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Original Article

Exploring the Relationship Between Sleep Quality and Cardiovascular Risk Factors in University Students

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ABSTRACT

Background: Cardiovascular risk factors may begin to develop during young adulthood, when sleep habits, dietary behavior, stress exposure, and lifestyle patterns become established. Poor sleep quality has been linked with cardiometabolic risk, but evidence among university students remains limited. Objective: To assess the association between sleep quality and cardiovascular risk-factor domains among university students. Methods: A cross-sectional observational study was conducted among 235 university participants aged 18–26 years. Data were collected from April to June 2024 using a structured questionnaire, the Groningen Sleep Quality Scale, and a cardiovascular risk assessment questionnaire. Demographic characteristics, body mass index category, waist circumference category, sleep-quality responses, and cardiovascular risk domains were analyzed using IBM SPSS Statistics version 25. Frequencies and percentages were used for descriptive analysis, and Pearson correlation was used to assess relationships among nonconstant risk scores. Results: Most participants were female (63.4%) and aged 19–24 years (81.7%). Sleep-related complaints were frequent, including morning tiredness (64.3%), sleep latency longer than 30 minutes (61.3%), insufficient sleep (56.2%), nocturnal rising (53.2%), and sleep duration of five hours or less (51.5%). Sleep-related cardiovascular risk was categorized as medium in 64.3% and high in 11.9%. Sleep score showed weak correlations with lifestyle ($r = -0.055$, $p = 0.404$), blood pressure ($r = 0.022$, $p = 0.739$), and diet ($r = 0.127$, $p = 0.051$). The only statistically significant correlation was between blood-pressure and diet scores ($r = 0.198$, $p = 0.002$). Conclusion: Sleep disturbance was common among university students, but sleep score was not strongly associated with other cardiovascular risk domains. The findings support the need for larger studies using validated tools and adjusted analyses to clarify sleep-related cardiovascular risk in young adults. Keywords: Sleep Quality; Cardiovascular Risk Factors; University Students; Blood Pressure; Diet; Cross-Sectional Study

EDITORIAL INFORMATION

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INTRODUCTION

Cardiovascular diseases remain a leading cause of premature morbidity and mortality worldwide, with a disproportionate burden in low- and middle-income countries where preventive screening, early risk identification, and lifestyle modification are often insufficiently implemented at population level (1). Although clinically apparent cardiovascular disease is more common in later adulthood, many behavioral and metabolic risk factors begin to accumulate much earlier, including during adolescence and young adulthood, when dietary patterns, sleep habits, physical activity, stress exposure, and body composition may become established as long-term health trajectories (2). Early identification of modifiable

cardiovascular risk factors is therefore important because hypertension, dyslipidemia, diabetes, obesity, sedentary behavior, smoking, and unhealthy dietary practices can interact over time and increase future cardiometabolic vulnerability (3,4).

Sleep quality has increasingly been recognized as an important behavioral and physiological determinant of health. It reflects not only sleep duration but also perceived restfulness, sleep continuity, sleep latency, awakenings, and daytime consequences of inadequate sleep (5). Among university students, poor sleep quality is common because academic workload, irregular routines, psychological stress, excessive screen exposure, social commitments, and late-night technology use may disrupt circadian rhythm and reduce restorative sleep (6). Poor sleep quality has also been associated with impaired quality of life, fatigue, reduced cognitive performance, emotional dysregulation, anxiety, depressive symptoms, and poorer daytime functioning, all of which can influence health behavior and cardiometabolic risk profiles (7,8).

