International Journal of Clinical Endocrinology

Research Article

Survey of Relationship between Prevalence of Metabolic Syndrome and Sleep Disorders among Adults in Ahvaz City, Southwestern of Iran

Seyed Mahmoud Latifi[1]*, Karandish M[2] and Shahbazian H[1]

[1]*Diabetes Research Center, Health Research Institute, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

[2]*Nutrition and Metabolic Diseases Research Centre, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

***Address for Correspondence:** Seyed Mahmoud Latifi, Diabetes Research Center, Health Research Institute, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, Tel: +98-916-113-3490; E-mail: sml1381@yahoo.com

Submitted: 03 December 2022; **Approved:** 19 December 202December; **Published:** 20 December 2022

Cite this article: Latifi SM, Karandish M, Shahbazian H. Survey of Relationship between Prevalence of Metabolic Syndrome and Sleep Disorders among Adults in Ahvaz City, Southwestern of Iran. Int J Clin Endocrinol. 2022 Dec 20 ;5(1): 001-006.

ISSN: 2640-5709

SUMMARY

Background: Metabolic Syndrome (MetS) is currently considered a health and well-being problem. Researchers are seeking to control and manage the risk factors of this syndrome. One of the factors considered in studies is the duration and quality of sleep. The present study, therefore, has investigated the relationship between sleep duration and quality with prevalence of adult MetS in Ahvaz City.

Methods: This cross-sectional was carried out on people aged over 20 years in Ahvaz (Iran) during 2014-15. Samples were selected by cluster sampling method, and were called from six health centers. Fasting blood sample (12 h), height, weight, blood pressure, and other demographic information were obtained through a questionnaire.

Results: Of totally 890 participants in this study, 25.3% had MetS and 81.5% of the subjects suffered from sleep disorder based on the Pittsburg test. In this study, with the help of logistic regression and the presence of age, sex, literacy level and BMI variables, there were no correlations between the duration and quality of sleep with the prevalence of metabolic syndrome.

Conclusion: This study showed that the prevalence of MetS and sleep disorder is very high in Ahwaz, with women being at a higher risk than men in terms of both variables are.

Keywords: MetS; Sleep disorder; Petersburg questionnaire; Ahvaz

INTRODUCTION

MetS suggests a simultaneous risk factor for cardiovascular disease such as insulin resistance, obesity, atherogenic lipids, and hypertension [1]. MetS is associated with a two-fold increase in the risk of myocardial infarction, cardiovascular disease, and mortality due to these diseases as well as a 1.5-fold increased risk of all types of deaths [2]. The global prevalence of MetS is increasing, largely attributable to an increase in obesity and a low-activity lifestyle. Given that, the syndrome is currently a health and well-being problem [3], researchers are seeking to identify the risk factors underlying the syndrome, thereby, reduce the risk of people affection through the control and management of the risk factors. The risky and examined variables include poor breakfast habits, increased TV watching times, and decreased physical activity, lower fiber consumption, and higher BMI in adolescents with a significant effect on the syndrome in adulthood [4-6]. The waist circumference also represents the obesity of the central body developing the risk of a metabolic syndrome incidence [7]. According to reports, the prevalence of adult MetS is 22.8% in Ahvaz (15.9% in men and 29.1% in women) [8].

Sleep is another related variable repeatedly considered in studies on adults, for instance, showing that sleep duration to be associated with the risk of MetS [9]. Low and high sleeps are both risky behaviors that increase the chance of developing the MetS [10], and also probability the ground for important metabolic diseases such as diabetes [11-13], obesity [14,15], and cardiovascular disease (especially Hypertension) [16,17]. Finally, prospective population based studies indicate that sleep duration may be a good predictor of all causes of mortalities [18,19].

A meta-analysis reviewed 18 papers and suggested that short-term sleep is more strongly associated with the development of MetS, with an hourly decrease in sleep corresponding to a 0.06 rise in odd ratio of the syndrome development. Sleeping less than 5 hour raises 1.5 fold the risk of MetS development, but oversleeping had no significant effects on the likelihood of developing a syndrome [20]. However, sleep assessment by simply examining the duration is not sufficient and one should consider all qualitative and quantitative aspects.

