The effect of sleep duration on the risk of diabetes mellitus in an open population of men aged 45–64 years (international epidemiological studies)

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Objective: *to study the effect of sleep duration on the 16-year risk of developing type 2 diabetes mellitus (DM) in an open population of men aged 45–64 years living in Novosibirsk.*

Patients and methods. *In 2003–2005 during the IV screening (HAPIEE project), a representative sample of men aged 45–69 years (n=781; mean age – 56.48±0.2 years, response rate – 61%) was examined. A standard clinical and epidemiological examination was carried out: sleep duration was assessed using the Jenkins scale, the level of state-trait anxiety (STA) – using the Spielberger self-assessment scale, depression, life exhaustion, family and workplace stress – with MONICA-MOPSY scales. Social support was assessed with Berkman–Syme Social Network Index. The cohort was followed up for 16 years.*

Results and discussion. *In the studied population of men aged 45–64 years, the most common sleep duration was 7 hours (44.7%), in second place – 8 hours of sleep (27.6%), in third place – 6 hours of sleep (16.4%). Among people with newly diagnosed DM, 7-hour sleep prevailed – 39.2%, 6- and 8-hour sleep – 25.3% each (χ^2=7.774; df=5; p>0.05). In men with 5–6 hours of sleep, compared with men sleeping for 7–8 hours, we found a 1.72-fold increased 16-year risk of developing diabetes (95% CI 1.066–2.776; p<0.05), and in men aged 45–54 years – a 1.868-fold increase (95% CI 1.089–3.927; p<0.05). In the Cox-proportional multivariate model, an independent effect on the diabetes risk was observed for: 5–6 hours of sleep at night: hazard ratio (HR) 1.561 (95% CI 1.063–2.83; p<0.001), depression (HR 1.767; 95% CI 1.058–2.952; p<0.05), life exhaustion (HR 1.511; 95% CI 1.266–2.984; p<0.05), and low and medium-1 SNI (HR 1.956; 95% CI 1.074–3.560; p<0.05).*

Conclusion. *Short and very short sleep duration could be defined as a major risk factor of DM.*

Keywords: *sleep duration; diabetes mellitus; state-trait anxiety; depression; life exhaustion; hostility; social support; family stress; workplace stress; population; men.*

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For reference: *Gafarov VV, Gromova EA, Panov DO, et al. The effect of sleep duration on the risk of diabetes mellitus in an open population of men aged 45–64 years (international epidemiological studies). Nevrologiya, neiropsikhiatriya, psikhosomatika = Neurology, Neuropsychiatry, Psychosomatics. 2021;13(6):23–28. DOI: 10.14412/2074-2711-2021-6-23-28*

According to the International Diabetes Federation, the estimated number of patients with diabetes mellitus is about 6% of the world adult population; by 2025 the number of patients with diabetes mellitus will double, and by 2035 it will increase up to 592 million [1]. Given its significant burden, it is necessary to identify modifiable lifestyle factors associated with a lower risk of diabetes [2].

Sleep is a biological behavior phenomenon that is regulated by circadian, homeostatic and neurohormonal processes [3]. In the past few years, suboptimal sleep duration, especially short sleep (6 hours) and very short sleep (<5 hours), characteristic of the 24-hour lifestyle in modern society, is increasingly regarded as an additional behavioral factor that negatively affects population health [4]. Several studies have reported a U-shaped relationship between sleep duration and type 2 diabetes [5, 6], but other studies have not found a uniform association [7, 8]. Recent meta-analysis showed that both short and long (>9 hours) sleep duration was associated with the risk of developing type 2 diabetes [9].

Other studies have also shown that both short and long sleep is more common among people diagnosed with depression [10], anxiety [11], and life exhaustion [12]. Hostility is an independent risk factor for sleep disorders, and hostility can lead to a reduction in sleep duration [13]. From an evolutionary point of view, a high level of social support contributes to long-term quality sleep [14]. In addition, the quality and duration of sleep are highly dependent on lifestyle and personal environment; it is believed that insomnia and stress are an integral part of our daily life, therefore, it is necessary to study their cumulative effect on the risk of developing diabetes mellitus [15].

