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REVIEW ARTICLE

The relationship between sleep and obesity – literature review

Związek snu z otyłością – przegląd literatury

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Abstract

Introduction and Objective. Obesity is a condition in which there is an excessive accumulation of body fat, resulting from an imbalance between energy intake and energy expenditure. This is a significant health problem that can negatively affect the quality of sleep. At the same time, sleep disorders, such as sleep deficiency or poor quality sleep, can promote the development of obesity, creating a vicious cycle. The aim of the review is to collect and summarize recent scientific findings on the relationship between sleep disorders and obesity.

Abbreviated description of the state of knowledge. Sources were obtained using PubMed and Google Scholar, using the key words: 'obesity', 'insomnia', 'sleep disorders'. The review was conducted from October 2024 – January 2025. Currently, there is no clear consensus on whether it is obesity that leads to sleep disorders, or whether sleep disorders promote the development of obesity. With the change of lifestyle, a shorter and shorter sleep duration is observed. Obesity can impair the secretion of ghrelin and leptin, and interfere with melatonin production. Additionally, it predisposes to the occurrence of sleep apnea, which itself contributes to sleep disorders. Studies have shown a link between different bedtimes and obesity risk. People who sleep less, often have difficulty reducing weight.

Conclusions. Obesity is a serious civilization problem that can lead to many disorders. Studies indicate its association with sleep disorders, although there is still no clear consensus on whether the relationship also works the other way round. What is known, however, is that obesity affects hormonal and anatomical disorders that can promote its further development. At the same time, an irregular sleep schedule is associated with an increased risk of obesity. It has been suggested that education, better sleep management, and an appropriate diet could improve sleep quality and thus support the treatment of obesity.

Key words

overweight, epidemic, sleep disorders, obesity

Streszczenie

Wprowadzenie i cel pracy. Otyłość to stan, w którym dochodzi do nadmiernego gromadzenia się tkanki tłuszczowej, wynikający z braku równowagi między poborem energii a jej wydatkowaniem. Jest to istotny problem zdrowotny, który może negatywnie wpływać na jakość snu. Jednocześnie zaburzenia snu, takie jak jego niedobór lub niska jakość, mogą sprzyjać rozwojowi otyłości, tworząc błędne koło. Artykuł ma na celu zebranie i podsumowanie najnowszych odkryć naukowych dotyczących związku między zaburzeniami snu a otyłością.

Opis stanu wiedzy. Źródła zostały pozyskane za pośrednictwem baz PubMed oraz Google Scholar, z wykorzystaniem słów kluczowych: „otyłość", „bezsenność", „zaburzenia snu". Przegląd literatury przeprowadzono w okresie od października 2024 roku do stycznia 2025 roku. Obecnie nie ma jasnego konsensusu co do tego, czy to otyłość prowadzi do zaburzeń snu, czy też zaburzenia snu sprzyjają rozwojowi otyłości. Wraz ze zmianami populacyjnymi obserwuje się coraz krótszy czas trwania snu. Otyłość może upośledzać wydzielanie greliny i leptyny oraz zaburzać produkcję melatoniny. Dodatkowo predysponuje do występowania bezdechu sennego, który przyczynia się do zaburzeń snu. Badania wykazały związek między różnymi porami snu a ryzykiem otyłości. Osoby, które śpią za krótko, mają trudności z redukcją masy ciała.

Podsumowanie. Otyłość to poważny problem cywilizacyjny, który może prowadzić do wielu zaburzeń. Badania wskazują na jej wpływ na zaburzenia snu, choć wciąż nie ma jednoznacznej zgody co do tego, czy zależność ta działa również w drugą stronę. Wiadomo jednak, że otyłość wpływa na zaburzenia hormonalne i anatomiczne, które mogą sprzyjać jej dalszemu rozwojowi. Jednocześnie nieregularne pory i niedobór snu wiąże się ze zwiększonym ryzykiem otyłości. Sugeruje się, że edukacja, lepsze zarządzanie snem i odpowiednia dieta mogą poprawić jakość snu, a tym samym wspomóc leczenie otyłości.

