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THE ASSOCIATION OF TOTAL SLEEP DURATION ON HYPERTENSION RISK IN PAKISTAN: A PROSPECTIVE ANALYSIS.

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Abstract

Background: Lack of sleep has been associated with negative cardiovascular events, such as high blood pressure. But evidence in South Asian population is limited. **Objective:** This prospective study aimed to assess the relationship between total sleep duration and the development of hypertension in adults aged 40-70 years. **Study place and duration** The study was conducted from January 2023 to August 2024 in rural areas of sindh. **Methodology** The study include adults (697) who didn't have hypertension initially. Researchers tracked who developed hypertension over time and categorized participants based on their reported sleep duration: less than 6 hours, 6-7.9 hours, 8-9.9 hours, or 10 hours or more. Multivariable logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs). **Results:** 70 participants (9.6%) were diagnosed as hypertension at follow-up.Sleeping <6h versus the reference group was associated with significantly higher risk of hypertension (adjusted OR, 1.71; 95% CI, 1.01 to 2.89; P<0.05). A significant association was not observed for longer sleep lengths. **Conclusions:** Short sleep was independently related to risk of incident hypertension. These results suggested sleep duration may be an indicator of cardiovascular risk discussing the importance of sleep hygiene to prevent hypertension

INTRODUCTION

The prevalence of hypertension worldwide is high as well as that it contributes substantially to the risk of developing renal and cardiac diseases [1-2]. Elevated blood pressure not only predisposes to diabetes, but also aggravates coronary and other vascular complications including those affecting the micro and microvasculature [3-4]. The prevalence of hypertension in Pakistan has increased up

to the alarming level, affecting approximately 35% of the total population. Although great endeavors have been exercised to apply workable interventions and preventions, the problem still remains challenging to the region. The upward trend emphasizes the importance of the targeted programs and policies to mitigate the multifaceted factors that are fueling high blood pressure, such as lifestyles changes, dietary habits and access to health services. The significantly elevated prevalence of hypertension in East Asia indicates that public health measures should be given priority so as to alleviate and control the disease burden on healthcare systems [5]. Because of high prevalence and impact, researchers are highly interested to explore lifestyle risk factors based on population based longitudinal studies [6].

For good health and overall well-being, a good night's sleep is essential. Long-term sleep restriction has consistently been shown to be an independent risk factor for developing a range of serious conditions, including obesity, type 2 diabetes, metabolic syndrome, and coronary heart disease . The focus should be on acquiring enough sleep to protect oneself from diseases and to combat existing conditions. Sleep affects numerous essential procedures in the human body. Deprivation has grave ramifications. One of the most evident is hormone fluctuations. A lack of sleep disrupts the ratio of hormones that control hunger, growth, and even widening. Another is metabolism. It plays a function in maintaining blood sugar levels, insulin sensitivity, and energy use. Deprivation may have long-lasting implications and increase one's chances of acquiring metabolic disorders, such as obesity and type 2 diabetes. Consideration of getting enough sleep is necessary for retaining optimal physiology conditions and low chances of getting chronic diseases. Previous studies have established a relationship between short sleep period and hypertension. However, much of this work has been done in the Western world. Consequently, the findings may not apply straightforwardly to other races. There are variations in lifestyle, genomic mark-up and the global cause differences that may influence the sleep-BP relationship. Besides, most researches on sleep and BP are cross-sectional, which can only be used to determine a relationship but not causation. As a result, prospective studies are critical in determining the link between reduced sleep and Hypertension. They will offer insight into the relationship between sleep duration, hypertension and factors to reduce and prevent Hypertension. Prospective efforts will also focus on different populations.

Health care workers should pay more attention to the significant risk factors for interventions for prevention and control of hypertension in order to reduce its burden on individuals and communities. However, the relationship between sleep duration and hypertension is complex and evidence from long-term follow-up studies has produced conflicting findings. Several previous reports showed that short sleep duration significantly increased the risk of hypertension, whereas a few studies failed to demonstrate a strong association. These conflicting results emphasize the need for further research to unravel the association of sleep with blood pressure, taking into account not only quality and quantity of sleep but also intersubjective variability. An enhanced knowledge of sleep and hypertension linkage helps to promote prevention and treatment approaches for health care professionals [21-22].

We aimed to study the association between short sleep duration and the risk of Hypertension in a group of high-risk population. The study showed that blood pressure rose more sharply each hour when people got only 5 hours of sleep per night in a disrupted pattern, compared to those who got consistent 5 or 8 hours of sleep per night. Furthermore, individuals who normally slept for 6 hours or less per night experienced greater increases in blood pressure compared to those who slept for more than 6 hours per night. By exploring whether sleep duration might be linked to hypertension, the study aimed to determine if short nocturnal sleep duration could play an important role in the prevalence of Hypertension and provide some targets that can contribute to its control and prevention. The findings of the study have important public health and clinical implications in the context of preventing cardiovascular diseases through the maintenance of healthy sleep habits.

