

ROLE OF SLEEP QUALITY IN THE DEVELOPMENT OF EARLY-STAGE HYPERTENSION AMONG YOUNG ADULTS

Muhammad Waqar Ali^{*1}, Umbreen Farrukh², Mehwish Butt³, Bacha Hussain⁴, Arfeen⁵, Kashan Ali⁶

^{*1}Department of Marine Sciences, Coast Guard University

²Department of Pharmacognosy, Faculty of Pharmacy and Pharmaceutical Sciences, Dow College of Pharmacy, Dow University of Health Sciences, Karachi

³Department of Medicine, Sultan Qaboos University Hospital, Muscat Oman

⁴Medical Officer, Department of Internal Medicine, DHQ Teaching Hospital MTI Bannu

⁵Department of Biotechnology, Federal Urdu University of Arts, Science and Technology

⁶Faculty of Pharmacy, Federal Urdu University of Arts, Science and Technology

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Corresponding Author: *
Muhammad Waqar Ali

Abstract

Background: Sleep plays a crucial role in cardiovascular regulation. Emerging evidence suggests that poor sleep quality may contribute to elevated blood pressure, particularly in younger populations. **Objective:** To assess the relationship between sleep quality and the development of early-stage hypertension in young adults. **Methods:** This cross-sectional, observational study was conducted at DHQ Teaching Hospital MTI Bannu from 10 Feb 2024 to 15 November 2024. A total of 325 young adults aged between 18 and 35 years were recruited through outpatient clinics, university campuses, and community health outreach programs. Participants were enrolled after providing informed written consent. Patients aged >18 years and who had no known history of chronic illness, cardiovascular disease, or psychiatric disorders were included in the study. **Results:** Poor sleep quality was observed in 60.9% of participants. Early-stage hypertension was present in 28.9% of the total sample, with a higher prevalence among those with poor sleep (34.3%) compared to those with good sleep (20.5%) ($p = 0.007$). After adjusting for BMI, smoking, physical inactivity, and family history, poor sleep quality remained a significant independent predictor of early-stage hypertension (adjusted OR = 1.89; 95% CI: 1.15–3.12; $p = 0.012$). Positive correlations were observed between PSQI scores and both systolic ($r = 0.29$, $p = 0.001$) and diastolic blood pressure ($r = 0.26$, $p = 0.003$). **Conclusion:** It is concluded that poor sleep quality is an independent and significant predictor of early-stage hypertension in young adults. These findings suggest the need for routine sleep quality assessment in cardiovascular risk screening and highlight the potential benefit of sleep-focused interventions in hypertension prevention strategies.

INTRODUCTION

Hypertension, long regarded as a disease of middle and older adulthood, is now alarmingly prevalent in younger populations. According to recent global

health surveys, approximately 10 to 15 percent of individuals aged 18 to 35 years exhibit elevated blood pressure levels, many of whom are unaware of

their condition [1]. This silent development of hypertension in early adult life significantly magnifies the total cardiovascular risk burden over a lifetime, exposing individuals to the perils of heart failure, stroke and renal complications at a younger age [2]. Although genetics, nutrition, and lack of physical activity have been historically blamed for early hypertension, poor sleep quality has become a key but under-acknowledged culprit. Sleep is critical to the physiological recovery, circadian regulation, and homeostasis of the cardiovascular system. Normal blood pressure oscillates in a dipping manner during sleep under the regulation of autonomic nervous system balance [3]. Sub-optimal sleep quality can interfere with this nightly dipping and individuals can have non-dipping hypertension, a pattern characterized by greater target organ damage. Furthermore, chronic sleep disruptions lead to enhanced sympathetic tone, heightened night-time cortisol, systemic inflammation, and endothelial dysfunction, all of which are valid mechanisms in the pathophysiology of hypertension [4].

In young adults, cases of sleep disturbance are increasing with changing societal norms, increased academic and occupational stress, and pervasive screen time at night. In a meta-analysis, over 40% of adults aged 18-25 years complained of poor sleep as measured by standard tools (Pittsburgh Sleep Quality Index) [5]. Although sleep is highly prevalent, it is often neglected during the regular cardiovascular risk evaluation in younger people. An increasing body of literature proposes a strong relationship between short sleep duration and propensity for developing hypertension, especially if sleep is interrupted, or not consistent [6]. A prospective cohort study demonstrated that individuals aged 25 to 35 years with poor sleep had a significantly higher incidence of prehypertension and stage 1 hypertension over five years, independent of BMI or physical activity. Furthermore, obstructive sleep apnea, which causes intermittent hypoxia and frequent arousals from sleep, is increasingly diagnosed even in non-obese young adults and is a well-established secondary cause of elevated blood pressure [7].

