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## **The correlation between sleep disorders and obesity – abnormal sleep duration as a risk factor for high weight**

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**Abstract**

Obesity and overweight are among the most common diseases in the world. Last data from 2016 showed that 650 million people were obese and since 1960 the number of obese people has increased three times, which is associated with "fast" lifestyle of the majority of the world's population. This is the clue why so many scientists are looking for modified obesity factors.

Overweight is a major risk factor for inter alia diabetes, cardiovascular diseases and cancers. Most studies have shown obesity as a cause of sleep disorders such as excessive daytime sleepiness EDS or sleep apnoea, but recent studies have suggested that sleep disorders cause obesity.

Otyłość i nadwaga należą do najczęstszych chorób na świecie, ostatnie dane opublikowane w 2016r. wykazały, że 650 milionów osób było otyłych, a od 1960 r. liczba osób zmagających się z otyłością wzrosła trzykrotnie, co wiąże się z "szybkim" stylem życia większości populacji na świecie. W związku z tym, wielu naukowców szuka modyfikowanych czynników otyłości.

Nadwaga jest głównym czynnikiem ryzyka między innymi cukrzycy, chorób sercowo-naczyniowych i nowotworów. Większość badań ukazuje otyłość, jako przyczynę zaburzeń snu, takich jak nadmierna senność EDS w ciągu dnia lub bezdech senny, ale ostatnie badania sugerują, że zaburzenia snu mogą powodować otyłość.

## **Background**

Obesity is a civilization disease, recognized by the World Obesity Federation as the most serious chronic disease, which leads to the development of cardiovascular disease, type 2 diabetes, metabolic syndrome, hormonal disorders and also increases the risk of certain cancers [1]. In 2016, over 1.9 billion adults (over 18 years and older) were overweight. Of them, 650 million were obese [2]. It follows that 39% of adults in the world were overweight and 13% were obese [2].

Overweight is defined as a body mass index (BMI) greater than or equal to 25, and obesity as greater than or equal to 30 [2]. There are many causes of obesity, WHO as the basis gives a distorted ratio of calories, that people consume and calories necessary for the proper functioning of humans [2]. There is an increased intake of high-calorie food with a high fat content, an increasing decrease in physical activity due to the settled nature of work, growing urbanization, and lack of appropriate policy of societies that would support health sectors in this area [2]. Another identified reason is genetic predisposition [3]. It may also be secondary

to endocrine disorders, organic hypothalamic disease, or iatrogenically, as a result of the use of specific drugs, such as neuroleptics, antidepressants, antiepileptic drugs, steroid hormones, beta-adrenergics, and insulin and sulfinylurea derivatives [4]. It has also been shown that the development of obesity has a huge impact on fetal life, infant life and early childhood, because only at this time is the differentiation and development of fat cells, the amount of which is reflected in the tendency to obesity in adulthood [5].

Another suggestion of the causes of obesity are sleep disorders. People often sleep less than the recommended sleep time due to a lifestyle based on work. Until now, most studies have linked obesity to sleep disorders as their cause. Recent studies have shown that there may be an inverse relationship, namely the impact of sleep disorders on the predisposition to development of obesity, which seems to be a reasonable assumption, because sleep and wakefulness disorders can affect metabolic disorders [6].

Searching for modifiable causes of obesity is very important because the forecasts for the coming years are very worrying, obesity-related illness will cost 1.2 trillion dollars annually by 2025 2.7 billion of the world's inhabitants will be overweight or obese at the time, according to report by the World Obesity Federation [1]. It is important to remember about the consequences of obesity, which are many, ranging from the effects on mental health and effects such as eating disorders or depression, and ending with serious chronic diseases such as the type 2 diabetes mentioned above, cardiovascular diseases, including significant increase in the risk of myocardial infarction or an increased risk of developing such cancers as: endometrium, breast, ovary, prostate, liver, gallbladder, kidneys and colon [2]. All this results in a shorter time of human life and deterioration of its comfort, which is why it is so important to look for the causes of obesity, which may be affected by a change in habits.

## **Objective**

Due to the prevalence of sleep disorders, we compare available examples of studies from years 2006-2017 based on the impact of sleep disorders and the predisposition to the development of obesity.