METHODOLOGY

A prospective cohort study was conducted to investigate the risk factors of chronic metabolic diseases, which include diabetes, dyslipidemia, obesity, metabolic syndrome and atherosclerosis. In the study, the sample size of 1000 adults male and female of age between 40-70years was taken from the rural Sindh, Pakistan. Follow up was also easier to access, as the rural population is more stationary and has low migration, thus monitoring of the outcomes is more secure.

The patient recruitment commenced in January 2023 to August 2024 in rural areas of sindh. A follow-up questionnaire was sent to all the participants whose response rate was 74.6% (n = 921). 185 of whom had hypertension at baseline, 7 had a history of cardiovascular disease, 19 had a cardiovascular event at follow-up and 13 were excluded for lack of complete data; the remaining 697 were included in the final analysis. All participants provided a written informed consent. The protocol for the study was approved by the College of Family Medicine Institutional Review Board.

Data Collection

Examination of subjects also occurred at baseline and at follow-up visit. Medical and physical histories were taken and lifestyle questionnaire were provided. Anthropometric measurements were performed while subjects were wearing light indoor clothes without shoes. Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared (kg/m^2). Waist circumference was used to define central obesity.The blood pressure was measured with a mercury sphygmomanometer, which is reliable and valid. For consistency, all subjects were tested on the right arm. Systolic (SBP) and diastolic (DBP) blood pressures were taken to indicate cardiovascular functioning and diagnose hypertension.

Activity Participants completed self-administration yes/no questionnaires for level of physical activity. Overall energy consumption was assessed using a validated dietary recall questionnaire and expressed as kilocalories per day. Demographic data also obtained included participants' education level (elementary, middle school, high school, college), and marital status (single, married).Fasting blood samples were obtained after an overnight fast of at least 12 hr. This study measured the following serum parameters of each subject: fasting blood glucose, total cholesterol, triglycerides, and high (HDL) and low (LDL) density lipoprotein cholesterols using the enzymatic method with an automatic chemistry analyzer. Fasting insulins were also measured.

Statistical Analysis

Key baseline characteristics were summarized using descriptive statistics. Continuous variables with normal distributions were described as the means and standard deviations; whereas categorical data was described as the counts and percentages. The relationship between sleep duration and incident hypertension was tested with two-sample t-tests and one-way analysis of variance (ANOVA) where appropriate.

We used multivariable logistic regression model to estimate odds ratios (ORs) and 95% confidence intervals (CIs) of baseline sleep duration for predicting new-onset hypertension at 1 year. Sleep time categories were <6 hours, 6 to 7.9 hours (reference category), 8 to 9.9 hours, and ≥10 hours. There were 4 stepwise models constructed after controlling for potential confounders: age, sex, education, lifestyle variables (smoking, physical activity), socioeconomic status (household income) and metabolic health variables (BMI, HDL cholesterol, triglycerides, fasting glucose). A p- value less than 0.05 served as reference for the level of significance.

Study Limitations

Several limitations should be noted. It should be mentioned that sleep time was based on self-report and may be susceptible to recall bias and information bias. Information on depressive symptoms, insomnia and sleep-disordered breathing was lacking and may have influenced both sleep pattern and blood pressure. Secondly, maybe owing to short follow-up duration (1 year), long term projection could be limited. Medications that could affect duration and quality of sleep were also not taken into account in the study.

RESULTS

The study found 9.56% of participants had hypertension over a median follow-up of 1 year. Individuals who became hypertensive were older and more likely to be male compared with those who remained normotensive. They also had higher baseline measurements for weight, waist circumference, blood pressure, triglycerides, total cholesterol and LDL cholesterol. Also, those who developed hypertension were less educated compared to who did not (table 1).

Baseline characteristics of participants according to sleep duration are shown in Table 2, which was divided into <6 hours/day, 6-7.9 hours/day, 8-9.9 hours/day, and ≥10 hours/day. Subjects who slept less than 6 h/day were older, with higher triglycerides, total cholesterol, LDL cholesterol and fasting blood glucose than those who slept 6-7.9 h/day. Compared with midrange sleepers, short sleepers were less likely to do regular physical activity, smokers or have a high total energy intake. Higher-income participants who slept for short periods were more likely to have hypertension. Conversely, those participants with ≥10-hour sleep/day had also poor profiles such as advanced age, elevated lipid levels, low HDL cholesterol, high fasting blood glucose and lower levels of exercise/physical activity.

