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Association of Sleep Disturbances with Body Mass Index and Age in Adult Participants

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ABSTRACT

The aim of this study was to examine the association between sleep disturbances, as an indicator of sleep quality, Body Mass Index, and age in adult participants. The study involved 73 participants (62 women and 11 men) with an average age of 35.74 years. Through an online questionnaire, we collected the data on participants' height, body mass, gender, and sleep disturbances. Based on their height and mass, we calculated the Body Mass Index as an indicator of body fat for each participant. We used items from a shorter version of the Pittsburgh Sleep Quality Index to assess sleep disturbances. Participants were asked to answer how often they experienced different disturbances while falling asleep or sleeping in the last month. The results of the study indicated an association between sleep disturbances and Body Mass Index. Compared to participants who rarely experienced sleep disturbances, participants with frequent disturbances were more likely to have a high Body Mass Index (indicating excess mass or obesity). Although older participants in most cases had a high Body Mass Index compared to younger participants, no significant association was found between sleep disturbances and age. The results of the study also suggest that the association between sleep disturbances and Body Mass Index did not depend on the age of the participants. The research findings indicate that in addressing the issues of obesity and excess mass, public health attention should also be given to sleep quality issues.

Key words: *sleep disturbances, Body Mass Index, adults*

Introduction

Sleep quality is related to a person's overall health and quality of life[1]. However, sleep disturbances are nowadays one of the most common disorders in adults and it is estimated that their prevalence in the general population is between 15 and 24%[2]. Research shows that sleep difficulties can contribute to the development of a number of other health problems such as cardiovascular diseases[3] and diabetes[4], and increase the risk of developing psychological disorders, especially depression[5]. Recently, the association between sleep quality and obesity and weight problems has been increasingly explored[6]. Thus, it is known that poor sleep quality is associated with a higher Body Mass Index (BMI)[6] which is one of the most commonly used nutrition measures. However, the relationship between sleep quality and BMI is still not sufficiently clear and explored. Poor sleep quality is thought to contribute to the development of a higher BMI through a range of different and interrelated neurological, metabolic, and endocrine processes caused by poor sleep quality. Among them are, for example, changes in the hormones leptin and ghrelin, which are associated with feelings of satiety and hunger[7], then, an increase in the so-called "stress hormone" cortisol and insulin resistance[8].

In order to better understand the relationship between sleep difficulties and BMI, it is important to consider different dimensions of sleep quality. According to one of the most commonly used self-assessment questionnaires in this area, the Pittsburgh Sleep Quality Index, it is possible to measure and distinguish between seven components of sleep quality: sleep duration, sleep latency, subjective sleep quality, sleep disturbances, sleep efficiency, use of sleeping medication and daytime dysfunction due to poor

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sleep quality[9]. However, the shortcoming of numerous studies in this field is the use of a single general sleep quality index which is why it cannot be determined how specific aspects of sleep quality are related to BMI[10]. Considering the different components of the Pittsburgh Sleep Quality Index, Vargas et al.[11] found in a sample of older adolescents that only sleep disturbances were associated with too high a BMI (≥25). Empirical findings to date generally suggest[12] that obesity and body mass problems, especially in younger adults, are more related to sleep aspects which refer to qualitative sleep determinants in a narrower sense, such as sleep disturbances (e.g., waking up at night, pain while sleeping, difficulty breathing) and not so much with the duration of sleep. These findings suggest that sleep duration, which is the most commonly researched aspect of sleep, should not be used as the only indicator of sleep quality[12].

Some research also suggests that there is an association between older age and difficulty sleeping[1,13–14]. It is thought that the basis of this association if the increased sensitivity of the regulatory system to the rhythm of wakefulness and sleep that develops with older age[1]. However, some research has shown that healthy older people do not necessarily have more difficulty sleeping than younger people, especially when self-assessment is used as a measure of sleep quality[15–16].

To contribute to the literature in this field, the aim of this study was to examine the association of sleep disturbances with BMI and age in adult participants, where BMI was used as an indicator of nutrition, and sleep disturbances as an indicator of sleep quality. Namely, as was already mentioned, recent research suggests that sleep disorders are the aspect of sleep quality that has the greatest impact on health outcomes[11]. Finally, since some findings suggest that the relationship between sleep quality and BMI may depend on the age of the participants[17], we examined whether the association between sleep disturbances and BMI differed in the group of younger and older participants.