Considering the heavy burden of MetS on health, Healing, and economic systems, as well as the priority of prevention to treatment in disease management, this study aimed to examine the relationship between overnight sleep quality and the prevalence of MetS in people aged over 20 years in Ahvaz. If there is a significant relationship between the two variables, the results can help adopt appropriate measures to improve lifestyle, including a proper and adequate sleep, in order to prevent the future occurrence of the syndrome or reduce the severity of possible catches.

MATERIALS AND METHODS

This descriptive-analytic study was conducted on people aged over 20 years in Ahvaz during 2014-15. Stratified cluster sampling method was used in order to select samples from six health centers in Ahvaz (four and two centers in the east and west, respectively, according to the population covered). Blood samples were collected and announcing and inviting people to the health center completed questionnaires. At each center, the health center staff who were involved in the project and had received the necessary training carried out the following activities.

1) Filling in a form containing questions about age, gender, educational level, parents' job, daily activity, and smoking.

2) Measuring the waist size on the middle end of the last hip, the hip, and the height with a standard meter. Also, determining the weight using a Seca standard scale.

3) Measurement of systolic and diastolic blood pressure from the right arm at least 5 minutes after rest in two times of 30 seconds in sitting position by a dial barometer while fitting the stethoscope appropriately under the cuff. Meanwhile, the hands of the subjects were in a hanging mode. The mean of two measurements was recorded as the blood pressure. To record the blood pressure, the Korotkoff sounds were recorded in Phases 1 and 5, preferably with the bell part of stethoscope. The numbers of blood pressure in the first and fifth Korotkoff phases were recorded as systolic and diastolic pressures, respectively, in the questionnaire.

4) Blood samples (5 cc) were collected from individuals (after 12 h of fasting) and transferred to the diabetes laboratory at the Ahvaz University of Medical Sciences. The samples were then centrifuged at 2500-3500 rpm for 10 min. High-Density Lipoprotein (HDL), Triglyceride (TG) and Cholesterol (Chol) levels were measured through the enzymatic method by an auto analyzer (BT3000, Italy). Low-Density Lipoprotein (LDL) level in subjects with triglyceride levels of 400 mg/dl or lower was calculated by the Friedewald equation [21].

5) Completing the Pittsburgh questionnaire.

Pittsburg sleep quality index

Pittsburgh questionnaire is a suitable method for studying

different aspects of sleep, which consists of 19 items and seven sections and the total points are calculated as the final score of the individual. The questionnaire is completed by the person or via interviews and examines sleep quality and disturbances over the past month [22]. The seven sections include the individual's understanding of sleep quality, sleep latency, sleep duration, sleep adequacy (the ratio of sleeping hours to bed hours), Sleep Disorders (sleep brake), soporific use, and the occurrence of dysfunction during the day (the problem of staying awake while being involved in a social activity). The questionnaire scores a total of 21 and the questions have a Likert scale scored zero to three. Attaining a score ≥ 6 in the questionnaire indicates suffering from sleep disorder.

Metabolic syndrome diagnostic criteria

For diagnosis of metabolic syndrome, at least three of the following five components were considered necessary (according to ATP III criteria update 2005) [23].

1. Abdominal obesity (Waist circumference ≥ 102 cm in men and ≥ 88 cm in women).

2. TG ≥ 150 mg/dl or history of drug consumption for hypertriglyceridemia.

3. HDL ≤ 40 mg /dl in men and ≤ 50 mg/dl in women or history of drug consumption.

4. BP systolic ≥ 130 mmhg or BP diastolic ≥ 85 mmhg or history of anti-hypertensive drug consumption.

5. FBS ≥100 mg/dl, history of diabetes mellitus history or using anti diabetic drugs.

BMI: BMI < 25 kg/m^2 is normal weight, 25 ≤ BMI ≤ 29.99 is overweight, and BMI ≤ 30 kg/m^2 is obesity [24].

Statistical analysis

Descriptive statistics were used to provide tables, percentages and mean ± SD.

Chi-square test was used for relation between qualitative variables and independent t-test was used to compare the mean variables.

Logistic regression was conducted to estimate the odds ratios and the corresponding 95% confidence intervals (95% C.I.s) for the associations between MetS and sleep quality using the global PSQI score and 7 other PSQI component subscales after adjusting for the aforementioned variables. Significance level was set to 0.05, and data analysis was performed using SPSS version 20.

