Research Paper

The Effect of Sleep Disorders on Blood Sugar in Children With Type 1 Diabetes Mellitus

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Citation Shamsadini A, Asghar Arabi A, Vares Vazirian M, Aftabi F. The Effect of Sleep Disorders on Blood Sugar in Children With Type 1 Diabetes Mellitus. Journal of Pediatrics Review. 2023; 11(3):273-278. http://dx.doi.org/10.32598/jpr.11.3.1079.1

http://dx.doi.org/10.32598/jpr.11.3.1079.1

Article info:
Received: 15 Oct 2022
First Revision: 01 Mar 2023
Accepted: 09 Jun 2023
Published: 01 Jul 2023

Key Words:
Diabetes mellitus, Hemoglobin A1c, Sleep disorders, Pittsburg sleep quality index

ABSTRACT

Background: Diabetes mellitus (DM) is a common metabolic disorder. The hemoglobin A1c (HbA1c) test is a simple laboratory test that shows the average amount of blood sugar in the last 3 months. Studies have shown that sleep is important in controlling blood sugar levels, so that sleep deprivation can reduce glucose tolerance. Lack of sleep and sleep disorders are also predictors of DM.

Objectives: Given the contradictory information about the effect of sleep on blood sugar, the impact of various factors in the process of DM, including the lifestyle of patients, and the limited number of studies in this field in Iran, we decided to investigate the effect of sleep disorders on blood sugar control in people with type 1 DM.

Methods: This cross-sectional descriptive-analytical study was performed on children with type 1 DM referred to the diabetes clinic. Their HbA1c levels were recorded in a checklist from the patient's last test recorded in their files, and the standard Pittsburg sleep quality index (PSQI) was completed to assess their sleep disorders with the help of the child's parents. Achieving a score higher than 5 in the whole questionnaire means poor sleep quality. After collecting data, they were analyzed in SPSS software, version 21.

Results: A total of 200 children with type 1 DM were studied, of whom 119(59.5%) were boys, 81(40.5%) were girls. Also, 79 children (39.5%) were less than 1 year old, 67(33.5%) were 1 to 2 years old and 54 were more than 3 years old. Also, 104 children (52.6%) had no sleep disorders, while 69(32.1%) had moderate, 20(11.6%) had severe, and 7(3.7%) had very severe sleep disorders. Their Mean±SD age was 10.86±4.68 years, and HbA1c level was 9.64±3.35 mmol/mol.

Conclusions: This study showed that the prevalence of sleep disorders based on the PSQI was approximately 50%. There was a significant relationship between elevated HbA1c and the prevalence of sleep disorders.

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Introduction

Diabetes mellitus (DM) is a group of common metabolic disorders usually characterized by varying degrees of insulin resistance, impaired insulin secretion, and increased glucose production. Approximately 90%-95% of diabetic patients have type 2 DM [1]. It is the most common endocrine disease with many fatal complications. According to the World Health Organization, the world population will reach 380 million by 2025 [2, 3]. It is said that the total number of Iranians with DM type 2 will exceed 6.4 million in 2030. The blood sugar tends to bind to Hb (Hb is responsible for carrying oxygen in the blood) in red blood cells. This process is called glycosylation. Sugar bound to Hb remains in it for 120 days of red blood cell life [4, 5].

The HbA1c test is a simple laboratory test that shows the average amount of sugar in a person's blood over 3 past months. It shows that the blood sugar of a diabetic person is close to normal or much higher than normal during this time. With this method, the physician can check the quality of patients' blood sugar control [5]. All people with DM should have this test at least twice a year. Routine measurement of blood sugar with glucose meters is a control of blood sugar at the same time as the test, while the HbA1c test shows a better picture of blood sugar control in the last quarter [6].

For people with DM, the HbA1c level should be less than 7 mmol/mol. Research has shown that the closer the HbA1c to 7, the less likely a person has complications such as visual, renal, and nervous disorders [7]. Diabetic people are at greater risk for psychiatric disorders than the general population, such as depression, eating disorders like obesity and anorexia nervosa, and sleep disorders [8].

Sleep is one of the most important circadian cycles and one of the basic human needs, which follows a complex biological pattern. Sleep disorder is often an early sign of various diseases [9]. Inadequate sleep (sleep deprivation and poor sleep quality) is prevalent in modern society. Approximately 33% of adults report one or more insomnia symptoms [10]. Studies have shown that sleep is important in controlling blood sugar levels, so sleep deprivation can reduce glucose tolerance. Lack of sleep and sleep disorders are also associated with predictors of type 2 diabetes, such as blood sugar and insulin resistance [11].