Material and Methods

Respondents

This study was conducted on a convenient sample of 73 adults aged between 18 and 72 years (M=35.74; SD=12.07). Table 1 shows the distribution of participants by age group. As can be seen, most participants (n=29, 39.72%) belong to the youngest age group (18 to 31 years). In the group between 32 and 45 years there are 23 participants (31.51%), and in the group between 46 and 59 years 19 participants (26%). In the oldest group (60 to 73 years) there are only two participants (2.74%). 62 women (84.9%) and 11 men (15.1%) participated in the study. The characteristics of the participants according to other characteristics measured in the research are presented in the *Results* section.

This study was conducted in full accordance with the ethical guidelines of the Declaration of Helsinki and approved by the relevant ethics bord.

TABLE 1

DISTRIBUTION OF PARTICIPANTS BY AGE GROUPS (N = 73)

Age range (in years)	Frequency
18 – 31	29
32 – 45	23
46 – 59	19
60 – 73	2

Study design

The research was conducted using the online survey method. The survey was anonymous and included questions about the sex and age of the participants, their body mass (in kilograms), their height (in centimeters) and six questions that examined the frequency of sleep disturbances in participants in the past month. These questions were taken from the Pittsburgh Sleep Quality Index (PSQI) questionnaire, which measures seven different components of sleep quality, and sleep disturbances are one of them. The original questionnaire has a higher number of items to measure sleep disturbances, and the six items used in this study were taken from its abbreviated version which also proved to be a psychometrically reliable and valid measure of sleep quality[18]. Participants had to state how often they suffered from sleep disturbances when falling asleep or while sleeping in the past month: waking up at night or early in the morning; difficulty breathing; coughing or snoring loudly; feeling too hot; having bad dreams; or feeling pain.

Participants were required to respond using a four-point scale: 0 = not in the last month; 1 = less than once a week; 2 = once or twice a week; 3 = three or more times a week. In order to obtain the final score for each participant on the sleep disturbance scale, their answers to all six items should first be summarized, with the theoretical score range being 0 to 18. Given the sum, participants are then put in the category of sleep disturbances from 0 to 3 where the higher category represents the higher intensity of sleep disturbances[18]. The final result is formed as follows: the sum of items 0 = disturbance category 0; the sum of the items greater than or equal to 1 and less than or equal to 6 = disturbance category 1; the sum of items greater than 6 and less than or equal to 12 = category 2; the sum of items greater than 12 = category 3.

As a measure of the participants' nutritional status, the Body Mass Index (BMI) was used, which is one of the most widespread measures of the nutritional status. Even though BMI cannot be used as a reliable clinical tool, it is an easily accessible measure that is very often used for research and epidemiological purposes[19]. BMI was calculated for each participant based on their height and body

mass. BMI is calculated by dividing a person's body mass in kilograms by their height in meters squared. The calculation formula is: BMI = [body mass (kg)/height (m) 2].

In order to categorize study participants into groups of different nutritional status, we used the World Health Organization categorization[20]. In accordance with this categorization, each participant was classified into one of the four BMI categories: 1 = Underweight (Malnutrition); 2 = Normal weight (Normal Body Mass); 3 = Overweight (Excess Body Mass); 4 = Obese (Obesity). According to this categorization, a BMI less than 18.5 indicates that a person is underweight, between 18.5 and 24.9 indicates a normal body weight, between 25 and 29.9 excess weight, while a BMI higher than 30 indicates obesity. This categorization is used for people over the age of 20, however, since there were only two participants younger than 20 in our sample, we applied it to the entire sample.

Statistics

For the purpose of data analysis, we first used descriptive statistics to describe the characteristics of the sample and the data collected for the research variables. For age, body mass, height, and BMI variables, the arithmetic mean (M) was calculated as a measure of central tendency, and standard deviation (SD) as a measure of result variability. Frequency distribution of the answers and associated percentages were calculated for the final BMI and sleep disturbance categories. The lowest (Min.) and highest (Max.) observed values are also shown for each variable.