Thus, given the ambiguous data on the risk of diabetes mellitus, depending on the duration of sleep, as well as the lack of such long-term studies conducted in Russia, the **purpose** of our study is to assess the effect of sleep duration on the 16-year risk of developing type 2 diabetes mellitus in an open population of men aged 45–64 living in Novosibirsk.

Materials and methods. The results of the study were obtained on the basis of a survey of a representative sample of men 45–69 years old (n=781 men, average age – 56.48±0.2 years, response rate – 61%) living in the Oktyabrsky district of Novosibirsk in 2003–2005 within the framework of screening IV with the support of the Wellcome Trust (UK) («HAPIEE») [16].

All participants in the study, in addition to the standard clinical and epidemiological examination, underwent psychological testing. The subjects filled out the scales independently. The level of personal anxiety (PA) was assessed using the Spielberger self-assessment scale [17], depression, vital exhaustion, hostility, stress in the family and at work - using the MONICA-MOPSY scales [18]. Sleep duration was assessed using the Jenkins scale [18]. Social support was assessed using 2 indices: close contacts index (ICC) and social network index (SNI) – Berkman-Syme test [19].

The study excluded 27 men with established diabetes mellitus (DM) that occurred before screening or identified at screening, as well as 29 men due to incorrectly completed questionnaires. The observation cohort included 725 men. During the 16-year follow-up period (from January 09, 2003 to December 31, 2018) 79 new-onset cases of type 2 diabetes mellitus were identified. Registration of all cases of type 2 diabetes was carried out according to the program «Register of Diabetes Mellitus».

Statistical analysis was performed using the SPSS version 11.5 software package [20]. To check the statistical significance of the differences between the groups, we used Pearson's chi-square test χ^2 [21]. To assess the risk ratio (HR), a univariate and multivariate Cox proportional hazards regression model (Cox-regres-

Table 1. *Distribution of sleep duration in an open population of men aged 45–64 years, n (%)*

Sleep duration	n %
5 hours	35 (4.8)
6 hours	119 (16.4)
7 hours	324 (44.7)
8 hours	200 (27.6)
9 hours	28 (3.9)
10 hours	19 (2.6)
Total	725 (100)

Table 2. *Distribution of sleep duration in a men population with and without DM, n (%)*

Sleep duration	Group of examined		
	without DM	DM	total
5 hours	30 (4.6)	5 (6.3)	35 (4.8)
6 hours	99 (15.3)	20 (25.3)	119 (16.4)
7 hours	293 (45.4)	31 (39.2)	324 (44.7)
8 hours	180 (27.9)	20 (25.3)	200 (27.6)
9 hours	25 (3.9)	3 (3.8)	28 (3.9)
10 hours	19 (2.9)	0 (0)	19 (2.6)
Total	646 (100)	79 (100)	725 (100)
χ^2=7.774; df=5; p>0.05			

Table 3. *Distribution of psychosocial factors among men in a population with and without DM, n (%)*