Słowa kluczowe

nadwaga, zaburzenia snu, epidemia

INTRODUCTION

Obesity is a condition characterized by excessive fat accumulation, caused by an imbalance between energy intake and energy expenditure. The main causes are excessive

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caloric intake, physical inactivity, genetic factors and mental disorders [1]. According to World Health Organization (WHO) criteria, obesity is defined as a body mass index (BMI) ≥ 30 kg/m², with normal weight corresponding to a BMI < 25.0 and overweight a BMI in the range of 25.0–29.9 [2].

Since the mid-1970s, the obesity problem has nearly tripled worldwide. According to 2016 data, more than 340 million children and adolescents aged 5–19 were overweight, an increase from 4% in 1975 to more than 18% in 2016. Projections indicate that if current trends continue, nearly 60% of the world's population will be overweight by 2030 [3]. Obesity affects about 13% of the world's adult population, and the number of obese people has tripled over the past 40 years [4].

One of the risk factors for developing obesity is too little sleep. It is recommended that sleep should last at least 7 hours per night. People who sleep less than 7 hours are 6% more likely to develop obesity [5]. Epidemiological studies have shown a worldwide trend toward poor sleep quality in parallel with the obesity epidemic [6]. One-third of adults do not sleep long enough, which is associated with metabolic disorders such as impaired glucose tolerance, insulin resistance, abnormal cortisol levels and disruption of hormones that regulate hunger and appetite [5, 7].

Studies have shown that sleeping less than 30 hours per week leads to severe impairment, particularly among health care workers [8]. Sleep deprivation is also associated with decreased alertness and behavioural changes [7]. Shift work, long working hours, and extended commute times contribute to sleep deprivation which, in turn, increases the risk of obesity [5, 9].

In children, excessive use of electronic devices leads to later bedtime and less physical activity compared to peers who fall asleep earlier, even if their total sleep time is similar [10]. A link between short sleep duration and obesity has been shown in all age groups [4]. On school days, 22.6% of children sleep below the recommended 7 hours. Interestingly, some studies suggest that going to bed late may be an independent risk factor for obesity, independent of total sleep time [10]. Other studies suggest that discrepancies in diurnal rhythms and sleep fragmentation may also contribute to the development of obesity [11].

OBJECTIVE

The aim of the study was to collect and summarize recent scientific research on the relationship between sleep disturbances and obesity.

MATERIALS AND METHOD

A review of the scientific literature was conducted using reputable databases such as Medline, Google Scholar and PubMed. The search criteria included papers published in English and Polish, with a focus on original studies, systematic reviews and meta-analyses. A combination of key words linked by logical operators was used to search for relevant publications: 'obesity', 'overweight', 'sleep problems'. Mainly publications from the last 10 years were analyzed. Older works were included only in exceptional cases, if they contributed significant substantive value to the study. Master's theses, conference proceedings, abstracts, and advertising materials were excluded to ensure the highest quality and reliability of the collected data. The literature search was conducted between October 2024 – January 2025. The workflow during the creation of the manuscript is shown in Figure 1.