RESULTS

Out of 890 participants in this study, 25.3% (225 persons) suffered from MetS, with the highest prevalence in the aged over 60 years 48.7% (men 40.4% and women 60%). The mean ages of MetS patients and healthy subjects were 52 ± 13.4 and 40.43 ± 15.1 years, respectively, showing a significant difference ($p < 0.001$). Pittsburg sleep disorder questionnaire revealed that 81.5% of subjects suffered from sleep disorder (79.2% in men and 83.1% in women), with the highest prevalence of 81.5% in patients aged 60 year. The mean ages of subjects with sleep disorder (42.2 ± 15.6 years) and those with normal sleep (43.3 ± 15.3 years) showed no significant differences. The difference between MetS prevalence in sleep disorder 25.9% and normal 21.8% subjects was not significant ($p = 0.62$). The mean score of PSQI in women (8.74 ± 2.56) was significantly higher than that (8.25 ± 2.5) of men ($p = 0.012$). The mean score of PSQI (8.71 ± 2.5) in MetS patients was non-significantly higher than that of non-syndromic subjects (8.8 ± 2.5). The average sleep duration in the group with normal sleep quality was 5.46 ± 1.53, and in the group with abnormal sleep quality was 3.38 ± 0.86; which is a significant difference ($p < 0.0001$).

There is a significant relationship between the prevalence of abnormal HDL components of MetS with sleep Duration and abnormal waist circumference with sleep latency. However, the rest of the components of sleep and metabolic syndrome did not show a significant relationship.

Table 1 shows the comparison of MetS prevalence in individuals with and without sleep disorders in terms of demographic variables.

As seen in table 1, MetS is significantly more prevalent (50.5%) in sleep disorder subjects aged over 60 years old than those (26.1%) with a normal sleep only.

As shown in table 2, there is no significant differences between

Table 1: Comparison of MetS prevalence in individuals with and without sleep disorders in terms of demographic variables.

		Prevalence of MetS (%)		*p*-value
		Sleep Disorder%	Sleep Normal	
Age	20-29	6.1	8.3	0.62
	30-39	12.9	22.2	0.21
	40-49	28.4	38.1	0.37
	50-59	36.5	23.1	0.18
	60 ≤	50.5	26.1	0.034*
BMI	< 25	11.5	6	0.25
	25 - < 30	27.4	23.5	0.58
	30≤	44.9	43.8	0.9
Sex	Male	21.8	15.4	0.25
	Female	29	27.9	0.85
Waist C.	Normal	9.7	10.8	0.39
	Un normal	55.9	51	0.81
FBS	Normal	10.3	6.5	0.08
	Un normal	59.1	57.5	0.44
HDL	Normal	16.9	14.5	0.29
	Un normal	35.9	34.7	0.44
Hypertension	Normal	14.4	12.7	0.31
	Un normal	55.9	58.4	0.41
TG	Normal	9.4	10.9	0.32
	Un normal	60.3	53.7	0.17
Education	Illiterate	47.9	55	0.37
	Primary	28.4	22.3	0.15
	High	14.7	17.6	0.31
	Diploma and above	21.1	50	0.27

Table 2: Prevalence components of MetS in sleep disorder and normal individuals.

Component of MetS	Sleep Disorder	Sleep Normal	*p*-value
	n (%)	*n* (%)	
TG	189 (32.4)	46 (34.6)	0.62
FBS	186 (31.8)	47 (35.3)	0.43
WC	204 (34.9)	39 (29.3)	0.21
Hypertension	161 (27.6)	23 (17.3)	0.014*
HDL	276 (47.3)	65 (48.9)	0.73

the prevalence of MetS components in normal and sleep disorder subjects, with statistically dissimilar prevalence of hypertension only.

In the logistic regression equation (age over 40) variable had a significant effect on prevalence of MetS (The age group of 40-49 with OR = 3.86, 50-59 with OR = 4.26, and over 60 with OR = 4.26 showing the effect of increasing age on prevalence of MetS.)

The second effective variable was the BMI > 25; indicating that being Overweight (with OR = 2.93) and obese (with OR = 5.95) increased the prevalence of the MetS.

The third effective variable was increasing the level of education, which had a significant effect on reducing the prevalence of MetS. Also, the gender variable has a significant effect, but the duration and quality of sleep did not show a significant correlation (Table 3).

