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Original Article

Relationship Between Sleep Quality, Sleep Disturbance, and Estimated Cardiovascular Risk

Heba G. Elnahas, Marwa S. Said, Radwa M. Elsyed, Ghada M. Khafagy ¥

Department of Family Medicine. Faculty of Medicine, Cairo University, Egypt

Abstract

Background: Sleep quality and disturbances have been suggested to play an important role in cardiovascular disease risk.

Objective(s): The aim of the present study is to investigate the possible relationship between quality of sleep, sleep disturbances, and cardiovascular disease risk in adults.

Methods: This cross-sectional study was conducted in the Family Medicine Outpatient Clinic at Cairo University, Kasr Alainy Hospital. The participants of this study were 124 adults who were subjected to be interviewed with sleep questionnaires, including the Pittsburgh Sleep Quality Index, Epworth Sleepiness scale, Berlin Questionnaire, and Restless Legs Syndrome Rating Scale. Their blood pressure and body mass index were measured, along with the fasting blood glucose and lipid profile assessment. Moreover, atherosclerotic cardiovascular disease (ASCVD) risk was calculated. The participants were then classified into two groups according to their estimated risk of ASCVD: low- or borderline-risk group and intermediate- or high-risk group.

Results: In both groups, the comparison of the results of the Pittsburgh Sleep Quality Index (PSQI) showed a significant difference: total score (about 40% of bad sleepers and 20% of good sleepers had intermediate to high ASCVD risk), subjective sleep quality, sleep efficiency, and the use of sleep medications (p values = 0.015, 0.023, and 0.023, respectively). Moderate positive correlations were observed between the ASCVD risk score and total PSQI score ($r = 0.4$, $p < 0.001$), subjective sleep ($r = 0.332$, $p < 0.001$), sleep latency ($r = 0.3$, $p = 0.006$), sleep duration ($r = 0.4$, $p < 0.001$), sleep efficiency ($r = 0.4$, $p = 0.001$), sleep disturbance ($r = 0.218$, $p = 0.016$), and the use of sleep medications ($r = 0.24$, $p = 0.002$). In both groups, a significant difference was observed in the severity of restless legs syndrome (p value = 0.012).

Conclusion: Based on the results of the study, the overall sleep quality was linked to a higher estimated risk of developing cardiovascular events. A significant positive moderate correlation was found between sleep quality scores and cardiovascular risk, especially sleep efficiency and duration.

Keywords: sleep quality, sleep disturbances, obstructive sleep apnea, restless legs syndrome, cardiovascular disease risk

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¥*Correspondence*:
Email:
ghada.khafagy@kasralainy.edu.eg

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INTRODUCTION

Cardiovascular diseases are considered one of the top 10 leading causes of death. The WHO reported that ischemic heart disease (IHD) and strokes accounted for an estimated 26.8% of all deaths worldwide per year.[1] The Institute for Health Metrics and Evaluation has shown that in Egypt, IHD and stroke are responsible for 32.3 and 8.6% of deaths as well as 14.6 % and 5.6% of disability adjusted life years lost, respectively.[2] As the prevalence rate of cardiovascular diseases (CVD) is rising, early detection and control of the modifiable risk factors are essential for the prevention of its development and progression.[3] Sleep is a critical modulator of neuroendocrine function and cardio-metabolic health.[4] It is an essential restorative physiologic function of the body that occupies almost one-third of our lifespan.[3]

The physiological changes that occur during sleep are vital and help people stay healthy. Good quality and proper sleep during night enhances longevity in humans.[5] Sleep which is a basic human behavior is found to be linked to CVD risk.[6] Although sleep quality is vital, it is difficult to outline and measure.[7] Over 90 types of sleep disorders have been classified. Ahmed et al. (2018) found that the most common sleep problem among Egyptians was insomnia (59.6%), followed by excessive daily sleepiness

(29.5%), sleep deprivation (12.1%), and restless legs syndrome (RLS) (10.4%).[8]

Although sleep quality is not considered a standard risk factor for CVD, studies have proven its effect on cardiovascular risk (CVR) factors.[4] Numerous possible mechanisms could clarify the relationship between cardiovascular events and sleep loss, including increases in blood pressure, impaired glucose tolerance, or sympathetic hyperactivity. Investigational data showing that acute sleep loss (around 3.6 hours of sleep) for one night results in an increase in blood pressure among fit young males.[9]

According to the National Sleep Foundation guidelines, the recommended sleep duration for people aged 26 to 64 years is 7 to 9 hours of sleep and for people aged ≥65 years 7 to 8 hours of sleep.[10] Sleep health is a multidimensional concept. Sleep disruption is classified into different types, and sleep quality is an important component of sleep health.[7]

The association between sleep quality and CVD has not yet been established in the Egyptian population.