The relationship between sleep and cardiovascular health is biologically plausible and clinically important. Sleep disturbance may affect autonomic regulation, sympathetic activation, inflammatory pathways, glucose metabolism, appetite regulation, endothelial function, and blood pressure control, thereby linking poor sleep with several cardiovascular risk domains (9). Previous evidence has shown that short sleep duration and poor sleep quality are associated with obesity, elevated blood pressure, metabolic syndrome, dysglycemia, and other cardiometabolic risk factors in younger populations (10-17). In large prospective cohorts, poor sleep quality and abnormal sleep duration have also been associated with increased risk of cardiovascular disease, cancer, and mortality, although the magnitude and direction of these associations vary according to population characteristics, sleep measurement methods, and adjustment for lifestyle factors (11). Irregular sleep timing and circadian disruption may further contribute to cardiovascular risk through effects on blood pressure, heart rate, vascular tone, and metabolic regulation (12,13, 18-21).

In young adults, sleep quality may also be connected with other modifiable cardiovascular risk factors, particularly diet, stress, physical inactivity, and weight-related indicators. Poor sleep may influence appetite, food choices, caloric intake, and preference for energy-dense foods, while unhealthy dietary patterns may worsen sleep quality through metabolic and behavioral mechanisms (14). Academic stress is another relevant factor in university students because stress can impair sleep initiation and maintenance, while insufficient sleep can worsen stress perception and coping capacity (15). Smartphone use and prolonged screen exposure have also been associated with poor sleep quality, psychological distress, and reduced academic performance in student populations (16–18). These overlapping behavioral pathways suggest that sleep quality should be assessed alongside broader cardiovascular risk domains rather than as an isolated lifestyle factor (22-26).

Despite growing evidence linking sleep disturbance with cardiovascular risk, local data among Pakistani university students remain limited, particularly studies examining sleep quality together with lifestyle, stress, blood pressure, dietary risk, body mass index, and waist-related indicators. University students represent an important preventive-health population because most are clinically young and apparently healthy, yet may already show early clustering of modifiable risk behaviors. However, available student-based evidence often focuses on sleep quality, stress, or academic performance separately, with less emphasis on cardiovascular risk-factor profiling. This creates a need for context-specific evidence examining whether poorer sleep quality is associated with higher cardiovascular risk-factor scores in young university populations (27-31).

Therefore, this study was conducted to investigate the association between sleep quality and cardiovascular risk factors among university students. The study specifically aimed to assess whether poorer sleep quality was correlated with higher levels of cardiovascular risk domains, including lifestyle, stress, blood pressure, and dietary risk. The research hypothesis was that sleep-quality scores would show a measurable relationship with cardiovascular risk-factor scores among university students, while the null hypothesis was that no such relationship would be observed.

MATERIAL AND METHODS

A cross-sectional observational study was conducted to assess the relationship between sleep quality and cardiovascular risk factors among university students. This design was selected because the objective was to measure sleep-quality status and cardiovascular risk-factor domains at a single point in time and determine whether statistically measurable associations existed between these variables. Data were collected between April 2024 and June 2024 from university students enrolled at the University of Management and Technology, the University of Lahore, and Superior University, Lahore, Pakistan.

Participants were recruited through convenience sampling from the selected universities. Eligible participants were young adults aged 18 to 26 years who were currently enrolled as university students or otherwise affiliated with the university setting, were apparently healthy, and were willing to provide informed consent. Participants were excluded if they were pregnant, receiving inpatient hospital care, had a known history of cardiovascular disease, had a significant medical illness that could substantially affect sleep or cardiovascular risk assessment, or had a recent history of stroke within three months before enrolment. Participants who did not provide consent or submitted substantially incomplete questionnaire responses were not included in the final analysis (32-36).

Data were collected using a self-administered structured questionnaire after obtaining informed consent from each participant. The questionnaire included demographic information, anthropometric and risk-related variables, the Groningen Sleep Quality Scale, and a cardiovascular risk assessment questionnaire. Demographic variables included age group, sex, occupation, and body mass index category. Body mass index was classified as underweight, normal, overweight, or obese according to the categories used in the study dataset. Waist circumference was recorded and categorized separately for male and female participants using sex-specific cutoffs. For men, waist circumference was categorized as ≤94 cm, 94–101 cm, or ≥102 cm, while for women it was categorized as ≤80 cm, 81–87 cm, or ≥88 cm (4, 11,, 37-41).