DISCUSSION

Sleep quality has been suggested to play an important role in development of MetS. However, the results have been inconsistent. In this study, MetS was more prevalent 25.9% (men 21.8% *vs.* women29%) in sleep disorder subjects than those with a normal sleep 21.8% (men 15.4% *vs.* women 27.9%) but this difference not significant. Of course, the prevalence of MetS in women with sleep disorders was significantly higher than in men (p = 048).

In a systematic and meta-analysis study that included 22 separate studies, a positive relationship between sleep quality and metabolic syndrome was confirmed (OR = 1.37, 95% CI 1.15-1.64). Similarly, sleep complaints, including difficulty in falling sleep (OR 1.18, 95% CI 1.05-1.33), difficulty in maintaining sleep (OR 1.15, 95% CI 1.02-1.30)

Table 3: Logistic regression analysis of sleep quality and duration on the prevalence of metabolic syndrome.

	B	SE	Wald	*p*-value	OR*	95% CI for OR	
						Lower	Upper
BMI			48.003	0.000			
BMI(25-29.99 /< 25)	1.078	0.247	18.999	0.000	2.939	1.810	4.772
BMI(> = 30/< 25)	1.791	0.259	47.933	0.000	5.995	3.611	9.954
age			58.796	0.000			
Age(30-39/20-29)	0.537	0.391	1.888	0.169	1.711	0.795	3.680
Age(40-49/20-29)	1.352	0.371	13.252	0.000	3.866	1.867	8.005
Age(50-59/20-29)	1.450	0.360	16.245	0.000	4.265	2.107	8.634
Age(> 60/20-29)	2.403	0.369	42.379	0.000	11.051	5.361	22.779
PSQI.(un normal/normal)	0.114	0.295	0.151	0.698	1.121	0.629	1.998
Sleep Duration	0.054	0.090	0.352	0.553	1.055	0.884	1.259
Sex(female/male)	0.398	0.200	3.955	0.047	1.489	1.006	2.204
Education			13.610	0.003			
(primary/illiterate)	-0.574	0.253	5.140	0.023	0.563	0.343	0.925
(high school/illiterate)	-1.009	0.281	12.888	0.000	0.365	0.210	0.632
(Diploma and above/illiterate)	-0.166	0.591	0.079	0.779	0.847	0.266	2.698
Constant	-3.262	0.700	21.714	0.000	0.038		

		Prevalence of MetS (%)		*p*-value
		Sleep Disorder%	Sleep Normal	
Age	20-29	6.1	8.3	0.62
	30`39	12.9	22.2	0.21
	40-49	28.4	38.1	0.37
	50-59	36.5	23.1	0.18
	60 ≤	50.5	26.1	0.034*
BMI	< 25	11.5	6	0.25
	25 - < 30	27.4	23.5	0.58
	30≤	44.9	43.8	0.9
Sex	Male	21.8	15.4	0.25
	Female	29	27.9	0.85
Waist C.	Normal	9.7	10.8	0.39
	Un normal	55.9	51	0.81
FBS	Normal	10.3	6.5	0.08
	Un normal	59.1	57.5	0.44
HDL	Normal	16.9	14.5	0.29
	Un normal	35.9	34.7	0.44
Hypertension	Normal	14.4	12.7	0.31
	Un normal	55.9	58.4	0.41
TG	Normal	9.4	10.9	0.32
	Un normal	60.3	53.7	0.17
Education	Illiterate	47.9	55	0.37
	Primary	28.4	22.3	0.15
	High	14.7	17.6	0.31
	Diploma and above	21.1	50	0.27

and sleep inefficiency (OR 1.40, 95% CI 1.04-1.89) were proved to be associated with the risk of MetS [23].

In this study, the logistic regression model showed that duration and quality of sleep have no significant effect on the development of MetS. Ying L, et al. [23] Study in South Korea showed that sleep quality (and also age and BMI), had a significant effect on MetS. But sleep duration (and also education level) had no significant effect [24]. The results of the Korean study show no significant relationship of sleep quality with MetS is not consistent with this study. Also in another the Korean study, PSQI scores significantly affected the prevalence of MetS [25].

Therefore, comparing the results of these studies, sleep quality results were not consistent, but sleep duration results were.