Although earlier studies have assessed sleep duration only and cardiovascular outcomes [11] or estimated the sleep quality and duration among patients who have coronary heart disease, only a few studies have assessed the estimated CVR in relation to sleep quality.[12] Thus, this study was conducted to investigate the possible relationship between quality of sleep, sleep disturbances, and cardiovascular disease risk in adults.

METHODS

Study setting and population

This cross-sectional study was conducted from January 2020 to July 2020 on adults from the Family Medicine Outpatient Clinic at Kasr Alainy Hospital. Patients aged 30–65years old were invited to take part in the research. Any patient who presented with cardiac insufficiency, acute disease, and hypo- or hyperthyroidism; took any medication that may affect sleep (e.g., beta-blockers); and was pregnant was excluded from the study.

Sampling

The sample size was calculated using Epi Info 7 with the following input: the prevalence of coronary artery disease according to the WHO STEPwise approach was 8%.[13] The frequency of adults attending the Family Medicine Outpatient Clinic in 4 months was 700 patients, with a confidence limit of ±5% and confidence level of 95%. The minimum required sample size was 98; the total sample size was modified to 124 participants. All adult patients who consented to participate in the study were recruited until the required sample size was reached.

Data collection tools and steps

The following tools used in this study are the following:

- Comprehensive socio-economic status data (SES) were evaluated on the basis of the scale created by El-Gilany et al. [14]. According to the quartiles of the score measured, the SES was graded as very low, low, middle, and high levels.
- The assessment of atherosclerotic cardiovascular disease (ASCVD) risk was done using the American College of Cardiology/American Heart Association ASCVD Risk Calculator.[15]
  A restricted assortment of variables, such as sex, race, total cholesterol, high density lipoprotein (HDL) cholesterol, history of diabetes, smoking status, systolic blood pressure (SBP), and treatment for blood pressure, was used.
  A 10-year chance for ASCVD is sorted as low- or borderline-risk (<5%–7.4%) and intermediate- or high-risk group (7.5%–≥20%).
- Sleep quality was measured using the Arabic version of the Pittsburgh Sleep Quality Index (PSQI). The PSQI is a valid instrument used to quantify the quality of sleep in adults. It distinguishes "poor" sleep quality from "good" sleep quality, with the best cut-off score at 5 (sensitivity 89.6%, specificity 86.5%). Furthermore, the Arabic version of the questionnaire proved to be reliable and valid [16].
- Daytime sleepiness was measured using the Arabic version of the Epworth Sleepiness Scale (ESS), which is a substantial and dependable instrument that can be utilized in Arabic-talking populations [17]. ESS is reliable with eight unique circumstances, and the subject is asked to rate the likelihood of snoozing in every circumstance on a scale of 0–3, with all-out scores going between 0 (normal sleep) and 24 (very sleepy). Values > 9 are considered as significant sleepiness.
- Obstructive sleep apnea (OSA) was measured using the Arabic version of the Berlin Questionnaire [18]. The Berlin Questionnaire is a straightforward, self-controlled, and approved questionnaire intended to evaluate three OSA chance classifications: the occurrence and frequency of snoring behavior, wake-time sleepiness or fatigue, and history of obesity and/or hypertension. The subjects were classified as high risk if two or more categories were positive.
- The restless legs condition was evaluated using the Arabic version of the RLS Rating Scale, which is a substantial and reliable instrument [19]. It was classified as mild (scores 1–10), moderate (scores 11–20), and severe (scores ≥ 21).
- Blood samples for biochemical assessment: 4 ml of blood was withdrawn after 8 hours of fasting and sent to the Cairo University labs for fasting blood glucose (FBG) and lipid profile assessment including total cholesterol, HDL, and low density lipoproteins.