The neurohormonal mechanisms linking sleep and blood pressure include upregulation of the renin-angiotensin-aldosterone system, blunting of baroreceptor sensitivity, and activation of pro-

inflammatory cytokines such as interleukin-6 and C-reactive protein [8]. These alterations collectively promote vascular stiffness and impair vasodilation. Poor sleep quality also adversely affects health-related behaviors such as physical activity, diet, and alcohol use, indirectly increasing hypertension risk [9]. Despite these connections, research on the role of sleep quality in the early stages of hypertension among young adults remains limited and often methodologically inconsistent. Most studies either focus on older adults or evaluate sleep duration in isolation, neglecting other critical dimensions such as sleep latency, disturbances, daytime dysfunction, and subjective sleep quality. Additionally, cultural and regional variations in sleep practices, especially in low- and middle-income countries, may further influence this association and merit specific exploration [10].

Objective

To assess the relationship between sleep quality and the development of early-stage hypertension in young adults.

Methodology

This cross-sectional, observational study was conducted at DHQ Teaching Hospital MTI Bannu from 10 Feb 2024 to 15 November 2024. A total of 325 young adults aged between 18 and 35 years were recruited through outpatient clinics, university campuses, and community health outreach programs. Participants were enrolled after providing informed written consent. Patients aged >18 years and who had no known history of chronic illness, cardiovascular disease, or psychiatric disorders were included in the study. Participants with diagnosed secondary hypertension, those on antihypertensive or sleep-altering medications, shift workers, or individuals with diagnosed sleep disorders such as obstructive sleep apnea were excluded.

Data Collection

Data were collected through a systematically designed questionnaire. A pre-validated questionnaire was used to collect demographic details (age, gender, education, occupation), lifestyle factors (smoking status, alcohol intake, physical activity), and family history of hypertension. Sleep quality was assessed

using the Pittsburgh Sleep Quality Index (PSQI), a widely used and validated instrument for evaluating sleep disturbances over the past one month. The PSQI consists of 19 self-rated questions that generate seven component scores (sleep latency, sleep duration, sleep efficiency, sleep disturbances, sleep quality, use of sleep medication, and daytime dysfunction). A global score >5 indicates poor sleep quality. Blood pressure was measured using a calibrated automatic sphygmomanometer following standard protocols. Measurements were taken on two separate occasions, at least five minutes apart, with the participant in a seated position after adequate rest. Early-stage hypertension was defined according to American College of Cardiology/American Heart Association (ACC/AHA) guidelines (2017) as a systolic blood pressure between 130–139 mmHg or a diastolic pressure between 80–89 mmHg.

Statistical Analysis

Data were analyzed using SPSS version 17. Descriptive statistics were used to summarize demographic and clinical variables. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as means \pm standard deviations. A p-value of <0.05 was considered statistically significant.

Results

A total of 325 participants were included in the study, with a mean age of 27.4 ± 4.5 years. Among them, 172 (52.9%) were male and 153 (47.1%) were female. The mean body mass index (BMI) was 24.7 ± 3.1 kg/m². Based on the Pittsburgh Sleep Quality Index (PSQI), 198 participants (60.9%) were categorized as having poor sleep quality (PSQI score >5), while 127 (39.1%) had good sleep quality.

Table 1. Demographic and Clinical Characteristics by Sleep Quality

Variable	Poor Sleep (n = 198)	Good Sleep (n = 127)	p-value
Age (years)	27.8 ± 4.3	26.9 ± 4.6	0.08
Male sex (%)	106 (53.5%)	66 (52.0%)	0.78
BMI (kg/m ²)	25.2 ± 3.3	23.9 ± 2.8	0.003
Smoking (%)	48 (24.2%)	18 (14.2%)	0.03
Family history of HTN (%)	72 (36.4%)	32 (25.2%)	0.04
Physical inactivity (%)	84 (42.4%)	31 (24.4%)	0.001
Hypertension (%)	68 (34.3%)	26 (20.5%)	0.007

In multivariate logistic regression analysis, poor sleep quality was found to be a significant independent predictor of early-stage hypertension (adjusted OR =

1.89; 95% CI: 1.15–3.12; $p = 0.012$). Higher body mass index (OR = 1.14; $p = 0.002$) and physical inactivity (OR = 1.73; $p = 0.045$) also showed significant associations with elevated blood pressure.