Sleep quality was assessed using the Groningen Sleep Quality Scale, which contains 15 true/false items assessing perceived sleep experience during the previous night. The first item was not included in the total score. One point was assigned for “true” responses to items reflecting poor sleep and for “false” responses to positively worded sleep items, producing a maximum possible score of 14. Higher scores indicated poorer sleep quality. Cardiovascular risk factors were assessed using a cardiovascular risk assessment questionnaire that generated domain scores for lifestyle, stress, sleep, blood pressure, and diet. Each domain was categorized into low-risk, medium-risk, and high-risk levels according to the scoring structure applied in the study dataset. Blood pressure risk was assessed as a cardiovascular risk domain, and dietary risk was assessed according to questionnaire-based responses reflecting cardiovascular health-related dietary practices.

The primary exposure variable was sleep quality, measured using the Groningen Sleep Quality Scale and the sleep-related cardiovascular risk domain. The main outcome variables were cardiovascular risk-factor domains, including lifestyle score, stress score, blood pressure score, and diet score. Additional descriptive variables included age group, sex, occupation, body mass index category, and sex-specific waist circumference category. To reduce measurement inconsistency, the same structured questionnaire format was used for all participants, and responses were coded according to predefined scoring criteria before analysis. Data were reviewed for completeness, coding consistency, and plausibility before statistical analysis.

Data were analyzed using IBM SPSS Statistics version 25. Descriptive statistics were used to summarize participant characteristics and questionnaire responses. Categorical variables were reported as frequencies and percentages. Cardiovascular risk domains were summarized using low-, medium-, and high-risk categories. Correlation analysis was used to examine the relationship between sleep-quality-related scores and cardiovascular risk-factor scores. Pearson correlation coefficients were reported for continuous or score-based variables where the assumptions of correlation analysis were considered acceptable. Statistical significance was evaluated using two-tailed p-values, with $p < 0.05$ considered statistically significant. Variables with no variability were not included in correlation interpretation because

a correlation coefficient cannot be meaningfully computed when all participants have the same score category. Ethical approval was obtained from the relevant institutional authority before data collection. Participation was voluntary, informed consent was obtained from all participants, and confidentiality of participant responses was maintained throughout data collection, coding, analysis, and reporting.

RESULTS

A total of 235 participants were included in the analysis. The sociodemographic and anthropometric characteristics of the participants are presented in Table 1.

Table 1. Sociodemographic and Anthropometric Characteristics of Participants (n = 235)

Variable	Category	n (%)
Sex	Female	149 (63.4)
	Male	86 (36.6)
Body mass index category	Underweight	59 (25.1)
	Normal	134 (57.0)
	Overweight	42 (17.9)
	Obese	0 (0.0)
Occupation	Housewife	4 (1.7)
	Job holder	47 (20.0)
	Student	170 (72.3)
	Unemployed	14 (6.0)
Age group	≤18 years	11 (4.7)
	19–24 years	192 (81.7)
	≥25 years	32 (13.6)

Most participants were female, representing 149 of 235 participants (63.4%), while males accounted for 86 participants (36.6%). The largest body mass index category was normal weight, reported in 134 participants (57.0%), followed by underweight in 59 participants (25.1%) and overweight in 42 participants (17.9%); no participant was categorized as obese. Most participants were students, accounting for 170 participants (72.3%), and the predominant age group was 19–24 years, which included 192 participants (81.7%).