After obtaining the informed consent from the participants who consented to participate in the study, the participants were interviewed for 10 minutes to complete the socio-demographic questionnaire. Afterwards, a comprehensive medical history and physical examination was performed including the measurements of weight, height, and body

mass index (BMI), which was calculated as body weight in kilograms divided by the square of height in meters (kg/m^2). The subjects were considered obese if BMI >30 kg/m^2.The blood pressure was measured using a standard mercury sphygmomanometer on the right arm and a suitable size cuff after an adequate rest period of at least10 minutes.

The participants were asked to visit again after fasting for 8 hours to withdraw the blood sample for FBG and lipid profile assessment. Afterwards, they were interviewed for 15 minutes to complete the Pittsburgh Sleep Quality Index questionnaire for sleep quality assessment, ESS for daytime sleepiness assessment, Berlin Questionnaire for OSA risk assessment, and RLS Rating Scale for RLS assessment.

After obtaining the laboratory results, all the data were revised and the ASCVD risk was estimated.

Statistical analysis

The gathered information was analyzed using the Statistical Package for Social Science version 20. Categorical data were represented as frequencies and percentages. For quantitative variables, mean ± standard deviation (SD) was computed. Chi-square (X^2) test was used to test for significance of qualitative variables, or Fisher's exact test when appropriate. Pearson's correlation (r) was used to correlate the CVR scores with the PSQI scores. The outcomes were viewed as statistically significant when the significant probability (p value) was <0.05.

Ethical considerations

The study conformed to the international ethics guidelines and that of Declaration of Helsinki (2013). Ethical approval was obtained from the Family Medicine department counsel and the Research Committee of Cairo University. Informed written consent was obtained from all participants after explaining the objectives of the study and confidentiality of the collected data.

RESULTS

Table 1 shows the demographic and clinical data of the studied group. It was found that the mean age was 51±7.8 years and most of the studied groups were females (66.1%). About 48.4% were non-diabetic and the rest were diabetic with the majority on oral hypoglycemic drugs; about 40.3% had hypertension. Most of the studied group (69%) had low or borderline CVD risk.

Table 2 shows the comparison of sleep quality among ASCVD risk groups. About 40% of bad sleepers had intermediate to high CVD risk, whereas about 20% of good sleepers had intermediate to high CVD risk; the difference was statistically significant. Moreover, there were significant differences between the two groups regarding many of the PSQI domains, as subjective sleep quality, sleep efficiency, and use of sleep medications (p values = 0.015, 0.023, and 0.023 respectively), while there was no significant difference regarding sleep latency, sleep duration, sleep disturbance and daytime dysfunction (p values < 0.05).

In the assessment of sleep apnea (snoring, day tiredness, and BMI), no significant difference was observed between those who had low CVR risk and those who had intermediate or high CVR risk (Table 3).

A significant difference was observed between both groups with regard to the severity of RLS scores (Table 4).

As shown in Table 5, moderate positive significant correlations were observed between the CVR scores and total PSQI scores ($r = 0.4$, $p < 0.001$), subjective sleep ($r = 0.332$, $p < 0.001$), sleep latency ($r = 0.3$, $p = 0.006$), sleep duration ($r = 0.4$, $p < 0.001$), sleep efficiency ($r = 0.4$, $p = 0.001$), sleep disturbance ($r = 0.218$, $p = 0.016$), and use of sleep medications ($r = 0.336$, $p = 0.002$), whereas no significant correlation was observed between CVR score and daytime dysfunction ($r = 0.24$, $p = 0.106$).

Table 1: Demographic and clinical characteristics of the studied group

Variables	Studied group (n = 124)	
Age (years) Mean± SD	50.975±7.811	
Variables	**No.**	**%**
Sex		
Male	42	33.9
Female	82	66.1
Social class		
Very low	1	0.8
Low	25	20.2
Middle	82	66.1
High	16	12.9
Diabetes mellitus		
Non-diabetic	60	48.4
Diabetic:		
On oral medications	50	40.3
On injections	14	11.3
Smoking		
Current	101	81.5
Never smoker	19	15.3
Former smoker	4	3.2
Hypertension		
Normal	74	59.7
Hypertensive	50	40.3
Risk of CVD		
Low or borderline risk	86	69
Intermediate or high risk	38	31