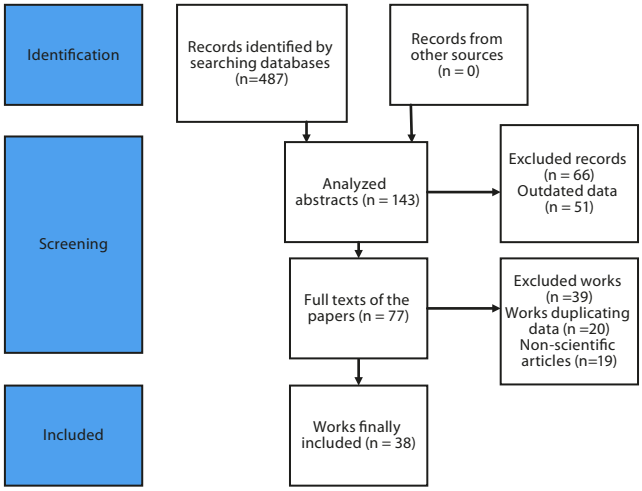

Figure 1. Diagram of the literature selection process

Proper sleep. Sleep is a key physiological process that is essential for health and well-being [12]. It is recommended that people over the age of 18 get an average of 7–9 hours of sleep per night, with an optimal sleep duration of about 7.5 hours. Adequate sleep is important for the body to function properly on a physical, mental and emotional level [13]. Newborns typically require 14–17 hours of sleep, infants 11–14 hours, pre-schoolers 10–13 hours, and school-aged children 9–11 hours. Adolescents are recommended to sleep between 8 10 – hours per night. For adults, the optimal sleep duration ranges from 7–9 hours, while older adults generally need slightly less, around 7–8 hours [12]. Studies indicate that good sleep quality and adequate sleep duration can promote weight loss [13]. It is indicated that interventions, such as going to bed at a consistent time, providing a dark environment, avoiding electronic devices 30 minutes before bedtime, stress reduction, breathing exercises, use of herbal medicines and avoidance of alcohol can improve sleep quality, and it is recommended to take care of proper temperature, select a comfortable mattress and pillow, isolation from noise and avoidance of sleep fragmentation [14]. Good practices related to sleep hygiene have been collected in the acronym SLEEP [15] (Fig. 2).

S (same sleep and wake time)

L (light in the morning)

E (eat well)

E (enviroment cool, calm, dark, quiet)

P (physically active during the day)

Figure 2. SLEEP acronym explanation

Sleep deprivation. Sleep that lasts less than 7 hours is considered sleep deprivation [16]. Modern lifestyle changes have contributed to a reduction in average sleep time [13]. A study conducted in the USA as part of surveillance of adolescent risk behaviours found that 57.8% of high school students and 72.7% of elementary school students do not sleep long enough [17]. For adults, more than 30% of the population sleeps less than 6 hours a night [18]. The number of people complaining of deteriorating sleep quality, insomnia, frequent awakenings during the night and prolonged sleep is increasing every year. These problems affect the general population, but are more common in women and the elderly (over 65 years of age) [12]. Sleep deprivation has a proven link to a number of conditions, including type 2 diabetes, cardiovascular disease and hypertension [13]. In addition, sleep deprivation increases the risk of depression, cancer, and infectious diseases [12]. It has been indicated that sleep deprivation is associated with changes in neural plasticity and cognitive functions such as learning and memory [7]. Another study suggests that sleep deprivation and obesity are associated with neurocognitive impairment [8]. Brzecka et al. showed that sleep deprivation can lead to impaired gene expression, immune dysfunction, and can increase the risk of cancers, including gastric, gastric squamous cell, and breast cancer [19].

Link between obesity and sleep quality. Studies have been unable to conclusively establish a cause-and-effect relationship between insufficient sleep and obesity, leaving open the question of whether it is sleep deficiency that leads to obesity, whether obesity causes sleep disorders, or whether the two factors interact [20]. It has been suggested that the relationship between obesity and sleep disorders is bi-directional: on the one hand, shorter sleep duration may contribute to weight gain, while on the other hand, higher BMI may negatively affect the quality and length of sleep [21]. A study by Patel et al. involving 3,053 men and 2,985 women found that each 1-hour reduction in sleep increased the risk of obesity 1.63-fold in men and 1.22-fold in women, while the association between going to bed late and obesity was less clear [22]. Other studies confirm that people who sleep less than 7 hours a night have higher body mass indexes [16]. In contrast, overweight individuals (BMI > 24.99) are more likely to suffer from insomnia compared to normal weight individuals (55.1% vs. 46.7%) [21]. Reducing sleep to 4 hours per night for 2 weeks led to an increase in daily caloric intake of more than 300 kcal, a weight gain of 0.5 kg, and an increase in visceral fat of 11% [20]. In addition, longer naps on weekdays (more than 30 minutes) were associated with higher rates of obesity, which is explained by disrupted nighttime sleep [7]. Sleep deprivation can also influence the development of obesity by increasing time spent sitting, decreasing physical activity and increasing time in front of a screen, and in children, sleep deprivation can lead to decreased activity due to fatigue [23]. Another study found that children's Internet addiction negatively affects physical activity, and this can affect metabolic disturbances and the development of obesity [19].