Table 2. Groningen Sleep Quality Scale Item-Level Responses (n = 235)

Item	False, n (%)	True, n (%)
I had a deep sleep last night	91 (38.7)	144 (61.3)
I feel like I slept poorly last night	126 (53.6)	109 (46.4)
It took me more than half an hour to fall asleep last night	91 (38.7)	144 (61.3)
I felt tired after waking up this morning	84 (35.7)	151 (64.3)
I woke up several times last night	137 (58.3)	98 (41.7)
I feel like I did not get enough sleep last night	103 (43.8)	132 (56.2)
I got up in the middle of the night	110 (46.8)	125 (53.2)
I felt rested after waking up this morning	108 (46.0)	127 (54.0)
I feel like I only had a couple of hours of sleep last night	100 (42.6)	135 (57.4)
I feel like I slept well last night	117 (49.8)	118 (50.2)
I did not sleep a wink last night	159 (67.7)	76 (32.3)
I did not have any trouble falling asleep last night	117 (49.8)	118 (50.2)
After I woke up last night, I had trouble falling asleep again	141 (60.0)	94 (40.0)
I tossed and turned all night last night	142 (60.4)	93 (39.6)
I did not get more than 5 hours of sleep last night	114 (48.5)	121 (51.5)

Several sleep-related symptoms were common in the sample. Difficulty initiating sleep was reported by 144 participants (61.3%), while tiredness after waking was reported by 151 participants (64.3%). More than half of the participants reported that they did not get enough sleep during the previous night, with 132 participants (56.2%) responding true to this item, and 135 participants (57.4%) reporting that they felt they had only a couple of hours of sleep. Night-time awakenings were also reported, with 125 participants (53.2%) stating that they got up in the middle of the night and 98 participants (41.7%) reporting that they woke up several times. At the same time, some positive sleep indicators were also present, as 144 participants (61.3%) reported deep sleep and 127 participants (54.0%) reported feeling rested after waking.

Lifestyle-related cardiovascular risk was categorized as low in 117 participants (49.8%), medium in 81 participants (34.5%), and high in 37 participants (15.7%). Stress was categorized as high risk in all 235 participants (100.0%), indicating absence of variability in this domain. Sleep-related cardiovascular risk was most frequently categorized as medium risk, observed in 151 participants (64.3%), while 28 participants (11.9%) were categorized as high risk. Blood pressure risk was low in 145 participants (61.7%), medium in 82 participants (34.9%), and high in 8 participants (3.4%). Dietary risk was low in 152 participants (64.7%), medium in 54 participants (23.0%), and high in 29 participants (12.3%).

Table 3. Cardiovascular Risk-Factor Categories (n = 235)

Risk-factor domain	Low risk, n (%)	Medium risk, n (%)	High risk, n (%)
Lifestyle	117 (49.8)	81 (34.5)	37 (15.7)
Stress	0 (0.0)	0 (0.0)	235 (100.0)
Sleep	56 (23.8)	151 (64.3)	28 (11.9)
Blood pressure	145 (61.7)	82 (34.9)	8 (3.4)
Diet	152 (64.7)	54 (23.0)	29 (12.3)

Table 4. Sex-Specific Waist Circumference Categories (n = 235)

Variable	Category	n (%)
Male waist circumference	Not applicable	149 (63.4)
	≤94 cm	51 (21.7)
	94–101 cm	27 (11.5)
	≥102 cm	8 (3.4)
Female waist circumference	Not applicable	86 (36.6)
	≤80 cm	94 (40.0)
	81–87 cm	47 (20.0)
	≥88 cm	8 (3.4)

Among male participants, 51 of the total sample (21.7%) had waist circumference ≤94 cm, 27 (11.5%) had waist circumference between 94 and 101 cm, and 8 (3.4%) had waist circumference ≥102 cm. Among female participants, 94 of the total sample (40.0%) had waist circumference ≤80 cm, 47 (20.0%) had waist circumference between 81 and 87 cm, and 8 (3.4%) had waist circumference ≥88 cm. The “not applicable” categories correspond to participants of the opposite sex for each sex-specific waist circumference variable.

