



Association between sleep duration and hypertension: Isfahan Healthy Heart Program, Iran

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Original Article

Abstract

BACKGROUND: Hypertension (HTN) is an important risk factor for atherosclerotic and non-atherosclerotic cardiovascular disease (CVD). HTN increases risk of stroke and diabetes complications and at the end stage renal disease. Sleep disorders including short sleep duration are involved in pathogenesis of HTN. This study aimed to examine the association between self-reported sleep duration and HTN in a group of adult population in Isfahan City, Iran.

METHODS: This cross-sectional survey was performed as part of the Isfahan Healthy Heart Program (IHHP). A total of 12492 individuals aged over 19 years (6110 men and 6382 women) entered the study. Sleep duration was recorded according to subjects' self-report. HTN was defined as a systolic blood pressure (SBP) of ≥ 140 mmHg, a diastolic blood pressure (DBP) of ≥ 90 mmHg, or use of antihypertensive medication. The relation between sleep hours and HTN was examined using multiple logistic regression in three models, unadjusted, adjusted according to age and sex, and adjusted according to age, sex, body mass index (BMI), and waist circumference (WC).

RESULTS: Sleeping time less than 5 hours, in comparison to sleep duration of 7-8 hours per night, was associated with a higher risk of HTN [odds ratio (OR) = 2.52, 95% confidence interval (CI): 2.17-2.93]. This association remained significant even after adjustment for age, sex, BMI, and WC (OR = 1.38, 95% CI: 1.16-1.64). Sleep duration over 9 hours had a negative association with risk of HTN among those under 60 years old (OR = 0.63, 95% CI: 0.47-0.86).

CONCLUSION: Sleep duration less than 5 hours is positively associated with HTN. It seems that sleep duration might affect HTN and atherosclerotic CVD.

Keywords: Sleep Duration, Hypertension, Cardiovascular Diseases

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Introduction

Several basic research studies have demonstrated the impact of sleep disorders in the occurrence or development of common diseases such as obesity, diabetes, or hypertension (HTN). More recent epidemiological surveys seem to confirm this association in Iranian population.^{1,2} These studies have observed that a total sleep time under 6 hours is associated with an increased body mass index (BMI) and a higher occurrence of diabetes and HTN.³ In longitudinal analysis of the first National Health And Nutrition Examination Survey (NHANES I), American adults aged 32 to 59 years with sleep duration of ≤ 5 hours per night had a 60% higher risk of incidental HTN.⁴

Sleep Heart Health Study (SHHS) with a cross-

sectional design showed a significant higher prevalence of HTN in persons with sleep duration above or below the median of 7 to 8 hours per night. This association was stronger in those persons with short sleep duration (6 hours per night), with a 66% higher risk of HTN.⁵

Prevalence of HTN in Iran is 25%.⁴ Age, male gender, obesity, central obesity, hypercholesterolemia, and diabetes have been known as determinants of HTN among Iranians.⁶

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However, little is known about usual sleep duration among Iranian subjects and whether it has any association with high blood pressure (BP).

This study aimed to assess the association of HTN with sleep duration in a sample of Iranian adult population. Moreover, it is the first report of daily sleep duration among Iranian subjects.

Materials and Methods

This cross-sectional study was conducted in 2000-2001 as a part of Isfahan Healthy Heart Program (IHHP) in Isfahan, Iran. IHHP is a six-year comprehensive integrated community-based program for cardiovascular disease (CVD) prevention and control via reducing CVD risk factors and improvement of cardiovascular healthy behaviors.⁷

Participants were 12492 individuals aged over 19 years. 6110 men and 6382 women entered the study. Sociodemographic characteristics such as age, sex, marital status, occupation, education, and income were recorded. Sleep time was obtained by the question "how many hours of sleep do you usually get?".⁸

Height, weight, waist circumference (WC), and BP were measured by trained health professionals. Weight was measured with calibrated scale, with patient in the standing position with light clothes. Height was measured in the standing position with the patient barefoot. BMI was calculated as weight/height² (kg/m²). WC was measured at the part of the trunk located midway between the lower costal margin (bottom of lower rib) and the iliac crest (top of pelvic bone) while the person was standing, with feet about 25-30 cm apart. BP was measured twice on the right arm, in sitting position and after 15-minute rest. The mean of two recordings was reported. The first and fifth Korotkoff sounds were considered as systolic BP (SBP) and diastolic BP (DBP), respectively. HTN

was defined as a SBP of 140 mmHg or more, a DBP of 90 mmHg or more, or use of antihypertensive medication.⁹

Baseline characteristic data of patients were presented as mean \pm standard deviation (SD) for quantitative variables and frequencies and percentages for multiple variables. Differences between groups for continuous variables was analyzed by one-way analysis of variance (ANOVA) and for multiple variables was assessed by chi-square test. The relation between sleep time and HTN was examined using binary logistic regression in three models, unadjusted, adjusted according to age and sex, and adjusted according to age, sex, BMI, and WC. P-values of 0.050 or less were considered statistically significant.