In order to determine the association between sleep disturbances and participants' BMI, we first merged participants in the overweight (BMI 25 to 29.9) and obese (BMI greater than 30) categories into one category of a high BMI (≥25). It should be noted that it was not possible to examine whether participants with a low BMI which indicates malnutrition (≤18.5) differed from participants with other BMI categories in sleep disturbances. Namely, in our study, in the low BMI group, there were only three participants, which was too low a number to compare them with other categories of BMI. A chi-square test was used to calculate the association between sleep disturbances and BMI. To determine whether there was a correlation between participant age as a continuous variable and sleep disturbance as an ordinal variable, a point-biserial correlation coefficient was calculated. The same correlation coefficient was used to calculate the correlation between BMI categories and the age of participants. Finally, to examine whether the association between BMI and sleep disturbances was age-constant, the sample was divided into two age groups based on median age (participants up to 37 years of age and participants older than 37 years) and using two chi-square tests. The test examined the relationship between BMI and sleep disturbances in these two age samples. Data was processed using the SPSS software package (version 20.0).

Results

Descriptive statistics

Table 2 shows the descriptive statistics measures for the body variables used in the study. As can be seen, the average height of the participants was 169.89 cm (SD=8.89), the average body mass was 72.64 kg (SD=15.64), and the average BMI was 25. On average, the participants had an increased body mass since the mean BMI in this study was equal to the value of the lower range limit in the overweight category.

TABLE 2

DESCRIPTIVE STATISTICS FOR HEIGHT, WEIGHT AND BMI OF PARTICIPANTS

(N = 73)

Variable	Min.	Max.	M	SD
Height	151	198	169.89	8.89
Weight	42	115	72.64	15.64
BMI	17.71	39.04	25	4.21

Legend: Min. – lowest observed value, Max. – highest observed value, M – arithmetic mean, SD – standard deviation.

Figure 1 shows the distribution of participants according to BMI categories. As can be seen, the largest number of participants, 37 of them (50.68%), are in the normal body mass group. However, when we combine the group of excess body mass participants, 26 participants (35.62%), and the group of participants in the obesity category, seven of them (9.59%), it turns out that a total of 33 participants in our study have too high a BMI (≥25) which is 45.01% of the sample. Finally, only three participants in our sample have a BMI that indicates malnutrition, which is 4.11% of the sample.

Table 3 shows the prevalence of sleep disturbances in the study. The table shows the number of participants who reported experiencing sleep disturbances at least once a week or more frequently in the past month (responses '2' or '3' on the response scale). In the table, sleep disturbances are ranked from most common to least common. As can be seen, the most common sleep disturbance was waking up in the middle of the night or early morning. About 62% of participants (45 of them) reported experiencing this disturbance at least once or several times a week in the past month. Furthermore, 23 participants (31.51%) reported feeling too hot while falling asleep or during sleep at least once a week, and a similar number – 20 (27.40%), reported having pain while falling asleep or during sleep. Table 3 also shows that the fewest participants, 11 of them (15.07%), experienced breathing difficulties while falling asleep or during sleep.

For the sleep disturbance scale, the Cronbach α internal consistency reliability was 0.672, which indicates satisfactory reliability[21]. For each participant, the total score

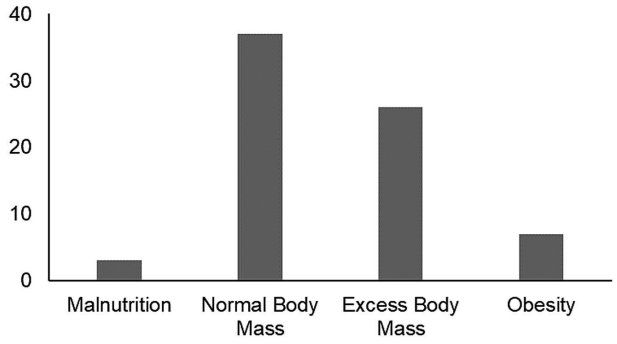

Fig. 1. Distribution of participants by BMI categories (N = 73).

TABLE 3

PREVALENCE OF SLEEP DISTURBANCES IN THE STUDY (N = 73)

Sleep disturbances	n	%
Wake up in the middle of the night or early morning	45	61.64
Feel too hot	23	31.51
Have pain	20	27.40
Cough or snore loudly	19	26.03
Had bad dreams	17	23.29
Cannot breathe comfortably	11	15.07

Legend: n – number of participants,% – percentage.

on the scale was calculated by first summing their responses to all six items. The minimum achieved result in the sample was 6, and the maximum was 15 (the theoretical score range is from 0 to 18). After that, for each participant, his total score was converted into the category of sleep disturbances from 0 to 3, according to the categorization described in the Methods section of this paper. The frequencies of individual categories of sleep disturbances are shown in Table 4. The higher category indicates more pronounced sleep disturbances. It can be seen that most participants, 43 of them, are in the first category of sleep disturbances (61.4%). In the second category of disturbances there are 22 participants (31.4%). In the highest and lowest sleep disturbance categories, there were only two and three participants, respectively. Because these categories were extremely underrepresented, we merged them with neighboring categories, resulting in two categories of sleep disturbances. In the category called "rare sleep disturbances", zero and the first category were merged (n=48, 65.75% of the sample), while participants from the third category were merged with the participants in the second category. This category was called frequent sleep disturbances (n=25, 34.25% of the sample).