Table 2: Sleep quality among atherosclerotic cardiovascular risk groups

Variables	Low- or borderline-risk ASCVD (n = 86)		Intermediate- or high-risk ASCVD (n = 38)		Total	p value
	No.	%	No.	%		
Component 1: subjective sleep quality						
Very good	27	87.1	4	12.9	31	0.015*[a]
Fairly good	36	70.6	15	29.4	51	
Fairly bad	19	51.4	18	48.6	37	
Very bad	4	80	1	20	5	
Component 2: sleep latency						
Normal	37	74	13	26	50	0.123[a]
Mild	28	73.7	10	26.3	38	
Moderate	14	70	6	30	20	
Severe	7	43.8	9	56.3	16	
Component 3: sleep duration						
> 7 hours	40	76.9	12	23.1	52	0.063 [a]
6–7 hours	32	72.7	12	27.3	44	
5–6 hours	10	55.640	8	44.4	18	
< 5 hours	4		6	60	10	
Component 4: sleep efficiency						
> 85%	44	75.9	14	24.1	58	0.023* [a]
75%–84%	14	73.7	5	26.3	19	
65%–74%	17	77.3	5	22.7	22	
< 65%	11	44	14	56	25	
Component 5: sleep disturbance						
No	7	70	3	30	10	0.277 [a]
Mild	46	75.4	15	24.6	61	
Moderate/severe	33	62.2	20	37.7	53	
Component 6: use of sleep medication						
Not during the past month	71	75.5	23	24.5	94	0.023* [a]
Less than once a week	12	46.2	14	53.8	26	
Once or more times a week	3	75	1	25	4	
Component 7: daytime dysfunction						0.264 [b]
No	85	70.2	36	29.8	121	
Mild to severe dysfunction	1	33.3	2	66.6	3	
Total scale categories						
Good sleeper (total score ≤ 5)	51	79.7	14	21.5	65	0.014* [a]
Poor sleeper (total score > 5)	35	59.3	24	40.7	59	

(*) Significant $p \leq 0.05$ (a) Chi-square test (b) Fisher's exact test

Table 3: Sleep apnea among atherosclerotic cardiovascular disease (ASCVD) risk groups

Variables	Low- or borderline-risk ASCVD (n = 86)		Intermediate- or high-risk ASCVD (n = 38)		Total	p value [a]
	No.	%	No.	%		
Category 1: snoring						
Positive	59	72.8	22	27.2	81	0.248
Negative	27	62.8	16	37.2	43	
Category 2: day tiredness						
Positive	40	72.7	15	27.34	55	0.467
Negative	46	66.7	23	33.3	69	
Category 3: obesity and/or hypertension						
Obese or Hypertensive	39	61.9	24	38.1	63	0.067
Not obese nor hypertensive	47	77	14	23	61	
Sleep apnea risk groups						
High risk (≥2 positive categories)	48	68.6	22	31.4	70	0.829
Low risk (<2 positive categories)	38	70.4	16	29.6	54	

(a) Chi-square test

Table (4): Sleepiness and restless legs syndrome among atherosclerotic cardiovascular disease (ASCVD) risk groups

Variables	Low- or borderline-risk ASCVD (n = 86)		Intermediate- or high-risk ASCVD (n = 38)		Total	p value
	No.	%	No.	%		
Sleepiness scale categories						
Normal (score ≤ 9)	82	70.7	34	29.3	116	0.220 [a]
Excessive daytime sleepiness (score > 9)	4	50	4	50	8	
Severity of restless legs syndrome						
Mild	73	68.9	33	31.1	106	
Moderate	13	86.7	2	13.3	15	0.012* [b]
Severe	0	0	3	100	3	

(*) Significant p ≤ 0.05 (a) Chi-square test (b) Fisher's exact test

Table 5: Correlation between atherosclerotic cardiovascular disease (ASCVD) risk scores and Pittsburg sleep quality index (PSQI) components

Variable	ASCVD risk score	
	R	*p*
Subjective sleep quality	0.332	<0.001**
Sleep latency	0.3	0.006*
Sleep duration	0.4	<0.001**
Sleep efficiency	0.4	0.001**
Sleep disturbance	0.218	0.016*
Use of sleep medication	0.336	0.002*
Daytime dysfunction	0.24	0.106
Total PSQI	0.4	<0.001**

(*) Statistically significant (**) Highly statistically significant

DISCUSSION

The present study was designed to examine the relationship between sleep quality and CVD risk in a sample of the Egyptian population. The results of the PSQI indicate a moderate positive linear relationship between sleep quality and CVR.