Index	Group of examined		
	without DM	DM	total
Anxiety			
low	11 (1.7)	4 (5.1)	15 (2.1)
moderate	234 (36.2)	28 (35.4)	262 (36.1)
high	401 (62.1)	47 (59.5)	448 (61.8)
χ^2=3.93; df=2; p>0.05			
Depression			
no	458 (70.9)	48 (60.8)	506 (69.8)
with	188 (29.1)	31 (39.2)	219 (30.2)
χ^2=3.432; df=1; p>0.05			
Vital exhaustion (VE)			
no	54 (8.4)	7 (8.9)	61 (8.4)
moderate	243 (37.6)	30 (38.0)	273 (37.7)
high	349 (54.0)	42 (53.2)	391 (53.9)
χ^2=2.854; df=2; p>0.05			
Hostility			
no	245 (37.9)	32 (40.5)	277 (38.2)
moderate	135 (20.9)	12 (15.2)	147 (20.3)
high	266 (41.2)	35 (44.3)	301 (41.5)
χ^2=1.420; df=2; p>0.05			
ICC			
low	321 (49.7)	37 (46.8)	358 (49.4)
moderate	276 (42.7)	34 (43.0)	310 (42.8)
high	49 (7.6)	8 (10.1)	57 (7.9)
χ^2=0.696; df=2; p>0.05			
SNI			
low	185 (28.6)	25 (31.6)	210 (29.0)
moderate-1	323 (50.0)	30 (38.0)	353 (48.7)
moderate-2	116 (18.0)	21 (26.6)	137 (18.9)
high	22 (3.4)	3 (3.8)	25 (3.4)
χ^2=5.113; df=2; p>0.05			
Family stress			
no	247 (38.2)	34 (43.0)	281 (38.8)
moderate	243 (37.6)	25 (31.6)	268 (37.0)
high	156 (24.1)	20 (25.3)	176 (24.3)
χ^2=1.137; df=2; p>0.05			
Stress at work			
no	235 (36.4)	31 (39.2)	266 (36.7)
moderate stress at work	293 (45.4)	37 (46.8)	330 (45.5)
high stress at work	118 (18.3)	11 (13.9)	129 (17.80)
χ^2=0.937; df=2; p>0.05			

sion) was used [22]. Values obtained at screening were taken as analyzed factors, without taking into account their temporal dynamics. Reliability in all types of analysis was accepted at a significance level of $p \leqslant 0.05$.

Results. In the studied population of men 45–64 years old, the most common duration of sleep was 7 hours a day – 44.7%, followed by 8 hours of sleep (27.6%), and 6 hours of sleep (16.4%) (Table 1).

Among men with newly diagnosed type 2 diabetes mellitus, the screening showed a tendency towards the prevalence of 7-hour sleep - 39.2%, 6-hour and 8-hour sleep accounted for 25.3% each (χ^2=7.774 df=5 p>0.05) (Table 2).

Among men with newly diagnosed diabetes mellitus, a high level of anxiety was 61.8% (χ^2=3.93; df=2; p>0.05); depression – 30.2% (χ^2=3.432; df=1; p>0.05); high level of life exhaustion – 53.9% (χ^2=2.854; df=2; p>0.05); high level of hostility – 41.5% (χ^2=1.420; df=2; p>0.05); low index of close contacts – 49.4% (χ^2=1.420; df=2; p>0.05); low index of social ties – 29% (χ^2=5.113; df=2; p>0.05); high level of stress in the family – 24.3% (χ^2=1.137; df=2; p>0.05) and high level of stress at work – 17.8% (χ^2=0.937; df=2; p>0.05) (Tab. 3).

Table 4 presents a 16-year risk of developing type 2 diabetes mellitus depending on the length of sleep. It was found that among men 45–64 years old with a nighttime sleep of 5-6 hours, compared with men sleeping 7–8 hours a day, the risk of diabetes increased by 1.72 (95% CI 1.066–2.776; p<0.05) times. Among men 45–54 years old sleeping 5–6 hours daily, in comparison with men with night sleep duration of 7–8 hours, the risk of developing diabetes increased by 1.868 times (95% CI 1.089–3.927; p<0.05).

In Cox multivariate regression model, after adjustment for age, low and medium levels of psychosocial factors, as well as 7–8 hours of night sleep as reference variables, the following variables showed their independent influence on the risk of developing diabetes mellitus: 5–6 hours night sleep (HR=1.561; 95% CI1.063–2.83; p<0.001), depression (HR=1.767; 95%CI 1.058–2.952; p<0.05), vital exhaustion (HR=1.511; 95%CI 1.266–2.984; p<0.05), as well as low and medium-1 scores of the social network index (HR=1.956; 95% CI1.074–3.560; p<0.05) (Table 5).