Table 2. Binary Logistic Regression Predicting Early-Stage Hypertension

Variable	Adjusted OR	95% CI	p-value
Poor sleep quality	1.89	1.15–3.12	0.012
BMI (per unit increase)	1.14	1.05–1.24	0.002
Smoking	1.61	0.92–2.82	0.09
Physical inactivity	1.73	1.01–2.96	0.045
Family history of HTN	1.48	0.87–2.52	0.14
Age	1.03	0.97–1.10	0.32
Male sex	1.12	0.67–1.88	0.64

Prolonged sleep latency (>30 minutes) was observed in 66.7% of the poor sleep group versus 15.0% of

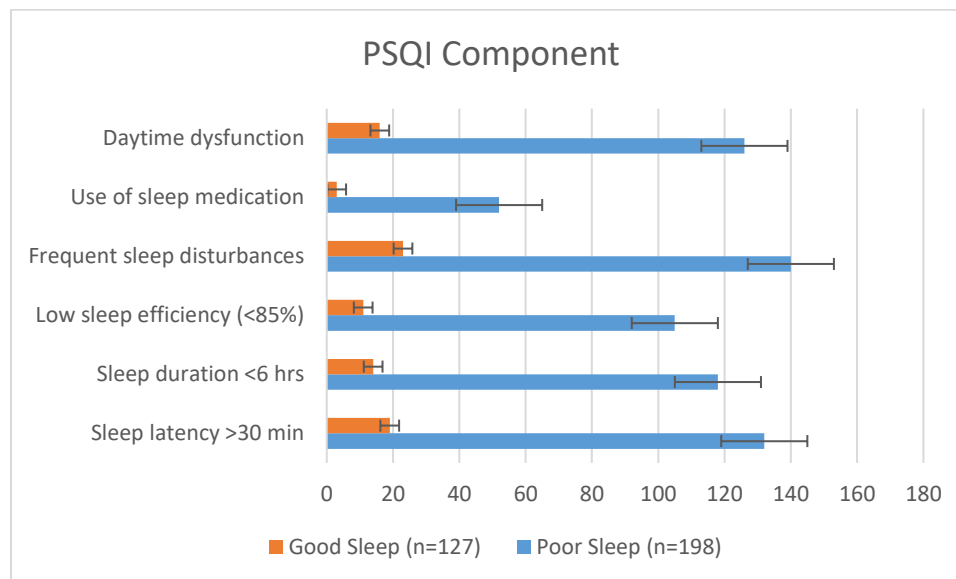
the good sleep group. Similarly, short sleep duration (<6 hours), low sleep efficiency, and frequent sleep

disturbances were markedly more prevalent in the poor sleep group, with p-values <0.001 for all

comparisons.

Table 3. PSQI Components by Sleep Quality

PSQI Component	Poor Sleep (n=198)	Good Sleep (n=127)	p-value
Sleep latency >30 min	132	19	<0.001
Sleep duration <6 hrs	118	14	<0.001
Low sleep efficiency (<85%)	105	11	<0.001
Frequent sleep disturbances	140	23	<0.001
Use of sleep medication	52	3	<0.001
Daytime dysfunction	126	16	<0.001

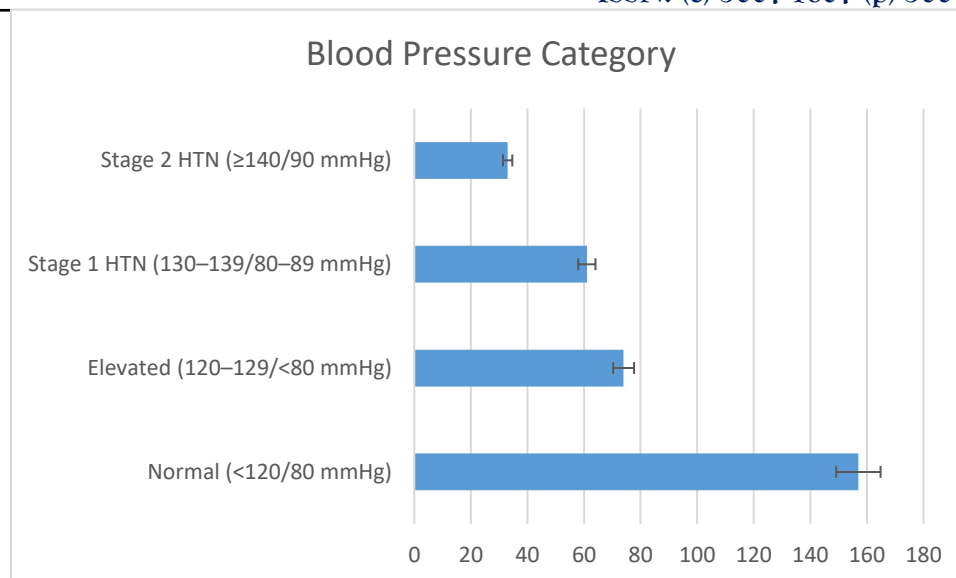


Among the 325 participants, 48.3% had normal blood pressure, while 22.8% fell into the elevated category. Early-stage hypertension (Stage 1) was present in 18.8% of individuals, and 10.1% were classified as having Stage 2 hypertension. These

findings highlight that nearly 29% of young adults already exhibit clinical hypertension, emphasizing the need for early screening and preventive strategies in this age group.