The mean score of PSQI in MetS patients was non-significantly higher than that of non-MetS subjects (8.71 ± 2.5 *vs.* 8.8 ± 2.5 $p > 0.05$); However, in Qazvin's Study (QMDS), Zohala and et al.'s showed that the average PSQI score in the MetS group was significantly higher than the non-MetS group (6.30 ± 3.20 *vs.* 5.83 ± 2.76, $p = 0.013$). Also in logistic regression analysis, sleep disturbances were associated with 1.388 fold-increased risk of metabolic syndrome after adjustment for age, gender, and body mass index [26] which is not consistent with the present study.

Our study discovered a relationship between hypertension and sleep disorder ($p = 0.014$), with more frequent hypertension in sleep disorder subjects (27.6%) than those without sleep disorders (17.3%) (Table 2). Sleep has increasingly been known as an important factor in the hemostasis of multiple body functions, and many adverse health effects, such as anxiety and endocrine disorders, can occur as a result of sleep deprivation [27]. Florentine et al. reported a hypertension prevalence 87.1% in people with poor-quality sleep while the figure reduced to 35.16% in those with high-quality sleep ($p < 0.001$) [28]. Hanus and et al. also states that hypertensive people have a poorer sleep quality than healthy people, while those with hypertension using sophomoric still have a weaker sleep quality than those who are hypertensive but do not consume soporifics [29].

A relationship between low HDL level and sleep duration was found in this study (Table 2). Smiley A, et al. [30] in the National Health and Nutrition Examination Survey (NHANES), 2013/2014 showed that there is a significant relationship between short sleep duration and low HDL cholesterol [30].

Based on the results of Hung, a low HDL is an independent predictor for the total score of Pittsburgh questionnaire, and it was stated that the mechanism of the relationship between dyslipidemia and sleep quality is still unclear. Sleep limitation is apparently associated with increases in cortisol and ghrelin levels, a sympathetic response, and a reduction in leptin levels, which could lead to the development of atherogenic lipid profile [20], though, Jenning found no correlations between the above [31].

CONCLUSION

This study showed that sleep disorder and MetS are highly prevalent in adult people in Ahvaz with a greater frequency of MetS in sleep disorder people than those with a normal sleep. There was no significant relationship between the quality and duration of sleep with the prevalence of metabolic syndrome.

Competing Interests

The authors declare that they have no competing interests.

ACKNOWLEDGMENT

This paper is issued from the research project with the registered number of D-9301. Health Research Institute, Diabetes Research Center, and Ahvaz Jundishapur University of Medical Sciences provided financial support. The authors would like to thank all staffs of Diabetes Research Center, especially Miss Dehghan, Hardani pasand and Moradi, for their help in this study.