Studies have shown that sleep deprivation increases cortisol levels in the evening and may reduce insulin sensitivity the next day [12]. Chronic sleep deprivation also disrupts carbohydrate metabolism and increases the risk of diabetes [13]. Insomnia has a two-way relationship with the prevalence and incidence of DM. Sometimes insomnia can be secondary to DM, or itself can be a predisposing factor for it [14]; that is, DM itself, due to nocturia, neuropathic pain, depression, and other pathologies, can cause a decrease in the quantity or quality of sleep in these people [15].

Given the contradictory information about the effect of sleep on blood sugar and its control, and due to the impact of various factors in the process of this disease, including the lifestyle of patients [16] and also the limited number of studies in this field in Iran, especially in relation to DM type 1, we decided to investigate the effect of sleep disorder on blood sugar control in children with type I DM.

Methods

This is a cross-sectional descriptive-analytical study in which the study population comprised all children with type 1 DM referred to the diabetes clinic of Bahonar Hospital. The sample size of this study was 200 people. The inclusion criteria were as follows: Being under 15 years old and the non-existence of other medical or psychiatric disorders. Before the children entered the study and after full explanations about the research and its goals, written informed consent was completed by the children's guardians to enter the study.

HbA1c levels were recorded in a checklist from the patients' last test recorded in their files, and the standard Pittsburg sleep quality index (PSQI) questionnaire was completed to assess sleep disorders with the help of the children's parents. The PSQI consists of 19 self-rated questions and 5 questions rated by the bed partner or roommate. The latter 5 questions are used for clinical information only; the 19 self-rated questions assess various factors relating to sleep quality, including sleep duration and latency estimates and the frequency and severity of specific sleep-related problems. These 19 items are grouped into 7 component scores; each weighed equally on a 0-3 scale. The 7 component scores are then summed to yield a global PSQI score, which ranges from 0-21; higher scores indicate worse sleep quality. The 7 components of the PSQI are standardized versions of areas routinely assessed in clinical interviews of patients with sleep/awake complaints. These components are subjective sleep quality, latency, duration, habitual

Table 1. Demographic information of the patients

Variables		No. (%)
Gender	Girl	81(40.5)
	Boy	119(59.5)
Duration of the disease (y)	<1 year old	79(39.5)
	1-3 years old	67(33.5)
	>3 years old	54(27.0)
Sleep disorder	Absent	104(52.0)
	Moderate	69(34.5)
	Severe	20(10.0)
	Very severe	7(3.5)

Journal of Pediatrics Review

Table 2. Mean age and HA1c of the studied children

Variables	Mean±SD	Maximum	Minimum
Age (y)	10.86±4.68	15	7
HbA1c (mmol/mol)	9.64±3.35	13.5	6.1

Table 3. Comparison of mean HbA1c by sleep disorder

Sleep Disorder	Mean±SD HbA1c (mmol/mol)	P
Absent	8.47±1.35	0.001
Moderate	10.51±1.63	
Severe	10.77±2.68	
Very severe	11.84±2.87	

Journal of Pediatrics Review

sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. The scoring of each component is illustrated in the Appendix. A global PSQI score >5 yielded a diagnostic sensitivity of 89.6% and specificity of 86.5% (kappa=0.75, P<0.001) in distinguishing between good and poor sleepers [17].

The validity and reliability of this questionnaire had been previously verified, and the questionnaire has been translated and modified for the Iranian population study [18]. The project co-worker was present when completing the questionnaire to answer parents' questions. Finally, after collecting data, they were analyzed by SPSS software, version 21.

Results

This study studied 200 children with type 1 DM, of whom 119(59.5%) were boys and 81(40.5%) were girls. Also, 79 children (39.5%) were under 1 year old, 67(33.5%) were 1 to 2 years old, and 54(27%) were more than 3 years old. A total of 104 children (52.6%) had no sleep disorders, while 69(34.5%) had moderate sleep disorders, 20(10%) had severe sleep disorders, and 7(3.5%) had very severe sleep disorders (Table 1)