Table 4. Blood Pressure Categories

Blood Pressure Category	Number of Participants	Percentage (%)
Normal (<120/80 mmHg)	157	48.3
Elevated (120–129/<80 mmHg)	74	22.8
Stage 1 HTN (130–139/80–89 mmHg)	61	18.8
Stage 2 HTN (≥140/90 mmHg)	33	10.1



There was a moderate positive correlation between PSQI scores and both systolic and diastolic blood pressure. Higher PSQI scores, indicating poorer sleep

quality, were associated with increased systolic blood pressure ($r = 0.29$, $p = 0.001$) and diastolic blood pressure ($r = 0.26$, $p = 0.003$).

Table 5. Correlation Between Sleep Score and Blood Pressure

Variable	Pearson Correlation (r)	p-value
PSQI score vs Systolic BP	0.29	0.001
PSQI score vs Diastolic BP	0.26	0.003

Discussion

This study investigated the association between sleep quality and early-stage hypertension among young adults aged 18 to 35 years. The findings indicate a significant relationship between poor sleep quality and elevated blood pressure, even after adjusting for confounding variables such as BMI, smoking status, physical inactivity, and family history of hypertension. Over 60 percent of participants in this study were classified as having poor sleep quality based on PSQI scores, highlighting the high prevalence of suboptimal sleep habits in young populations. Among poor quality sleep group, 34.3 percent had early stage hypertension from 20.5 percent in good sleep group. These results are in line with previous studies that hypothesize that inadequate or disrupted sleep poses a risk of elevated sympathetic nervous system activity, impaired nocturnal blood pressure falling, and systemic inflammation – all of which play a role in the pathophysiology of hypertension [11].

Logistic regression analysis confirmed that poor sleep quality was an independent predictor of early-stage hypertension (adjusted OR = 1.89, 95% CI: 1.15–3.12, $p = 0.012$). Moreover, high BMI and physical inactivity were also important predictors. These results are consistent with previous studies that identified poor sleep as a modifiable risk factor that acts in interaction with metabolic and behavioral pathways to affect blood pressure regulation [12]. Surprisingly, various PSQI elements, including prolonged sleep latency, shortened sleep duration, low sleep efficiency, and daytime dysfunction were significantly higher among subjects with poor sleep quality [13]. These levels of sleep have previously been associated with greater activation of the hypothalamic-pituitary-adrenal (HPA) axis and decreased vagal tone, mechanisms that directly influence blood pressure regulation. The PSQI score positive correlation with both systolic and diastolic blood pressure ($r = 0.29$ and 0.26 correspondingly)

also confirms the hypothetical association of worse sleep with greater cardiovascular stress [14].

Our results also show a worrying trend in the blood pressure profile of the studied population. The proportion who were classified as having early-stage hypertension was approximately 29 percent and 10 percent reached stage 2 hypertension [15]. This emphasizes the need for inclusion of lifestyle factors such as sleep even in screening and prevention strategies for hypertension in younger cohorts who have previously been regarded as low-risk. The use of a validated tool to evaluate multidimensional sleep quality and the study's focus on a young, otherwise healthy demographic are two of its strengths. However, there are some limitations to be aware of [16]. The cross-sectional design prevents causal inferences, and the reliance on self-reported sleep quality may introduce recall bias. Objective sleep assessments such as actigraphy or polysomnography would offer more precision but were beyond the scope of this study [17]. Additionally, the study did not consider undiagnosed conditions like sleep apnea, which could have muddled the connection between hypertension and sleep. Despite these limitations, the findings have important public health implications. Given the growing prevalence of poor sleep among young adults due to academic stress, technology use, and lifestyle irregularities, early intervention strategies focused on sleep hygiene education and behavior change may help mitigate the rising incidence of hypertension in this age group.

Conclusion

It is concluded that poor sleep quality is significantly associated with the development of early-stage hypertension among young adults. The study findings demonstrate that individuals with inadequate or disturbed sleep are at a nearly two-fold higher risk of developing elevated blood pressure compared to those with good sleep quality. This association remains significant even after adjusting for traditional risk factors such as BMI, smoking, and physical inactivity. These results highlight the importance of recognizing sleep quality as an independent and modifiable cardiovascular risk factor.

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