Discussion. Sleep duration depends on various cultural, social, psychological, behavioral, pathophysiological factors, as well as environmental influences. Changes in modern society, for example, an increase in the number of working hours, shift work, round-the-clock availability of consumer goods and 24-hour global communication – are associated with a gradual reduction in the duration of sleep [23]. In our population, one fifth of men (21.2%) spent less than 7 hours a day sleeping, and among those with new-onset diabetes mellitus - one third of men (31.6%). Our results are very similar to the data on sleep duration published by the American Academy of Sleep Medicine (AASM) and the Sleep Research Society (SRS) as well as the Centers for Disease Control and Prevention. This report found that about one third of the US adult population is not getting the recommended the amount of sleep. Specifically, when asked «On average, how many hours of sleep do you have in a 24-hour period?», 28.3% of respondents answered that they slept <7 hours [24]. Grandner MA et al. estimated this value as 39.92% [25]. According to a study on the epidemiology of cardiovascular diseases in various regions of Russia (ESSE-RF) (the mean age of participants was 50), the average sleep duration was 7.3±1.2 hours. At the same time, in 22.5% of participants the duration of sleep was 6 hours per day or less [26].

Table 4. *Sixteen-year risk of DM among 45–64-year-old men (IV screening) depending on the number of hours of sleep at night (Cox univariate regression model)*

Age groups	Risk factors Sleep hours	Reference group Sleep hours	p	HR (95% CI for HR)
45–54 years	5-6 hours	7-8 hours	0.045	1.868 (1.089–3.927)
55–64 years	5-6 hours	7-8 hours	0.201	1.609 (0.776 –3.339)
45–64 years	5-6 hours	7-8 hours	0.026	1.720 (1.066 –2.776)
45–54 years	9-10 hours	7-8 hours	0.353	0.387 (0.052–2.866)
55–64 years	9-10 hours	7-8 hours	0.420	1.816 (0.425–7.755)
45–64 years	9-10 hours	7-8 hours	0.491	0.664 (0.207–2.128)

Table 5. *Sixteen-year risk of DM among 45–64-year-old men (IV screening) depending on the number of hours of night sleep and psychosocial RF (multivariate Cox regression model)*

Index	Risk factors	Reference group	p	HR (95% CI for HR)
Sleep hours	5–6 hours	7–8 hours	0.001	1.561 (1.063–2.830)
Anxiety	High	Low and moderate	0.088	1.579 (0.934–2.669)
Depression	Yes	No	0.030	1.767 (1.058–2.952)
Vital exhaustion	Yes	No	0.045	1.511 (1.266–2.984)
Hostility	Yes	No	0.418	0.813 (0.492–1.343)
ICC	Low	High and moderate	0.589	1.182 (0.644–2.171)
SNI	Low and moderate-1	High and moderate-2	0.028	1.956 (1.074–3.560)
Family stress	Yes	No	0.147	0.709 (0.445–1.129
Stress at work	Yes	No	0.985	1.004 (0.622–1.623)

According to the AASM and SRS guidelines, for adults, sleep duration of 7 or more hours is likely to be necessary to maintain optimal health and function [27, 28]. Reiterating these recommendations, the American Thoracic Society also issued a statement that its consensus panel warns that insufficient sleep duration (which they define as 6 hours or less) is likely to be associated with poor health outcomes, including diabetes [29]. Various types of studies have shown that impairment or decrease in the number of hours of sleep per day is associated with glucose intolerance, insulin resistance, and a decrease in the acute phase of glucose insulin secretion, which predisposes people to the development of type 2 diabetes [30]. If the reduction in sleep is short-lived, the effects are reversible; however, if long-term chronic sleep deprivation occurs, it can lead to long-term adverse health effects [31]. Finally, prolonged sleep restriction with simultaneous circadian sleep disturbance decreases the metabolic rate at rest and increases postprandial plasma glucose levels (due to insufficient insulin secretion) [32]. We have determined that in our population the 16-year risk of developing diabetes mellitus among 45–64-year-old men who sleep no more than 5–6 hours a day is 1.7 times higher, and in the age group of 45–54 years old it is 1,8 times higher than among men sleeping 7–8 hours a day. Numerous data from meta-analyzes given in foreign literature indicate that if the duration of sleep is reduced, for example, to <5 hours a day (very short naps) or <6 hours (short naps), then they equally predict the development of diabetes mellitus with the relative risk of 1.48 (95% CI 1.25–1.76) and 1.18 (95% CI 1.10–1.26), respectively [33].