Obesity is associated with metabolic and hormonal disturbances that affect sleep regulation [15]. Sleep restriction leads to an increase in ghrelin (hunger hormone) and a decrease in leptin (satiety hormone), which increases feelings of hunger [24]. In obese individuals, the pattern of ghrelin secretion is disturbed – the nocturnal increase in its levels is blunted or absent [4]. Short sleep duration also affects the decrease in melatonin, which disrupts the diurnal rhythm and may contribute to the metabolic syndrome [25]. In addition, increased evening cortisol levels can affect appetite. In obese individuals, lower levels of obesatin, a hormone that affects feelings of satiety, are observed. Sleep deprivation also affects the reward system, increasing preference for high-calorie foods [4]. People who sleep less than 7 hours have twice the risk of developing pre-diabetes and type 2 diabetes which, in turn, predisposes to obesity [26]. It has been shown that people with obesity experience increased hunger and decreased feelings of satiety, and people with sleep deprivation are more likely to snack, especially on carbohydrate-rich foods, and spend more on food [18]. Shorter sleep duration is associated with unhealthy eating habits, such as increased consumption of sugar and sweetened beverages [23]. This was confirmed in a study from Denmark, where 1-hour shorter sleep in children aged 8–11 was associated with higher sugar intake [27]. In contrast, longer sleep duration in children correlated with lower weight gain with age [28]. Studies indicate that obese individuals often co-occur with obstructive sleep apnea (OSA), which leads to frequent awakenings and sleep fragmentation, resulting in insufficient sleep duration [29]. In animal models, it has been shown that obesity itself can disrupt sleep structure, regardless of the severity of apnea [30]. OSA also occurs in overweight and obese children, but in this age group, tonsillar hypertrophy is the main risk factor [31]. Another study also points out that sleep disturbances in obese children may not only be related to OSA, but also to malocclusion [32]. Apnea sufferers experience episodes of arrested or shallow breathing due to collapse of the upper airway, leading to awakenings and impaired sleep quality. Additionally, patients with OSA have elevated leptin levels and exacerbated ghrelin secretion [4, 25]. Other studies point to a role for orexin. Orexin regulates both sleep and appetite, affecting wakefulness, REM sleep and eating behavior. Its deficiency disrupts energy balance, can increase appetite and promote the consumption of high-calorie foods, which is associated with the risk of obesity. Sleep disturbances, especially shortening of the REM phase, further enhance this effect by disrupting physiological mechanisms that inhibit appetite [33].

Increased adipose tissue can also lead to increased secretion of inflammatory cytokines that disrupt circadian rhythms [9]. In addition, sleep deprivation hinders weight loss – in one study, people with sleep deprivation lost less than half of their body fat compared to those sleeping enough, suggesting that sleep deprivation increases the difficulty of weight loss and the risk of weight gain again [24]. In terms of diet, certain foods like dairy, fish, fruits, and vegetables can help improve sleep quality. A lack of dietary protein may disrupt sleep continuity, while fibre intake has been shown to enhance sleep. Cow's milk, particularly when collected at night, contains natural melatonin, and foods rich in tryptophan (a precursor to melatonin) can also support better sleep regulation [9].