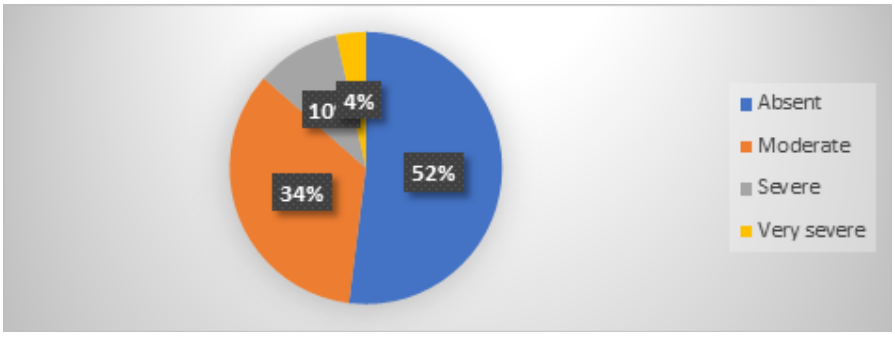

Figure 1. Frequency distribution of sleep disorders 10%

Journal of Pediatrics Review

(Figure 1). The mean age of the children in this study was 10.86±4.68 years, and the mean HA1c value in these children was 9.64±3.35 mmol/mol (Table 2). The results showed that the mean HbA1c value in children without sleep disorders was significantly lower than in children with sleep disorders (P=0.001) (Table 3).

Discussion

According to a review study, the prevalence of sleep disorders increases with the onset of type 1 and 2 DM and poor glycemic control, and sleep disorders increase the prevalence of cardiovascular, neurological, and metabolic diseases. Restricted sleep at night also negatively affects glucose homeostasis, reduces beta cell function and insulin sensitivity, and increases the risk of developing diabetes [19]. In the present study, 200 patients with type 1 DM were studied, of which only 52% lacked sleep disorders, and the rest (48%) had moderate to severe sleep disorders. In the Kim et al. study, the prevalence of sleep disorders in patients with DM, according to the PSQI questionnaire, was approximately 65% [20]. Also, in the study of Zhu et al., the prevalence of sleep disorders in diabetic people with HbA1c of more than 7 mmol/mol was 47.1% [21]. Also, in the present study, a significant relationship was observed between increased HbA1c and the prevalence of sleep disorders. Hence, sleep disorders increase HbA1c levels and may be a risk factor for increased HbA1c levels. Our study results were consistent with other studies such as Keskin et al. [22]. A study by Nakajima et al. on 1062 people in a rural community in Japan found that HbA1c levels were U-shaped in relation to sleep duration so that people with 7-8 hours of sleep at night had the lowest HbA1c level and people who slept less than 6 hours and more than 9 hours had the highest HbA1c level [15]. The significant relationship between HbA1c level and the incidence of sleep disorders, as shown in many studies, shows the role of incomplete and abnormal sleep in the metabolic control of blood sugar in diabetic patients [16, 20, 22]. Another study showed that insufficient sleep (less than 7 hours a day) does not affect the subjects' blood sugar [23]. Also, Van Helder et al. did not observe a significant relationship between insomnia and diabetes [24]. It seems that the difference between the results of this study and the mentioned study is in the age range of the people under investigation and the measurement of HbA1c. Previous studies have shown that a decrease in glucose tolerance overnight and an increase in the resistance of peripheral tissues to insulin can lead to diabetic conditions. Decreased overnight glucose tolerance may be partly due to a decrease in insulin sensitivity and secretion of insulin in response to an increase in blood glucose. Various mechanisms disrupt the maintenance of glucose stability throughout the day. Studies have shown that poor sleep at night effectively increases the function of cortisol and growth hormones, which also affect the metabolic cycle and are involved in reducing glucose tolerance and thus inducing diabetes [25].

Conclusion

In the present study, the prevalence of sleep disorders based on the Pittsburgh questionnaire was approximately 50%. There was also a significant relationship between increased HbA1c and the prevalence of sleep disorders. Sleep disorders increased HbA1c levels.

Limitation

The limitation of our study was that we did not have polysomnography for advanced assessment of sleep disorders. This study's strength was conducting few studies on this topic in Iran.

Ethical Considerations

Compliance with ethical guidelines

The study protocol was approved by the Ethics Committee of Kerman University of Medical Sciences (Code: IR.KMU.AH.REC.1396.2294). Written informed consent was obtained from all participants.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors contributions

All authors equally contributed to preparing this article.

Conflicts of interest

The authors declared no conflict of interest.

Acknowledgements

The authors are especially grateful to health advocates for the coronavirus pandemic.

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