Over the past 20 years, research on psychosocial correlates of sleep has skyrocketed. Most of these studies have focused on the influence of psychosocial factors on sleep, such as depression, anxiety, psychological stress – they are associated with sleep duration and insomnia [34, 35]. In our study, two-thirds of men with newly diagnosed diabetes mellitus experienced high levels of anxiety, one-third had depression, more than a half experienced high levels of vital exhaustion, two-fifths had high levels of hostility, a quarter of men had high levels of family stress, and one fifth experienced high levels of stress at work. Among men with diabetes, approximately a half had low scores of the index of close contacts, and one third had a low score of the index of social network. When included in the multivariate analysis of the above psychosocial factors, the following variables were shown to have an independent effect on the risk of developing diabetes mellitus: 5–6 hours of night sleep (HR=1.56), depression (HR=1.76), vital exhaustion (HR=1.51), as well as low and moderate-1 scores of the social network index (HR=1.95).

Conclusion. The most common duration of sleep in the studied male population aged of 45–64 years was 7 hours a day - 44.7% of men; 27.6% of participants had 8 hours of sleep daily; and 16.4 % of respondents had 6 hours of sleep. Among men with newly diagnosed type 2 diabetes mellitus, 7-hour sleep prevailed – 39.2% of respondents, 6-hour and 8-hour sleep was reported by 25.3% of respondents. Among men with newly diagnosed diabetes mellitus, a high level of anxiety was noted in 61.8%; depression – in 30.2%; high level of vital exhaustion – in 53.9%; high level of hostility – in 41.5%; low index of close contacts - in 49.4%; low index of social ties – in 29%; high level of stress in the family – in 24.3%, and high level of stress at work – in 17.8%. The 16-year risk of diabetes among men who sleep 5–6 hours per night compared with men who sleep 7–8 hours in the group aged 45–64 years increases by 1.72, and in the group aged 45–54 years – by1.868 times. In multivariate model an independent effect on the risk of developing diabetes was exerted by: 5–6 hours of night sleep (HR=1.561), depression (HR=1.767), vital exhaustion (HR=1.511), as well as low and medium-1 values of social network index (HR=1.956).

Thus, short (6 hours) and very short (5 hours) sleep duration can be identified as a new and important risk factor for diabetes. This is especially alarming, since about a third of men in the studied population had a shorter sleep duration than recommended, so the chosen direction – elucidation of the epidemiological links between diabetes and specific sleep phenotypes – is promising.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 6th ed. Brussels: International Diabetes Federation; 2013.

2. Shan Z, Ma H, Xie M, et al. Sleep Duration and Risk of Type 2 Diabetes: A Meta-analysis of Prospective Studies. *Diabetes Care*. 2015 Mar;38(3):529-37. doi: 10.2337/dc14-2073

3. Bowden J, Tierney JF, Copas AJ, Burdett S. Quantifying, displaying and accounting for heterogeneity in the meta-analysis of RCTs using standard and generalised Q statistics. *BMC Med Res Methodol*. 2011 Apr 7;11:41. doi: 10.1186/1471-2288-11-41

4. Xi B, He D, Zhang M, et al. Short sleep duration predicts risk of metabolic syndrome: a systematic review and meta-analysis. *Sleep Med Rev*. 2014 Aug;18(4):293-7. doi: 10.1016/j.smrv.2013.06.001. Epub 2013 Jul 23.

5. Jackson CL, Redline S, Kawachi I, Hu FB. Association between sleep duration and diabetes in black and white adults. *Diabetes Care*. 2013 Nov;36(11):3557-65. doi: 10.2337/dc13-0777. Epub 2013 Sep 11.