In this study, the positive relationship between sleep quality and CVD risk is in accordance with the data from the study conducted by Yazdanpanah et al. (2020) that investigated the sleep quality and sleep quantity among Iranian people and concluded that the prevalence of CVD was nearly 30% in males who sleep less than 6 hours. The increase was just around 19% in people with long sleep duration [20], which could indicate that many neuroendocrine systems affect sleep homeostasis. However, further research is needed to clarify this [21].

Sleep duration and sleep-disordered breathing may influence metabolism and the neurohormonal system [22]. The high incidence of sleep complications among females could be related to changes during the different phases of the menstrual cycle [21].

Similarly, a study conducted by Im and Kim in 2017 in Korea on participants above the age of 18 years old found that the Framingham Risk Score of the participants is affected if they sleep less than 5 hours or above 8 hours, and the study population has a moderate to severe likelihood of developing CVD in the following 10 years[23].

Impaired blood glucose, overactive sympathetic nervous system, and increased blood pressure could be due to many mechanisms linked to sleep deprivation [9]. This finding is different from that of Magee et al. 2012 who found in an Australian study that oversleeping for ≥ 9 hours increases the incidence of stroke, heart disease, diabetes, and high blood pressure in comparison to sleeping for 7 hours. The reason for this could be that the study included participants over 45 years old and above[11]. Another reason could be that many endocrinal hormones and coagulation activities accompany sleep disorders [24].

The findings of this study indicate that sleep efficiency apart from the number of sleep hours might be a vital risk factor for cardiovascular diseases. This could be supported by the results of the study of Ross et al. 2014, which revealed that the individuals having low sleep efficiency expressed a diminished drop of nocturnal heart rate and systolic arterial blood pressure matched with the group with high sleep efficiency. Many studies found that sleep affects the autonomic nervous system and further physiological events that may have an influence on blood pressure [26].

In comparing the Berlin Questionnaire scores for assessing sleep apnea between the studied groups, no statistical significance was observed between the severity of the CVR and the obstructive sleep apnea syndrome (OSAS) scores. This is in contrast to the findings of Ghazal et al. (2015) which indicate that OSAS is linked to a significant possibility of incidence and severity of coronary artery disease. This could be due to the types of patients included in Ghazal et al. study who enrolled only patients

with chronic stable angina [5]. However, the reason for this difference can be that the positive predictive value of the Berlin Questionnaire scores for assessing sleep apnea severity is not high, although the Berlin Questionnaire has a high sensitivity in detecting OSAS [26].

Archontogeorgis et al. (2018) found that in evaluating the coronary risk among patients with indicative obstructive sleep apnea syndrome symptoms, sleep efficiency was obviously reduced among the group with severe OSAS with a reduction in the percentage of slow-wave sleep [27]. Fung et al. 2011 found that the chance of developing hypertension among the elderly is increased with reduced slow-wave sleep because the sympathetic activity is decreased during slow-wave sleep. The reason for this could be that breathing disorders during sleep can result in high SBP [22]. What happens during OSAS is related to the sympathetic arousal and systemic inflammation which occurs secondary to hypoxia [28].

In comparing the PSQI scores between the studied individuals, the present study found a significant relationship between the use of sleep medication and the severity of CVR (p value = 0.023) compared to the results of the study of Kim et al. 2018 who found that the risk of mortality from CVD was significantly decreased with the use of hypnotics [29]. The reason for the difference in the results could be that most participants in our study did not receive sleep medications during the last month. This can be clarified by the emerging evidence on anxiety, insomnia, and CVD risk. The hypnotics relieve insomnia and alleviate anxiety, therefore decreasing CVD risk. The use of hypnotics for CVD treatment is still controversial. Moreover, the effect of hypnotics depends on the type of hypnotics as zolpidem decreases while benzodiazepines increase the risk of mortality from CVD [30].

The present study revealed that participants with PSQI ≤5 indicating good sleep quality had lesser risk for CVD (p value = 0.014). This is consistent with the study of Lao et al. (2018) conducted on Asian adults which stated that short sleep duration and sleep quality are related to the risk of coronary heart disease [6]. In contrast, Abraham 2016 found no significant link between sleep and CVR factors using PSQI. The reason for this could be that the participants enrolled in Abraham's study were college students aging from 18 to 25 years old [31].

The present study found a significant relationship (p value = 0.012) between the severity of the CVR and RLS which is consistent with the study of Winkelman et al. (2008) which found an association between RLS and CVD. The association appears stronger with greater frequency or severity of RLS symptoms [32]. The reason for this could be that leg movement during sleep leads to the activation of the sympathetic nervous system resulting in an increase in blood pressure and heart rate. Furthermore, co-occurring conditions such as elevated blood pressure and obesity may explain the link between RLS and CVD.