The analysis was performed using SPSS statistical software (version 15, SPSS Inc., Chicago, IL, USA).

Results

The study population included 12492 persons, 6110 (49.9%) men and 6382 (51.1%) women with a mean age of 38.89 ± 14.93 years. 1911 (15.3%) participants were hypertensive. Of all the participants, 7622 (61%) reported sleeping 7-8 hours per night, 3783 (30.3%) reported sleeping 6 hours or less, and 1087 (8.7%) reported sleeping 9 hours or more (Table 1).

Considering sleep duration of 7-8 hours per night as reference category, multiple logistic regression showed that sleep duration less than 5 hours was associated with a higher risk for HTN [odds ratio (OR) = 2.52, 95% confidence interval (CI): 2.17-2.93]. The association remained significant even after adjustment for age, sex, BMI, and WC (OR = 1.38, 95% CI: 1.16-1.64). However, among subjects with sleep duration of 9 hours or more, a reverse association with HTN was found (OR = 0.71, 95% CI: 0.56-0.89) (Table 2).

Table 1. Characteristics of the study participants

| Sleep duration (hour) | Reported usual sleep time per night | | | | Total | P |
|------------------------------|-------------------------------------|-------------------|-------------------|-------------------|-------------------|---------|
| | ≤ 5 | 5-6 | 7-8 | ≥ 9 | | |
| Number of subjects [n (%)] | 1447 (11.6) | 2336 (18.7) | 7622 (61.0) | 1087 (8.7) | 12492 | - |
| Female sex [n (%)]* | 725 (50.1) | 1109 (47.5) | 3894 (51.1) | 652 (60.0) | 6380 (51.1) | < 0.010 |
| BP [n (%)] | | | | | | < 0.010 |
| HTN | 379 (26.2) | 378 (16.2) | 1030 (13.5) | 124 (11.3) | 1911 (15.3) | |
| Normal | 535 (37.0) | 1042 (44.6) | 3658 (48.0) | 572 (52.6) | 5789 (46.5) | |
| Age (year) (mean \pm SD)** | 47.35 \pm 16.19 | 40.52 \pm 14.36 | 37.26 \pm 14.08 | 35.49 \pm 15.81 | 38.89 \pm 14.93 | < 0.010 |
| BMI (mean \pm SD)** | 26.21 \pm 5.12 | 26.00 \pm 4.68 | 25.32 \pm 4.68 | 25.02 \pm 5.08 | 25.52 \pm 4.78 | < 0.010 |
| WC (mean \pm SD)** | 93.30 \pm 13.57 | 92.23 \pm 13.48 | 89.86 \pm 13.13 | 88.40 \pm 13.63 | 90.57 \pm 13.37 | < 0.010 |

* Chi-square test; ** ANOVA test

BMI: Body mass index; WC: Waist circumference; BP: Blood pressure; HTN: Hypertension; SD: Standard deviation

Table 2. Data for hypertension (HTN) and pre HTN by reported usual time in subjects

| Usual sleep time/night | Model | | | | | | |
|------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------------------------|
| | 1 | | 2 | | 3 | | 4 |
| | HTN | Pre HTN | HTN | Pre HTN | HTN | Pre HTN | HTN Pre-HTN |
| ≤ 5 | 2.52 (2.17,2.93) | 1.24 (1.09,1.41) | 1.58 (1.33,1.86) | 1.15 (1.01,1.31) | 1.38 (1.16,1.64) | 1.06 (0.93,1.22) | 0.99 (0.82,1.19) 0.98 (0.86,1.12) |
| 6 | 1.30 (1.13,1.49) | 1.09 (0.99,1.21) | 1.21 (1.04,1.40) | 1.07 (0.97,1.18) | 1.06 (0.91,1.23) | 0.99 (0.89,1.10) | 0.86 (0.73,1.02) 0.96 (0.87,1.07) |
| ≥ 9 | 0.77 (0.63,0.95) | 0.85 (0.74,0.98) | 0.66 (0.53,0.83) | 0.86 (0.75,0.98) | 0.71 (0.56,0.89) | 0.90 (0.79,1.04) | 0.79 (0.61,1.02) 0.93 (0.81,1.08) |

HTN: Hypertension

Data are given as odds ratio (OR) and 95% confidence interval (CI) for the presence of HTN and pre HTN relative to normal blood pressure, from categorical logistic regression models using 7-8 hours of sleep per night as the reference category. Model; 1: Was unadjusted, 2: Adjusted for age and sex, 3: Adjusted for age, sex, waist circumference (WC), and body mass index (BMI), and 4: Adjusted for age, sex, WC, BMI, and physical activity.

When adjusted for age and sex, this relation was true for subjects aged under 60 years. Sleeping less than 5 hours (OR = 1.67, 95% CI: 1.29-2.16) or 6-8 hours (OR = 1.28, 95% CI: 1.02-1.59) was associated with higher odds for HTN among women under 60 years (Table 3).