TABLE 1 Baseline characteristics of study population by incident hypertension

Incident Hypertension			
	No	**Yes**	**P Value**
No. (%)	630 (90.44)	67 (9.56)	
Age, y	53.31±8.18	55.79±8.00	**<.001**
Male sex	224 (35.6)	77 (47.0)	**.005**
Weight, kg	59.83±9.15	64.12±9.80	**<.001**
WC, cm	80.59±8.44	85.80±7.70	**<.001**
BMI, kg/m^2	23.69±2.87	25.10±2.71	**<.001**
SBP, mm Hg	117.23±11.02	122.47±9.99	**<.001**
DBP, mm Hg	73.82±7.39	75.32±6.91	**0.014**
Triglycerides, mg/ld.	127.39±84.06	143.88±84.43	**0.017**
Total cholesterol, mg/ld.	196.90±35.78	202.83±34.51	**0.043**
HDL cholesterol, mg/ld.	46.72±10.78	45.61±11.41	**0.214**
LDL cholesterol, mg/ld.	115.26±30.86	120.43±28.45	**0.040**
FBG, mg/ld.	92.95±18.90	95.31±14.96	**0.122**
Regular exercise, %	185/630 (29.4)	39/163 (23.9)	**0.171**
Current smoker, %	102/630 (16.3)	29/162 (17.9)	**0.689**
Education levels			**0.121**
Elementary	284/630 (45.2)	86/164 (52.4)	
Middle school	120/630 (19.0)	34/164 (20.7)	
High school	146/630 (23.2)	31/164 (18.9)	
College	80/630 (12.6)	13/95 (8)	
Married			**0.378**
Yes	562/630 (89.2)	142/164 (86.6)	
No	68/630 (10.8)	22/164 (13.4)	
Sleep duration, h/d			**0.100**
<6	58 (9.2)	25 (15.2)	
6–7.9	346 (54.9)	82 (50.0)	
6–7.9	82 (50.0)	51 (31.1)	
≥10	**26 (4.2)**	**6 (3.7)**	

Data are expressed as number (percentage) or mean standard deviation. BMI, body mass index; DBP, diastolic blood pressure; FBG, fasting blood glucose; HDL-C, high-density lipoprotein cholesterol ; LDL-C, low-density lipoprotein cholesterol; MAP, mean arterial pressure; SBP, systolic blood pressure; WC, waist circumference.

TABLE 2 Baseline characteristics of patient data according to sleep duration

	<6 h/d (n=69)	6–7.9 h/d (n=379)	8–9.9 h/d (n=220)	≥10 h/d (n=29)	P Value
Incident cases	11 (14.9)	34 (8.8)	22 (9.4)	3 (8.5)	**.100**
Age, y	56.36±8.12	53.02±8.23	53.42±7.91	54.80±8.49	**<.001**
Male sex	20 (29.2)	139 (36.7)	86(38.9)	11(38.0)	**0.152**
Weight, kg	58.88±9.13	60.22±9.12	60.58±9.75	61.01±8.42	**0.183**
WC, cm	81.26±8.08	80.70±8.41	81.61±8.78	81.68±8.59	**0.223**
BMI, kg/m^2	23.97±3.02	23.75±2.77	23.85±3.08	24.25±2.43	**0.447**
SBP, mm Hg	117.84±11.24	117.67±11.18	118.07±10.68	115.70±11.19	**0.399**
DBP, mm Hg	73.98±7.03	74.08±7.39	73.85±7.42	73.63±7.24	**0.924**
Triglycerides, mg/dL	129.26±129.74	125.23±75.65	131.32±77.06	158.86±100.15	**0.010**
Total cholesterol, mg/dL	203.28±36.32	195.29±35.03	198.05±36.12	207.17±36.66	**0.004**
HDL-C, mg/dL	48.43±10.91	46.29±10.89	46.82±10.71	44.54±10.67	**0.039**
LDL-C, mg/dL	118.60±30.90	114.24±30.31	116.33±31.10	124.31±29.58	**0.024**
FBG, mg/dL	94.80±23.54	92.93±16.63	92.39±14.94	98.42±40.83	**0.044**
Regular exercise	11/69 (15.0)	125/379 (33.0)	60/220 (27.3)	4/29(19.7)	**<.001**
Current smoker	9/ 69 (13.7)	61/379 (16.1)	40/220 (18.1)	12/29 (15.5)	**0.513**
Energy intake (calorie)	2001.19±202.08	2068.67±227.64	2075.23±218.85	2044.29±227.55	**0.001**
Education levels					**<.001**
Elementary	43/69 (62.9)	152/379 (40.4)	106/220 (48.2)	17/29 (60.0)	
Middle school	12/ 69 (17.4)	73/379 (19.4)	44/220 (20.0)	4/29 (14.3)	
High school	10/69 (13.8)	95/379(25.2)	48/220 (21.7)	6/29 (20.0)	
College	4/69 (6.0)	57/379 (15.1)	22/220 (10.0)	2/29 (5.7)	

TABLE 3 ORs (95% confidence intervals) for new-onset hypertension according to baseline sleep duration.