## **Description of the state of knowledge**

The relationship between obesity and sleep disorders has been proven by many researchers [7,8, 9]. Recently, researchers have been trying to find out the impact of sleep disorders on obesity. Studies which show that connection are: "Association between reduced sleep and weight gain in women" by Patel SR (2006) [10]. "Overweight and obese patients in a primary

care population report less sleep than patients with a normal body mass index” by Vorona RD et al. published in 2005 [11] and “Sleep characteristics modify the association of genetic predisposition with obesity and anthropometric measurements in 119,679 UK Biobank participants” by Carlos Celis-Morales (2017) [12]. The first two publications mentioned above were among the first ones to cover this topic. First study by Patel SR et al. was a prospective one, based on 68 183 women who reported habitual sleep duration in 1986 and then were followed for sixteen years [10]. Second one, by Vorona et al. was based on 1001 patients (women and men) from the primary care practice who completed a questionnaire about medical problems, sleep habits, and sleep disorders [11]. Researchers looked for the relationship between body mass index (BMI) and reported total sleep time per 24 hours. They had measured height and weight. Third study was based on the biggest group, researchers (Carlos CM., Donald M., et al.) analyzed data of 119 859 adults from United Kingdom Biobank at the age between 37 and 73 years old [12]. Researchers investigated interactions of sleep characteristics, including sleep duration, chronotype, day napping, shift work and their effects on Body Mass Index BMI [12]. The results of the research made by Patel SR. et al. can be found in the table number 1 below. Although the results of body weight changes of participants in this study may seem small, even slight weight gain can have significant health effects.

**Tab. No. 1. Results of the study by Patel SR. and co-authors [10]:**

1. Over 16 years, women sleeping 5 hours or less gained 1.14 kg more than those sleeping 7 hours.
2. Over 16 years, women sleeping 6 hours gained 0.71 kg more than those sleeping 7 hours.
3. The relative risks of a 15-kg weight gain were 1.32 (95% CI: 1.19, 1.47) and 1.12 for those sleeping 5 and 6 hours, respectively.
4. The relative risks for incident obesity (body mass index:  $>30 \text{ kg/m}^2$ ) were 1.15 and 1.06.

The results of the study by Vorona RD. et al. can be found in the table number 2 below. This study showed that reducing sleep is associated with overweight and obesity.

**Tab. No. 2 Results of the study by Vorona RD. and co-authors [11]:**

Analyzed forms from 924 patients (18-91 years old) indicated that:

1. The mean BMI was 30.
2. Women slept more than men.
3. Overweight and obese patients slept less than patients with a normal BMI (patients reported less sleep in a nearly linear relationship between the normal through the obese group); and this trend of decreasing sleep time was reversed in the extremely obese patients.

**Minutes of total sleep time per 24 hours in relation to sex and BMI**

Variable	Normal Weight	Overweight	Obese	Extremely Obese
Men n= 326	473 +/- 104	454+/-96	469+/-95	465+/-96
Woman n=598	483 +/-96	482+/-97	434+/-89	476+/-102

Results of the third study are presented in the table number 3 below.

**Tab. No. 3. Results of the study by Carlos CM. and co-authors [12]:**

1. Obesity is partly genetically determined, lifestyle plays a major role.
2. Adults from group of high genetic risk of obesity, whose sleep duration was shorter or longer than recommended 7-9 hours, were heavier than people with correct sleep duration. People with sleep duration shorter than 7 hours were about 2 kilograms heavier (0.6 higher BMI) and people who slept longer than 9 hours were around 4 kilograms heavier (1.1 higher BMI) than people sleeping 7-9 hours with similar genetic risk.
3. Genetic predisposition to obesity seems to be enhanced by the evening chronotype, day napping, shift work and night work.
4. Notwithstanding, people with low genetic risk of obesity seems that abnormal sleep duration do not have important influence for their weight.

All studies have found the relationship between sleepiness and the increased risk of obesity but the latest publication by Carlos CM. was carried out on the largest group of patients, considering both a small amount of sleep and too much as the cause of the inclination to obesity [12]. The study also took into account other factors such as evening chronotype, day napping, shift work and night work, or genetic predisposition [12]. The results of the above study coincided with other publications suggesting the importance of these factors in predisposition to obesity [13,14, 15, 16, 17]. It has been proven that sleep is an important modulator of neuroendocrine function and glucose metabolism. Insufficient sleep time results in metabolic and endocrine variations, including decreased glucose tolerance, decreased insulin sensitivity, increased levels of ghrelin, decreased levels of leptin, increased evening concentrations of cortisol and increased hunger and appetite, which is responsible for the increased predisposition to obesity [18].

### **Summary**

The problem certainly requires more research, concerning, the mechanism of increasing body mass in people who have abnormal sleep duration. However, this statement is only valid for a person with genetic predisposition towards obesity. Exploring the causes of this dependence is extremely important due to the increasing risk of obesity epidemics and ubiquitous workaholism in highly developed countries. Proposing a healthy lifestyle, taking care of the diet, the right amount of sleep hours not only affects the better well-being, but also prevents the development of overweight or obesity and many consequences of these pathologies. Therefore, it is so important to pay attention to the proper habits related to sleep duration.

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