviews with diverse student groups should provide more substantial evidence.

Conslusions

In this multicenter group of medical students from Punjab, SHS was common and was clearly linked with lifestyle factors such as sleep, physical activity, screen time, diet, tobacco use, and alcohol use, as well as lower academic performance (GPA < 3). These results highlight the need for colleges to offer practical support, including lifestyle counselling, better sleep and screen-time guidance, and more opportunities for physical activity. As this was a cross-sectional study based on self-reported data from medical students only, the findings cannot prove causation. They may not apply to all university students in Pakistan.

Authors' contributions

MA, AJ, MM, and RY contributed to data collection, data analysis, study design, manuscript drafting, and revision. GJ and WUK contributed to the conceptualization of the study and performed critical revisions for important intellectual content. All authors read and approved the final manuscript.

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Competing interests

The authors declare no competing interests.

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