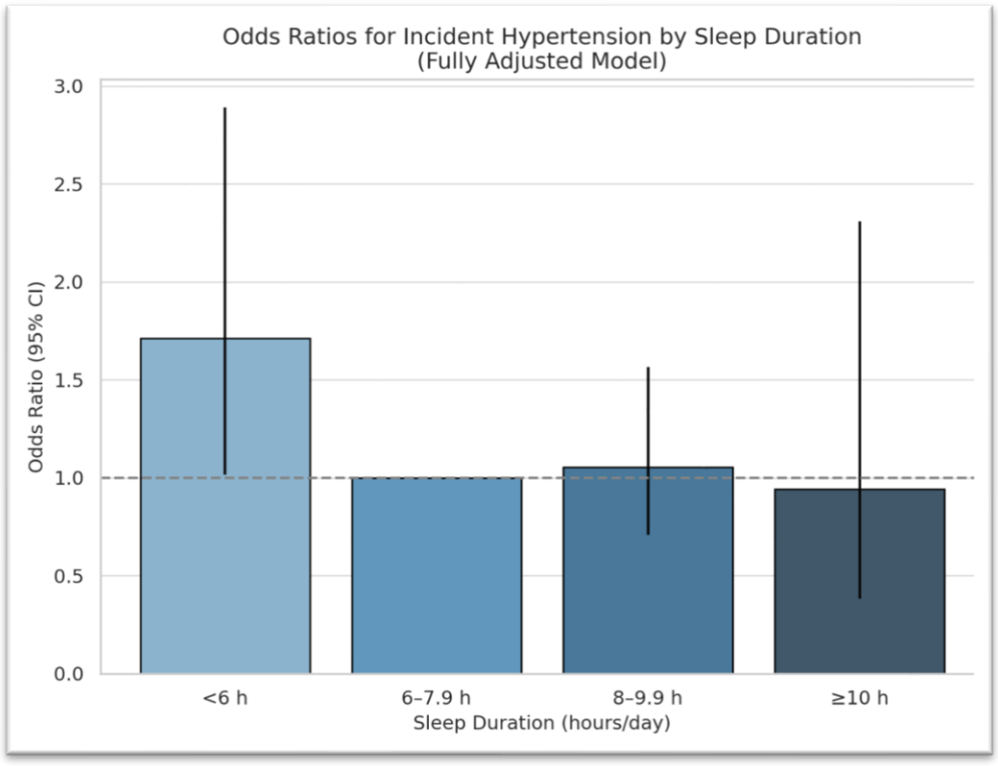
Incident Hypertension				
Sleep duration, h	**Scheme 1**	**Scheme 2**	**Scheme 3**	**Scheme 4**
<6	1.991 (1.210–3.275)[a]	1.854 (1.115–3.082)[a]	1.761 (1.048–2.958)[a]	1.712 (1.014–2.890)[a]
6–7.9	1 (reference)	1 (reference)	1 (reference)	1 (reference)
8–9.9	1.148 (0.779–1.692)	1.103 (0.746–1.629)	1.036 (0.698–1.537)	1.053 (0.708–1.565)
≥10	1.129 (0.470–2.709)	1.070 (0.443–2.583)	0.965 (0.396–2.352)	0.940 (0.383–2.309)

Scheme 1: Crude odds ratio (OR).
Scheme 2: Adjusted OR: adjusted for age and sex.
Scheme 3: Adjusted OR: adjusted for age, sex, education, smoking, alcohol status, income, regular exercise, and obesity.

Scheme 4: Adjusted OR: adjusted for age, sex, education, smoking, alcohol status, income, regular exercise, obesity, high-density lipoprotein, triglyceride, glucose, and mean arterial pressure.
[a]P<.05 compare with the reference.