Abnormal sleep patterns, such as going to bed late, are associated with a higher risk of obesity. Studies have shown that late bedtime correlates with increased energy intake, and that variability in bedtimes between weekdays and weekends in children aged 4–10 years is associated with metabolic

disorders. In older children, going to bed late and getting up early also correlated with higher body weight [34]. It has been pointed out that the evidence considered here suggests that sleep deprivation is associated with several changes in the epigenome, particularly with respect to DNA methylation, histone modifications and non-coding RNAs, and this may have implications [7].

Sleep prevention. It has been shown that prolonging sleep in a non-pharmacological manner (through lifestyle changes) in obese individuals for an average of 468 days led to improvements in sleep quality, sleep duration and reduced daytime sleepiness. Neurocognitive functions also improved, especially attention and global cognitive function, while memory and executive functions tended to improve [8]. In addition, it is emphasized that education is of key importance in the fight against obesity and its complications, including sleep disorders.

The importance of education from an early age is emphasized, involving parents in the process as well. In order to improve public health, it is necessary to implement programmes that promote healthy lifestyles, in which health care professionals should actively participate. In patients with OSA, treatment with continuous positive airway pressure (CPAP) is recommended [25]. Researchers emphasize that promoting a healthy lifestyle, including regular physical activity and a balanced diet, can help maintain a normal BMI and improve sleep quality. Individuals who are overweight or obese should be especially encouraged to consult a physician to diagnose possible sleep disorders, such as OSA [14]. It has been indicated that weight loss itself improves sleep quality [25, 35]. Studies have shown that increasing sleep by 1.6 hours per night reduces appetite by 14% and reduces cravings for sweets by as much as 62%. Similar results were observed in the Quebec Family Study, where extending sleep by 1.5 hours improved body mass indices [24]. In another study, participants who increased their sleep time took in fewer calories, and over the course of the study, this resulted in a loss of 0.5 kg. This was a statistically significant loss with no significant change in total energy expenditure [20]. In addition, following a Mediterranean diet is associated with better sleep quality, easier maintenance of a normal BMI and a smaller waist circumference [9]. On the other hand, a low-calorie ketogenic diet has been shown to have positive effects on weight reduction, reduced cravings for sweets and a reduction in sleep disturbances [36]. It is argued that more research is needed to examine the impact of obesity on sleep quality and vice versa [37, 38].

CONCLUSIONS

Obesity is a serious public health problem, and its association with sleep disorders remains the subject of intense scientific research. There is still no clear consensus on whether the relationship between obesity and sleep disorders is unidirectional or bi-lateral. On the one hand, obesity is associated with endocrine disorders, such as abnormal secretion of ghrelin (hunger hormone) and leptin (satiety hormone), which increases appetite and makes weight control difficult. It is also often accompanied by obstructive sleep apnea (OSA), which causes frequent awakenings and impairs sleep quality, negatively affecting self-esteem and mental health. On the other hand, sleep deprivation and irregular sleep patterns, such as going to bed late, lead to metabolic disturbances, an increase in cortisol, a decrease in melatonin, and disrupted diurnal rhythms. This increases appetite for high-calorie foods, reduces physical activity and raises the risk of obesity. Therefore, there is an urgent need for further research to better understand the mechanisms linking obesity and sleep disorders. It is also necessary to develop effective preventive and therapeutic strategies that address both nutritional and behavioural aspects, including improving sleep hygiene. Educating the public about the importance of regular sleep, a healthy diet and physical activity can play a key role in preventing both obesity and sleep disorders, thereby improving public health on a global scale.

List of abbreviations

BMI – Body Mass Index; **CPAP** – Continuous Positive Airway Pressure; **OSA** – Obstructive Sleep Apnea

Ethics approval and consent

The study did not require any ethical approval or consent as it did not involve the use of human or animal subjects.

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