Study limitations

Although the sample was calculated, the small sample size and limited age as well as limited collection of the sample from one place, despite a high flow rate, might have affected the results. Despite the valuable self-reports of sleep, electroencephalographic studies provide better direct measures of sleep.

CONCLUSION AND RECOMMENDATIONS

The findings of this study provide a further understanding of the connection between cardiovascular health and sleep, since sleep might be considered a modifiable factor for cardiovascular diseases. For patients with sleep disorders, a CVR assessment should be part of their routine evaluation. Moreover, sleep should be added as part of assessing heart health. Large epidemiological studies in Egypt are required for a better understanding of the link between sleep and cardiovascular health. Finally, in patients with sleep problems, improving sleep to prevent CVD should be considered, since the treatment costs of sleep disorders and sleep loss are expensive.

Family physicians are ideally suited to manage the risk factors for CVD in patients with sleep problems in order to prevent future cardiovascular events.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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REFERENCES

1. Global health estimates 2016: deaths by cause, age, sex, by country and by region, 2000-2016. Geneva: World Health Organization; 2018. Available at: https://www.who.int/healthinfo/global_burden_disease/estimates/en/. Last accessed October 2020
2. GBD compare. Institute for Health Metrics and Evaluation (IHME). Available at: http://vizhub.healthdata.org/gbd. Updated 2019. Last accessed October 2020
3. Miller MA, Kruisbrink M, Wallace J, Ji C, Cappuccio FP. Sleep duration and incidence of obesity in infants, children, and adolescents: a systematic review and meta-analysis of prospective studies. Sleep. 2018;41(4):zsy018.
4. Murillo-Rodriguez E, editor. The behavioral, molecular, pharmacological, and clinical basis of the sleep-wake cycle. Academic Press; 2019.
5. Ghazal A, Roghani F, Sadeghi M, Amra B, Kermani-Alghoraishi M. Obstructive sleep apnea, diagnosed by the Berlin questionnaire and association with coronary artery disease severity. ARYA Atheroscler. 2015;11(5):275.
6. Lao XQ, Liu X, Deng HB, Chan TC, Ho KF, Wang F, Vermeulen R, Tam T, Wong MC, Tse LA, Chang LY. Sleep quality, sleep duration, and the risk of coronary heart disease: a prospective cohort study with 60,586 adults. J Clin Sleep Med. 2018;14(1):109-17.