Table 5. Pearson Correlations Among Cardiovascular Risk-Factor Scores

Variable pair	r	p-value	n
Lifestyle score and total sleep score	-0.055	0.404	235
Lifestyle score and total BP score	0.004	0.954	235
Lifestyle score and total diet score	0.034	0.605	235
Total sleep score and total BP score	0.022	0.739	235
Total sleep score and total diet score	0.127	0.051	235
Total BP score and total diet score	0.198	0.002	235

BP, blood pressure; r, Pearson correlation coefficient. Correlations involving total stress score were not computed because the stress score was constant across participants.

Correlation analysis showed weak relationships among most cardiovascular risk-factor scores. Lifestyle score had a weak negative correlation with total sleep score ($r = -0.055$, $p = 0.404$) and weak positive correlations with total BP score ($r = 0.004$, $p = 0.954$) and total diet score ($r = 0.034$, $p = 0.605$). Total sleep score had a negligible positive correlation with total BP score ($r = 0.022$, $p = 0.739$) and a weak positive correlation with total diet score ($r = 0.127$, $p = 0.051$). The only statistically significant correlation observed in the matrix was between total BP score and total diet score ($r = 0.198$, $p = 0.002$), indicating a weak positive association between these two cardiovascular risk domains. Correlations involving stress score could not be interpreted because all participants were categorized as high risk for stress, producing no score variability.