6. Gottlieb DJ, Punjabi NM, Newman AB, et al. 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

7. Beihl DA, Liese AD, Haffner SM. Sleep duration as a risk factor for incident type 2 diabetes in a multiethnic cohort. *Ann Epidemiol*. 2009 May;19(5):351-7. doi: 10.1016/j.annepidem.2008.12.001

8. Mallon L, Broman JE, Hetta J. High incidence of diabetes in men with sleep complaints or short sleep duration: a 12-year follow-upstudy of a middle-aged population. *Diabetes Care*. 2005 Nov;28(11):2762-7. doi: 10.2337/diacare.28.11.2762

9. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes: a systematic reviewand metaanalysis. *Diabetes Care*. 2010 Feb;33(2):414-20. doi: 10.2337/dc09-1124. Epub 2009 Nov 12.

10. Van Mill JG, Hoogendijk WJ, Vogelzangs N, et al. Insomnia and sleep duration in a large cohort of patients with major depressive disorder and anxiety disorders. *J Clin Psychiatry*. 2010 Mar;71(3):239-46. doi: 10.4088/JCP.09m05218gry

11. Kalmbach DA, Abelson JL, Arnedt JT, et al. Insomnia symptoms and short sleep predict anxiety and worry in response to stress exposure: a prospective cohort study of medical interns. *Sleep Med*. 2019 Mar;55:40-7. doi: 10.1016/j.sleep.2018.12.001. Epub 2018 Dec 14

12. Krummenacher R, Lukas PS, Biasiutti FD, et al. Independent association of sleep quality, fatigue, and vital exhaustion with platelet count in patients with a previous venous thromboembolic event. *Platelets*. 2009 Dec;20(8):566-74. doi: 10.3109/09537100903295922

13. Grano N, Vahtera J, Virtanen M, et al. Association of Hostility With Sleep Duration and Sleep Disturbances in an Employee Population. *Int J Behav Med*. 2008;15(2):73-80. doi: 10.1080/10705500801929510

14. Kent de Grey RG, Uchino BN, Trettevik R, et al. Social support and sleep: A meta-analysis. *Health Psychol*. 2018 Aug;37(8):787-98. doi: 10.1037/hea0000628. Epub 2018 May 28.

15. Kim HJ, Oh SY, Joo JH, et al. The Relationship between Sleep Duration and Perceived Stress: Findings from the 2017 Community Health Survey in Korea. *Int J Environ Res Public Health*. 2019 Sep 3;16(17):3208. doi: 10.3390/ijerph16173208

16. UCL department of epidemiology and public health central and Eastern Europe research group HAPIEE study. Available from: http://www.ucl.ac.uk/easteurope/hapiee-cohort.htm

17. Spielberger CD. Anxiety as an emotional state. In: Spielberger CD, ed. Anxiety: current trends in theory and research. Vol. 1. New York: Academic Press; 1972. P. 24-49.

18. MONICA Monograph and Multimedia Sourcebook. Helsinki; 2003. 237 p.

19. Berkman LF, Krishna A. Social network epidemiology. In: Berkman LF, Kawachi I, Glymour MM, eds. Social Epidemiology (2nd ed.). New York: Oxford University Press; 2015. P. 234-48 (published online). doi: 10.1093/med/9780195377903.003.0007

20. Бююль А, Цёфель П. SPSS: искусство обработки информации. Анализ статистических данных и восстановление скрытых закономерностей. Санкт-Петербург: ООО «DiaSoftЮП»; 2015. 608 с. [Bjujul' A, Cjofel' P. SPSS: art processing. Analysis of statistical data and restore hidden patterns: Transl. by German. St. Petersburg: OOO «DiaSoftJuP»; 2002. 608 p. (In Russ.)].

21. Pandis N. The chi-square test. *Am J Orthod Dentofacial Orthop*. 2016 Nov;150(5):898-9. doi: 10.1016/j.ajodo.2016.08.009

22. Cox DR. Regression Models and Life Tables. *J Royal Stat Soc Series B*. 1972;34:187-220.

23. Cappuccio FP, Miller MA. Sleep and Cardio-Metabolic Disease. *Curr Cardiol Rep*. 2017 Sep 19;19(11):110. doi: 10.1007/s11886-017-0916-0

24. Liu Y, Wheaton AG, Chapman DP, et al. Prevalence of Healthy Sleep Duration among Adults — United States, 2014. *MMWR Morb Mortal Wkly Rep*. 2016 Feb 19;65(6):137-41. doi: 10.15585/mmwr.mm6506a1

25. Grandner MA, Chakravorty S, Perlis ML, et al. Habitual sleep duration associated with self-reported and objectively determined cardiometabolic risk factors. *Sleep Med*. 2014 Jan;15(1):42-50. doi: 10.1016/j.sleep.2013.09.012. Epub 2013 Oct 28.