The ORs and 95% CIs for hypertension according to sleep duration are summarized in Table 3. The refrence group was 6-7.9 hours/day sleepers. In the unadjusted analysis, subjects sleeping less than 6 hours per day had increased odds of incident hypertension (OR 1.991, 95% CI 1.201-3.275). The association was still significant after controlling for other factors such as age, sex, lifestyle and metabolic factors. In the multivariable analysis, those sleeping less than 6 hours/day were 1.712 (CI 95%, 1.014-2.890) times as likely to develop hypertension as compared to the latter category. Conversely, no significant positive relationship existed between long sleep duration and risk of hypertension.

Fig 1 showed the relation of hypertension with sleep duration



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DISCUSSION

This study demonstrated that sleeping less than 6 hours was associated with an increased risk of developing hypertension during a follow-up year in participants aged 40 years and older. A short sleep length was identified as an independent predictor of hypertension. In contrast, long sleep duration (10 or more hours) was not associated with an elevated risk for hypertension. Participants who slept less than 6 h/day were more likely to develop hypertension (OR = 1.712) compared to those who slept 6-7.9 h/day. Hypertension in the population was 9.56% during follow-up.

Similar link between short sleep duration and the prevalence of hypertension has been noted in previous studies with odds ratio of 1.66 and 1.56, which is in line with the current finding. However, these studies were not prospective, as was done in our study. Not withstanding such differences, the finding in the similarity of estimates shows that short sleep duration is a strong predictor of hypertension and the present study increases the weight of evidence for this association (23-27).

It has been analyzed through epidemiological studies and meta-analyses how short sleep duration relates to hypertension risk. Sample sizes, duration of follow-up, ethnic differences, methodologies for measuring sleep duration and hypertension have differed across these studies. Recent seems to be showing systematic reviews and meta-analyses of longitudinal studies the short duration of sleep is long-term with an increased risk of hypertension. For example, one meta-analysis had found a relative risk of 1.23, while another demonstrated a relative risk of 1.21 for incident hypertension in short sleep duration subjects. The precise biological mechanisms of the association have not been entirely elucidated, but it is believed that sleep deprivation can cause sympathetic hyperactivity, decreased sensitivity to insulin and changes in appetite and satiety hormone secretion, resulting in obesity and type 2 diabetes, which are established risk factors for hypertension [28-30]. Sleep restriction is associated with greater risk of hypertension by several pathways. One potential pathway is what is known as endothelial dysfunction, when blood vessels are not functioning as well as they should. When the blood vessels are not working properly, you can bet you’re going to

see high blood pressure. Moreover, unhealthy behaviors, which are frequently related to lack of sleep can also enhance blood pressure towards the development of hypertension. These factors may act synergistically to increase blood pressure and the risk of cardiovascular disease [31-34].
Research has shown that sleep quality plays a crucial role in the development of hypertension. Studies have consistently found that individuals with poor sleep quality have a higher prevalence of hypertension. Furthermore, the combination of poor sleep quality and short sleep duration has been shown to have an additive effect on the risk of hypertension, particularly in certain populations. Despite these findings, the relationship between sleep quality and the risk of future hypertension development requires further investigation through longitudinal studies [35]. Notably, our study did not assess sleep quality and its association with incident hypertension, highlighting an area for future research. Some studies have found no significant association between short sleep duration and the risk of hypertension. Cross-sectional studies by Bansil et al. and Hall et al. reported odds ratios of 1.03 and 1.10, respectively, indicating a non-significant relationship between short sleep duration and hypertension. These findings suggest that short sleep duration may not be a significant risk factor for hypertension in certain populations [36, 37]. Research has shown that both short and long sleep durations are associated with an increased risk of type 2 diabetes and cardiovascular disease, forming a U-shaped relationship [38]. A previous cross-sectional study found a U-shaped relationship between sleep duration and hypertension, but our prospective study did not replicate this finding. We observed no significant relation between long sleep duration and incident hypertension (adjusted odds ratio = 0.940). The reasons behind this difference remain unknown, and additional prospective studies with other measures of sleep are required to confirm our findings [39].

This study is among the few that are prospective to test the association of sleep time with fine risk of incident hypertension. Of note, a previous study among this population has reported similar associations between short sleep duration and new-onset hypertension. Nevertheless, in the present study, we have expanded this line of research, using a large sample size, controlling for a great number of potential confounders (socioeconomic factors, dietary habits (energy intake) or lipid profiles (cholesterol levels). Taking these factors into consideration, the results of our study enhanced the real relationship between sleep length and hypertension and have significant public health and preventive health value.

CONCLUSIONS

In this study, regardless of age classification, short sleep duration are significant independent risk factors for hypertension in middle-aged and older adults. In conclusion, the present study demonstrates that the duration of sleep is an independent predictor of hypertension and that having a healthy sleep pattern is very important for preventing hypertension.

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