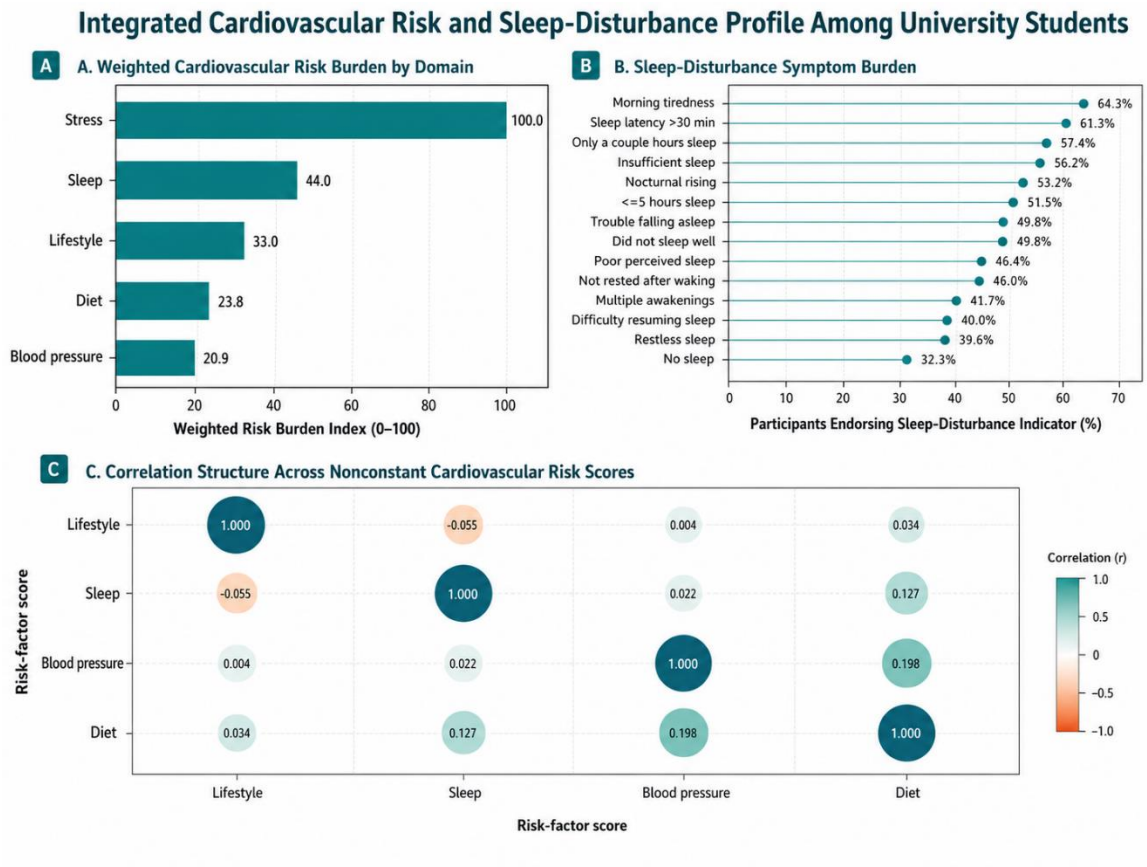

Figure 1. Integrated Cardiovascular Risk and Sleep-Disturbance Profile Among University Students. The panelled figure demonstrates that the highest weighted cardiovascular risk burden was observed for stress (100.0), followed by sleep-related risk (44.0), lifestyle risk (33.0), dietary risk (23.8), and blood-pressure risk (20.9). Sleep-disturbance indicators were frequent, with morning tiredness reported by 64.3% of participants, sleep latency longer than 30 minutes by 61.3%, only a couple of hours of sleep by 57.4%, insufficient sleep by 56.2%, nocturnal rising by 53.2%, and sleep duration of five hours or less by 51.5%. The correlation panel showed weak relationships among nonconstant cardiovascular risk scores; the strongest observed association was between blood-pressure and diet scores (r = 0.198), while sleep showed weak co rrelations with diet (r = 0.127), blood pressure (r = 0.022), and lifestyle (r = -0.055). Overall, the figure indicates a high burden of perceived stress and sleep disturbance in this university sample, but the available correlation structure does not support a strong statistical relationship between sleep score and other cardiovascular risk domains.

DISCUSSION

This cross-sectional study assessed sleep quality and cardiovascular risk-factor domains among 235 university participants and found that sleep-related complaints and behavioral risk indicators were common in this young adult sample. Most participants were aged 19–24 years, and the majority were female, students, and within the normal body mass index category. Despite the relatively young age and low frequency of obesity, several sleep-disturbance indicators were frequently reported, including morning tiredness, sleep latency longer than 30 minutes, insufficient sleep, nocturnal rising, and sleeping five hours or less. These findings are consistent with previous student-based evidence showing that poor sleep quality, insomnia symptoms, academic stress, and irregular routines are common among undergraduate and university populations (19, 42-44). The high frequency of sleep complaints in this study is clinically relevant because university years are a transitional period during which sleep hygiene, dietary patterns, physical activity, technology use, and stress-coping behaviors may become persistent lifestyle habits.

The present findings should, however, be interpreted with caution because the correlation analysis did not show a strong statistical relationship between sleep score and other cardiovascular risk domains. The correlation between lifestyle score and total sleep score was weak and negative, while the correlations of total sleep score with blood-pressure score and diet score were weak and statistically non-significant. Therefore, the data do not support a conclusion that poor sleep quality was a major independent contributor to cardiovascular risk factors in this sample. Rather, the results suggest that sleep disturbance

was common and may coexist with other cardiovascular risk domains, but the observed associations were small in magnitude. This distinction is important because previous studies have reported stronger links between sleep quality and cardiometabolic outcomes, but those associations are often influenced by differences in population age, clinical risk profile, measurement tools, sleep-duration assessment, obesity prevalence, confounder adjustment, and availability of biomarker-based cardiovascular outcomes (20,21).

The weak correlation between sleep and diet observed in this study may still be clinically meaningful as a preliminary signal, although it did not reach conventional statistical significance. Prior evidence indicates that poor sleep can influence appetite regulation, food timing, preference for calorie-dense foods, and overall dietary quality, while unhealthy dietary patterns may reciprocally worsen sleep quality through metabolic and behavioral pathways (22). In the current analysis, dietary risk showed a weak but statistically significant positive correlation with blood-pressure risk, suggesting that diet may be more closely aligned with early cardiovascular risk indicators than sleep score in this dataset. This finding is biologically plausible because dietary patterns, including excess sodium intake, low intake of protective nutrients, irregular eating behavior, and poor overall diet quality, are established contributors to elevated blood pressure and cardiometabolic risk (23,24). However, because the study used questionnaire-based risk categories rather than detailed nutrient intake or measured biochemical markers, the observed relationship should be considered exploratory.