26. Бочкарев МВ, Коростовцева ЛС, Свиряев ЮВ. Продолжительность и качество сна — есть ли связь с сердечно-сосудистыми заболеваниями? *Артериальная гипертензия*. 2014;20(5):450-61. doi: 10.18705/1607-419X-2014-20-5-450-461 [Bochkarev MV, Korostovtseva LS, Sviryayev YuV. Sleep duration and quality — is there a link to cardiovascular disease? *Arterial'naya gipertenziya*. 2014;20(5):450-61. doi: 10.18705/1607-419X-2014-20-5-450-461 (In Russ.)].

27. Hirshkowitz M, Whiton K, Alpert SM, et al. National Sleep Foundation's updated sleep duration recommendations: final report. *Sleep Health*. 2015 Dec;1(4):233-43. doi: 10.1016/j.sleh.2015.10.004. Epub 2015 Oct 31.

28. Hirshkowitz M, Whiton K, Alpert SM, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health*. 2015 Mar;1(1):40-3. doi: 10.1016/j.sleh.2014.12.010. Epub 2015 Jan 8.

29. Mukherjee S, Patel SR, Kales SN, et al. An official American Thoracic Society statement: the importance of healthy sleep. Recommendations and future priorities. *Am J Respir Crit Care Med*. 2015 Jun 15;191(12):1450-8. doi: 10.1164/rccm.201504-0767ST

30. Spiegel K, Tasali E, Leproult R, van Cauter E. Effect of poor and short sleep on glucose metabolism and obesity risk. *Nat Rev Endocrinol*. 2009 May;5(5):253-61. doi: 10.1038/nrendo.2009.23

31. Cohen DA, Wang W, Wyatt JK, et al. Uncovering residual effects of chronic sleep loss on human performance. *Sci Transl Med*. 2010 Jan 13;2(14):14ra3. doi: 10.1126/scitranslmed.3000458

32. Buxton OM, Cain SW, O'Connor SP, et al. Adverse metabolic consequences in humans of prolonged sleep restriction combined with circadian disruption. *Sci Transl Med*. 2012 Apr 11;4(129):129ra43. doi: 10.1126/scitranslmed.3003200

33. Anothaisintawee T, Reutrakul S, van Cauter E, Thakkinstian A. Sleep disturbances compared to traditional risk factors for diabetes development: systematic review and meta-analysis. *Sleep Med Rev*. 2016 Dec;30:11-24. doi: 10.1016/j.smrv.2015.10.002. Epub 2015 Oct 21.

34. Hall MH, Brindle RC, Buysse DJ. Sleep and Cardiovascular Disease: Emerging Opportunities for Psychology. *Am Psychol*. 2018 Nov;73(8):994-1006. doi: 10.1037/amp0000362

35. Gafarov VV, Gagulin IV, Gromova EA, Gafarova AV. Sleep disorders in 45–69-year-old population in Russia/Siberia (Epidemiology study). *Int J Med Med Sci*. 2013;3(6):469-75. Available from: https://www.researchgate.net/publication/274195813_Sleep_disorders_in_45-69-year-old_population_in_RussiaSiberia_Epidemiology_study

Received/Reviewed/Accepted
03.09.2021/18.10.2021/21.10.2021

Conflict of Interest Statement

The investigation has not been sponsored. There are no conflicts of interest. The authors are solely responsible for submitting the final version of the manuscript for publication. All the authors have participated in developing the concept of the article and in writing the manuscript. The final version of the manuscript has been approved by all the authors.

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