REFERENCES

1. Huang PL. A comprehensive definition for metabolic syndrome. Dis Model Mech. 2009 May-Jun;2(5-6):231-7. doi: 10.1242/dmm.001180. PMID: 19407331; PMCID: PMC2675814.
2. Mottillo S, Filion KB, Genest J, Joseph L, Pilote L, Poirier P, Rinfret S, Schiffrin EL, Eisenberg MJ. The metabolic syndrome and cardiovascular risk a systematic review and meta-analysis. J Am Coll Cardiol. 2010 Sep 28;56(14):1113-32. doi: 10.1016/j.jacc.2010.05.034. PMID: 20863953.
3. Motala AA, Esterhuizen T, Pirie FJ, Omar MA. The prevalence of metabolic syndrome and determination of the optimal waist circumference cutoff points in a rural South african community. Diabetes Care. 2011 Apr;34(4):1032-7. doi: 10.2337/dc10-1921. Epub 2011 Feb 17. PMID: 21330644; PMCID: PMC3064018.
4. Carnethon MR, Loria CM, Hill JO, Sidney S, Savage PJ, Liu K; Coronary Artery Risk Development in Young Adults study. Risk factors for the metabolic syndrome: the Coronary Artery Risk Development in Young Adults (CARDIA) study, 1985-2001. Diabetes Care. 2004 Nov;27(11):2707-15. doi: 10.2337/diacare.27.11.2707. PMID: 15505009.
5. Wennberg M, Gustafsson PE, Wennberg P, Hammarström A. Poor breakfast habits in adolescence predict the metabolic syndrome in adulthood. Public Health Nutr. 2015 Jan;18(1):122-9. doi: 10.1017/S1368980013003509. Epub 2014 Jan 28. PMID: 24468205.
6. Wennberg P, Gustafsson PE, Dunstan DW, Wennberg M, Hammarström A. Television viewing and low leisure-time physical activity in adolescence independently predict the metabolic syndrome in mid-adulthood. Diabetes Care. 2013 Jul;36(7):2090-7. doi: 10.2337/dc12-1948. Epub 2013 Jan 22. PMID: 23340896; PMCID: PMC3687313.
7. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. Diabet Med. 2006 May;23(5):469-80. doi: 10.1111/j.1464-5491.2006.01858.x. PMID: 16681555.
8. Shahbazian H, Latifi SM, Jalali MT, Shahbazian H, Amani R, Nikhoo A, Aleali AM. Metabolic syndrome and its correlated factors in an urban population in South West of Iran. J Diabetes Metab Disord. 2013 Feb 8;12(1):11. doi: 10.1186/2251-6581-12-11. PMID: 23497506; PMCID: PMC3598198.
9. Ju SY, Choi WS. Sleep duration and metabolic syndrome in adult populations: a meta-analysis of observational studies. Nutr Diabetes. 2013 May 13;3(5):e65. doi: 10.1038/nutd.2013.8. PMID: 23670223; PMCID: PMC3671750.
10. Chaput JP, Després JP, Bouchard C, Tremblay A. Association of sleep duration with type 2 diabetes and impaired glucose tolerance. Diabetologia. 2007 Nov;50(11):2298-304. doi: 10.1007/s00125-007-0786-x. Epub 2007 Aug 24. PMID: 17717644.
11. Gottlieb DJ, Punjabi NM, Newman AB, Resnick HE, Redline S, Baldwin CM, Nieto FJ. Association of sleep time with diabetes mellitus and impaired glucose tolerance. Arch Intern Med. 2005 Apr 25;165(8):863-7. doi: 10.1001/archinte.165.8.863. PMID: 15851636.
12. Kim J, Kim HM, Kim KM, Kim DJ. The association of sleep duration and type 2 diabetes in Korean male adults with abdominal obesity: the Korean National Health and Nutrition Examination Survey 2005. Diabetes Res Clin Pract. 2009 Nov;86(2):e34-6. doi: 10.1016/j.diabres.2009.06.027. Epub 2009 Jul 23. PMID: 19631400.
13. Hitze B, Bosy-Westphal A, Bielfeldt F, Settler U, Plachta-Danielzik S, Pfeuffer M, Schrezenmeir J, Mönig H, Müller MJ. Determinants and impact of sleep duration in children and adolescents: data of the Kiel Obesity Prevention Study. Eur J Clin Nutr. 2009 Jun;63(6):739-46. doi: 10.1038/ejcn.2008.41. Epub 2008 Jul 30. PMID: 18665183.

14. Park SE, Kim HM, Kim DH, Kim J, Cha BS, Kim DJ. The association between sleep duration and general and abdominal obesity in Koreans: data from the Korean National Health and Nutrition Examination Survey, 2001 and 2005. Obesity (Silver Spring). 2009 Apr;17(4):767-71. doi: 10.1038/oby.2008.586. Epub 2009 Jan 29. PMID: 19180067.

15. Cappuccio FP, Stranges S, Kandala NB, Miller MA, Taggart FM, Kumari M, Ferrie JE, Shipley MJ, Brunner EJ, Marmot MG. Gender-specific associations of short sleep duration with prevalent and incident hypertension: the Whitehall II Study. Hypertension. 2007 Oct;50(4):693-700. doi: 10.1161/HYPERTENSIONAHA.107.095471. Epub 2007 Sep 4. Erratum in: Hypertension. 2007 Nov;50(5):e170. PMID: 17785629; PMCID: PMC3221967.

16. Lombardi C, Hedner J, Parati G. Sex and age differences in the relationship between sleep duration and hypertension. J Hypertens. 2010 May;28(5):883-6. doi: 10.1097/HJH.0b013e3283383d73. PMID: 20395747.

17. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. Sleep. 2010 May;33(5):585-92. doi: 10.1093/sleep/33.5.585. PMID: 20469800; PMCID: PMC2864873.

18. Vgontzas AN, Liao D, Pejovic S, Calhoun S, Karataraki M, Basta M, Fernández-Mendoza J, Bixler EO. Insomnia with short sleep duration and mortality: the Penn State cohort. Sleep. 2010 Sep;33(9):1159-64. doi: 10.1093/sleep/33.9.1159. PMID: 20857861; PMCID: PMC2938855.