The finding that all participants were categorized as high risk for stress requires careful methodological consideration. Stress is a recognized contributor to cardiovascular risk through neuroendocrine activation, sympathetic stimulation, inflammation, oxidative stress, behavioral dysregulation, and adverse effects on sleep and blood pressure (25,26). However, a variable with no dispersion cannot be meaningfully examined in correlation analysis. The uniform classification of all participants as high-risk for stress may reflect genuinely high perceived stress in the sample, but it may also indicate a scoring, coding, or cutoff problem in the cardiovascular risk assessment questionnaire. Future analyses should verify the stress-domain scoring procedure and consider using a validated stress instrument that provides adequate score variability. Without such verification, the present study cannot determine whether stress modifies or mediates the relationship between sleep quality and cardiovascular risk (43-46).

Blood-pressure risk was mostly categorized as low, although more than one-third of participants were in the medium-risk category and a small proportion were categorized as high risk. This pattern is expected in a young university sample but should not be dismissed, because elevated blood pressure in early adulthood may track into later life and contribute to future cardiovascular disease risk (27). The weak but statistically significant association between blood-pressure and diet scores in this study supports the need for early preventive interventions targeting dietary habits, physical activity, weight control, stress management, and routine blood-pressure monitoring. Evidence from lifestyle and hypertension literature consistently supports healthy diet, regular physical activity, sleep optimization, and avoidance of smoking and excess alcohol as central components of cardiovascular risk reduction (28,29).

The present study has several limitations. The cross-sectional design prevents inference about temporal sequence or causality between sleep quality and cardiovascular risk factors. The sample was recruited from university settings through convenience sampling, which limits generalizability to all young adults. Several variables were self-reported, creating potential recall and response bias. The cardiovascular risk assessment questionnaire and its domain-specific scoring criteria require clearer reporting and validation. The stress domain had no variability, preventing meaningful correlation analysis involving stress. The study also relied primarily on descriptive statistics and bivariate correlations without adjusted models controlling for age, sex, body mass index, waist circumference, physical activity, or other potential confounders. In addition, the available data did not include mean Groningen Sleep Quality Scale scores, biomarker profiles, detailed dietary intake, or repeated blood-pressure measurements, which would strengthen clinical interpretation (44).

Despite these limitations, the study provides useful preliminary evidence on sleep disturbance and cardiovascular risk profiling among university students. The findings highlight a high burden of reported

sleep-related symptoms and a notable distribution of lifestyle, diet, and blood-pressure risk categories in a young population. However, the corrected statistical interpretation indicates that sleep-quality scores were not strongly correlated with the measured cardiovascular risk domains. Future studies should use larger probability-based samples, validated multidimensional sleep and stress instruments, objectively measured blood pressure and anthropometric indicators, detailed physical activity and dietary assessment, and multivariable regression models to clarify whether sleep quality independently predicts early cardiovascular risk among university students.

CONCLUSION

In this cross-sectional study of university participants, sleep-related complaints and cardiovascular risk-factor domains were common, particularly medium-risk sleep scores, high reported stress classification, and measurable lifestyle, dietary, and blood-pressure risk categories. However, the correlation analysis showed only weak and mostly statistically non-significant relationships between sleep score and other cardiovascular risk domains, while the only statistically significant association was a weak positive correlation between blood-pressure and diet scores. These findings suggest that sleep disturbance is an important health concern in university students, but the present data do not establish sleep quality as a major independent contributor to cardiovascular risk. Larger, methodologically rigorous studies using validated tools, objective cardiovascular measurements, and adjusted statistical models are required to clarify the role of sleep quality in early cardiovascular risk development among young adults.

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