7. Hoevenaar-Blom MP, Spijkerman AM, Kromhout D, van den Berg JF, Verschuren WM. Sleep duration and sleep quality in relation to 12-year cardiovascular disease incidence: the MORGEN study. Sleep. 2011;34(11):1487-92.
8. Ahmed MA, Zaki NF, Morsy NE, Awadalla NJ, Hammad MA, Saleh NM, Elhefnawi SA. Survey of sleep practice and sleep-related problems among a sample of Egyptian youths. Egypt J Chest Dis Tuberc. 2018;67(2):169.
9. Altevogt BM, Colten HR, editors. Sleep disorders and sleep deprivation: an unmet public health problem. National Academies Press; 2006.
10. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, Hazen N, Herman J, Katz ES, Kheirandish-Gozal L, Neubauer DN. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health. 2015;1(1):40-3.
11. Magee CA, Kritharides L, Attia J, McElduff P, Banks E. Short and long sleep duration are associated with prevalent cardiovascular disease in Australian adults. Journal of Sleep Research. 2012;1(4):441-7.
12. Wang Q, Cheng HY, Lo SW, Li XM, Wong EM, Sit JW. Relationship between sleep quality and cardiovascular disease risk in Chinese post-menopausal women. BMC Women's Health. 2017;17(1):1-7.
13. World Health Organization. WHO STEPS Surveillance Manual: The WHO STEPwise approach to noncommunicable disease risk factor surveillance. Last Updated: 26 January 2017. Avaialable at: https://www.who.int/ncds/surveillance/steps/STEPS_Manual.pdf?ua=1. Last accessed October 2020
14. El-Gilany A, El-Wehady A, El-Wasify M. Updating and validation of the socioeconomic status scale for health research in Egypt. East Mediterr Health J. 2012;18(9).
15. American Heart Association. ASCVD Risk Calculator. Available at: https://professional.heart.org/professional/GuidelinesStatements/ASCVDRiskCalculator/UCM_457698_ASCVD-Risk-Calculator.jsp. Accessed February 16, 2020.
16. Suleiman KH, Yates BC, Berger AM, Pozehl B, Meza J. Translating the Pittsburgh sleep quality index into Arabic. West J Nurs Res. 2010;32(2):250-68.
17. Ahmed AE, Fatani A, Al-Harbi A, Al-Shimemeri A, Ali YZ, Baharoon S, Al-Jahdali H. Validation of the Arabic version of the Epworth sleepiness scale. J Epidemiol Glob Health. 2014;4(4):297-302.
18. Saleh AB, Ahmad MA, Awadalla NJ. Development of Arabic version of Berlin questionnaire to identify obstructive sleep apnea at risk patients. Annals of Thoracic Medicine. 2011;6(4):212.
19. Ahmed AE. Validation of Arabic versions of three sleep surveys. Qatar Med J. 2015;2014(2):20.
20. Yazdanpanah MH, Homayounfar R, Khademi A, Zarei F, Shahidi A, Farjam M. Short sleep is associated with higher prevalence and increased predicted risk of cardiovascular diseases in an Iranian population: Fasa PERSIAN Cohort Study. Sci Rep. 2020;10(1):1-3.
21. Mong JA, Baker FC, Mahoney MM, Paul KN, Schwartz MD, Semba K, Silver R. sleep, Rhythms, and the endocrine brain: Influence of sex and Gonadal Hormones. J Neurosci. 2011;31(45):16107-16
22. Fung MM, Peters K, Redline S, Ziegler MG, Ancoli-Israel S, Barrett-Connor E, Stone KL, Osteoporotic Fractures in Men Research Group. Decreased slow wave sleep increases risk of developing hypertension in elderly men. Hypertension. 2011;58(4):596-603.
23. Im E, Kim GS. Relationship between sleep duration and Framingham cardiovascular risk score and prevalence of cardiovascular disease in Koreans. Medicine. 2017;96(37).
24. Von Känel R, Princip M, Schmid JP, Barth J, Znoj H, Ulrich S, Meister-Langraf RE,. Association of sleep problems with neuroendocrine hormones and coagulation factors in patients with acute myocardial infarction. BMC Cardiovasc Disord. 2018;18:213.
25. Ross AJ, Yang H, Larson RA, Carter JR. Sleep efficiency and nocturnal hemodynamic dipping in young, normotensive adults. Am J Physiol Regul Integr Comp Physiol. 2014;307(7):R888-92.
26. Tan A, Yin JD, Tan LW, van Dam RM, Cheung YY, Lee CH. Using the Berlin questionnaire to predict obstructive sleep apnea in the general population. J Clin Sleep Med. 2017;13(3):427-32.
27. Archontogeorgis K, Voulgaris A, Nena E, Strempela M, Karailidou P, Tzouvelekis A, Mouemin T, Xanthoudaki M, Steiropoulos S, Froudarakis ME, Steiropoulos P. Cardiovascular risk assessment in a cohort of newly diagnosed patients with obstructive sleep apnea syndrome. Cardiol Res Pract. 2018; Mar 8 doi: 10.1155/2018/6572785.
28. Lévy P, Kohler M, McNicholas WT, Barbé F, McEvoy RD, Somers VK, Lavie L, Pépin JL. Obstructive sleep apnoea syndrome. Nat Rev Dis Primers. 2015;1:15015.
29. Kim YH, Kim HB, Kim DH, Kim JY, Shin HY. Use of hypnotics and the risk of or mortality from heart disease a meta-analysis of observational studies: Korean J Intern Med. 2018;33(4):727-36.
30. Vermeeren A. Residual effects of hypnotics: epidemiology and clinical implications. CNS Drugs. 2004;18(5):297-328.
31. Abraham C. The effect of sleep quality and high intensity physical activity on inflammation and cardiovascular disease risk factors in college students. (2016). Honors Scholar Theses. 500.
https://opencommons.uconn.edu/srhonors_theses/500.
32. Winkelman JW, Shahar E, Sharief I, Gottlieb DJ. Association of restless legs syndrome and cardiovascular disease in the Sleep Heart Health Study. Neurology. 2008;70(1):35-42.