19. Parks EJ, Hellerstein MK. Carbohydrate-induced hypertriacylglycerolemia: historical perspective and review of biological mechanisms. Am J Clin Nutr. 2000 Feb;71(2):412-33. doi: 10.1093/ajcn/71.2.412. PMID: 10648253.

20. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989 May;28(2):193-213. doi: 10.1016/0165-1781(89)90047-4. PMID: 2748771.21- Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. 112. 2005 Oct 25;17:2735-52.

21. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Gordon DJ, Krauss RM, Savage PJ, Smith SC Jr, Spertus JA, Costa F; American Heart Association; National Heart, Lung, and Blood Institute. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. Circulation. 2005 Oct 25;112(17):2735-52. doi: 10.1161/CIRCULATIONAHA.105.169404. Epub 2005 Sep 12. Erratum in: Circulation. 2005 Oct 25;112(17):e297. Erratum in: Circulation. 2005 Oct 25;112(17):e298. PMID: 16157765.

22. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004 Jan 10;363(9403):157-63. doi: 10.1016/S0140-6736(03)15268-3. Erratum in: Lancet. 2004 Mar 13;363(9412):902. PMID: 14726171.

23. Lian Y, Yuan Q, Wang G, Tang F. Association between sleep quality and metabolic syndrome: A systematic review and meta-analysis. Psychiatry Res. 2019 Apr;274:66-74. doi: 10.1016/j.psychres.2019.01.096. Epub 2019 Feb 1. PMID: 30780064.

24. Kim YJ, Yeom HE. Interactive Impact of Sleep Duration and Sleep Quality on the Risk of Developing Metabolic Syndrome in Korean Adults. Healthcare (Basel). 2020 Jun 25;8(2):186. doi: 10.3390/healthcare8020186. PMID: 32630519; PMCID: PMC7349834.

25. Lee J, Choi YS, Jeong YJ, Lee J, Kim JH, Kim SH, Joe SH, Jeon TH. Poor-quality sleep is associated with metabolic syndrome in Korean adults. Tohoku J Exp Med. 2013 Dec;231(4):281-91. doi: 10.1620/tjem.231.281. PMID: 24305464.

26. Zohal M, Ghorbani A, Esmailzadehha N, Ziaee A, Mohammadi Z. Association of sleep quality components and wake time with metabolic syndrome: The Qazvin Metabolic Diseases Study (QMDS), Iran. Diabetes Metab Syndr. 2017 Nov;11 Suppl 1:S377-S380. doi: 10.1016/j.dsx.2017.03.020. Epub 2017 Mar 6. PMID: 28284911.

27. Guo Y, Liu Y, Huang X, Rong Y, He M, Wang Y, Yuan J, Wu T, Chen W. The effects of shift work on sleeping quality, hypertension and diabetes in retired workers. PLoS One. 2013 Aug 16;8(8):e71107. doi: 10.1371/journal.pone.0071107. PMID: 23976988; PMCID: PMC3745433.

28. Fiorentini A, Valente R, Perciaccante A, Tubani L. Sleep's quality disorders in patients with hypertension and type 2 diabetes mellitus. Int J Cardiol. 2007 Jan 8;114(2):E50-2. doi: 10.1016/j.ijcard.2006.07.213. Epub 2006 Oct 30. PMID: 17070940.

29. Hanus JS, Amboni G, Rosa MI, Ceretta LB, Tuon L. Características e qualidade do sono de pacientes hipertensos [The quality and characteristics of sleep of hypertensive patients]. Rev Esc Enferm USP. 2015 Aug;49(4):596-602. Portuguese. doi: 10.1590/S0080-623420150000400009. PMID: 26353096.

30. Smiley A, King D, Harezlak J, Dinh P, Bidulescu A. The association between sleep duration and lipid profiles: the NHANES 2013-2014. J Diabetes Metab Disord. 2019 Jun 22;18(2):315-322. doi: 10.1007/s40200-019-00415-0. PMID: 31890656; PMCID: PMC6914752.

31. Jennings JR, Muldoon MF, Hall M, Buysse DJ, Manuck SB. Self-reported sleep quality is associated with the metabolic syndrome. Sleep. 2007 Feb;30(2):219-23. doi: 10.1093/sleep/30.2.219. PMID: 17326548.