Discussion

In this study, sleep duration under 5 hours was positively associated with HTN. This was independent of age, sex, BMI, and abdominal obesity. Sleep duration more than 9 hours was negatively associated with HTN only in subjects under 60 years old. The mean age of subjects in our study was 38.89 ± 14.93 years, so majority of them were middle-aged.

Other studies have reported inconsistent results regarding association of HTN and sleep duration. Vgontzas et al. evaluated the combined effect of insomnia and short sleep duration on HTN risk. They found an increased risk of HTN in persons who had insomnia and short sleep duration; this risk was comparable to that of other common sleep disorders such as sleep apnea. They examined the

joint effect of insomnia and objective short sleep duration on HTN risk and found that insomnia with short sleep duration was associated with increased risk of HTN, to a degree comparable to that of other common sleep disorders such as sleep apnea.¹⁰ In the NHANES I after an 8- to 10-year follow-up, incidence of HTN was higher in participants aged 32 to 59 years who slept 5 hours or less, compared to those sleeping 7 to 8 hours.⁴ In the Whitehall II Study, prevalence of HTN was higher in women with short sleep duration (< 5 hours).¹¹ On the other hand, Lopez-Garcia et al. studied 3600 individuals over 60 years old and concluded that self-reported sleep duration was not associated with HTN in older adults.¹² Moreover, in NHANES I or in older adults in the Rotterdam Study, no association was observed between sleep duration and HTN in subjects aged 59 years and older.¹³ In addition, one meta-analysis of 17 cohort studies reported that short sleep duration was related to increased HTN risk.¹⁴ Conversely, some cross-sectional, but not longitudinal studies revealed that long sleep duration was associated with prevalence of HTN.^{15,16}

Table 3. Odds ratio (OR) of hypertension (HTN) in relation to sleep duration adjusted for age and sex (logistic regression models using 7-8 hours of sleep per night as reference category)

| Variable | Number | Reported usual sleep time per night | | | | P |
|-------------------|--------|-------------------------------------|------------------|-----|-------------------|-------|
| | | < 5 | 5-7 | 7-8 | ≥ 8 | |
| HTN [OR (95% CI)] | | | | | | |
| Sex | | | | | | |
| Male | 3494 | 1.11 (0.84,1.47) | 0.83 (0.65,1.06) | ref | 0.62 (0.42,0.930) | 0.030 |
| Female | 4139 | 1.67 (1.29,2.16) | 1.28 (1.02,1.59) | ref | 0.73 (0.53,1.002) | 0.001 |
| Age (year) | | | | | | |
| < 60 | 6525 | 1.48 (1.19,1.84) | 1.08 (0.90,1.29) | ref | 0.63 (0.47,0.860) | 0.001 |
| ≥ 60 | 1108 | 1.13 (0.79,1.59) | 0.89 (0.61,1.29) | ref | 0.78 (0.48,1.270) | 0.510 |

HTN: Hypertension; OR: Odds ratio; CI: Confidence interval

It has been shown that decreased sleep duration and sleep deprivation are associated with higher activity of autonomic sympathetic system and increased activity of hypothalamic-pituitary-adrenal axis (HPA axis). Sleep deprivation may also increase the activity of these systems by its effect on other body stressors.¹⁷ Acute sleep deprivation increases sympathetic and decreases parasympathetic cardiovascular modulation and baroreflex sensitivity (BRS).¹⁸

Sleep duration under 5 hours may induce small autonomic imbalance that is not significant immediately, but in long time, will increase BP.¹⁸ Short sleep duration also increases cardiovascular events in patients with HTN independently, and according to recent studies, it also increases mortality from heart disease.^{19,20}

The mechanism of the effect of short sleep duration on HTN may be different in the elderly.¹³ Sympathetic tone decreases with age,²¹ so the effect of short sleeping hour is not significant in the elderly. This may explain why some studies found no relation between sleep duration under 5 hours and HTN in those over 60 years old.^{4,13}

In our study, sleep duration over 9 hours in those under 60 years old, was negatively associated with HTN. In the SHHS, sleep duration was associated with increased prevalence of HTN.⁵ This difference may be explained by different level of daily stress in different societies. It means that in a society with a high level of daily stress, increased sleep duration means lower level of waking-time stresses and lower sympathetic tone, and this means decreased prevalence of HTN. Consequently, a recent review has concluded that enough duration of sleep has several advantages and few complications; however, it is required to prioritize proper time for rest.²²

Our findings were based on subjects' self-report of the duration of their sleep. We did not also check quality of sleep or sleep disorders in our sample.

Conclusion

Sleep duration under 5 hours is associated with HTN. Although a casual relation can not be inferred from this cross-sectional study, it may influence patients with CVD. Further studies are needed to characterize any causal relationship and find whether short sleep duration might be considered as a risk factor or at least as a health problem in preventive cardiology.

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Conflict of Interests

Authors have no conflict of interests.

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