Association of sleep disturbances with BMI

The result of the conducted chi-square test showed that there is a statistically significant correlation between

TABLE 4

PREVALENCE OF SLEEP DISTURBANCE CATEGORIES, WITH A HIGHER CATEGORY INDICATING MORE PRONOUNCED SLEEP DISTURBANCES (N = 73)

n	Sleep disturbance categories	%
3	0	4.1
45	1	61.6
23	2	31.5
2	3	2.7

Legend: n – number of participants,% – percentage.

sleep disturbances and BMI:$\chi^2(1)=5.59$, p=0,018. The proportion of participants with too high a BMI was higher in the group with frequent sleep disturbances than in the group with rare sleep disturbances. As can be seen from Figure 2, in the group of frequent sleep disturbances, 66.7% of participants (16 of 24) had too high a BMI. On the other hand, in the group of rare sleep disturbances, the share of those with too high a BMI was twice as lower and amounted to 33.3% (17 out of 46). The magnitude of the effect for the association between BMI and sleep disturbance was phi =0.28 (p=0.018) indicating a small to moderate effect[22].

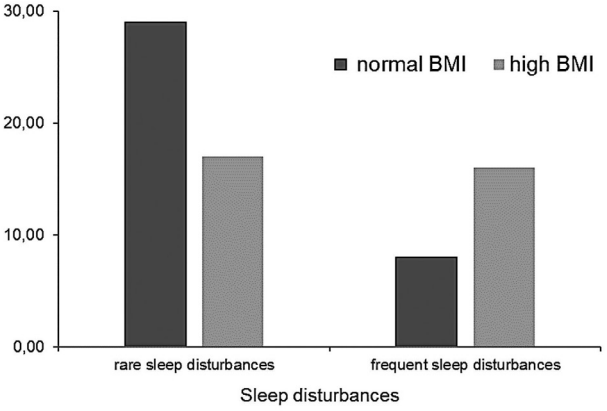

Fig. 2. Association of age with sleep disturbances and BMI

In order to calculate the association of participants' age with sleep disturbances and BMI, two point-biserial correlation coefficients were calculated. Higher age was shown to be associated with higher BMI (r=0.26; p=0.031), but age of participants was not associated with the frequency of their sleep disturbances (r=0.23; p=0.050).

Association of BMI and sleep disturbances in a group of younger and older participants

To verify whether the association between sleep disturbances and BMI was age-constant, the sample was first divided into two sub-samples with respect to the median age value of 37 years. Accordingly, the first sub-sample consisted of participants under the age of 37 (n=37) and

the second sub-sample of participants older than 37 (n=36). Subsequently, chi-square tests were conducted within both groups to assess the association between sleep disturbances and BMI. Both tests were statistically insignificant (in the group of younger participants: $\chi^2(1)=1.56$, p=0.254; in the group of older participants: $\chi^2(1)=3.29$, p=0.096), which can probably be attributed to the low statistical power resulting from small age sub-samples. However, the distribution of participants according to BMI categories and sleep disturbance categories was the same in both age groups as in the whole sample (in the group of rare sleep disturbances there were more participants with a normal BMI, while in the group of frequent sleep disturbances there were more participants with too high a BMI), suggesting that the relationship between sleep disturbances and BMI is not different in younger and older participants.

Discussion

The findings of this study indicate that adults with frequent sleep disturbances are significantly more likely to have too high a BMI than adults with rare sleep disturbances. This finding is consistent with some previous research that also indicated a link between frequent sleep disturbances and excess mass and obesity[11–12,23]. Research also suggests that sleep disturbances are the most important indicator of overall sleep quality in the context of impact on other health problems which also include obesity[11]. For example, in a study conducted by Vargas et al.[11] participants who had more sleep disturbances had a higher BMI than participants with fewer sleep disturbances regardless of the duration of sleep in both groups.

There are various explanations for the mechanisms underlying the association between sleep disturbances and a high BMI. One of the explanations is that people who have more sleep disturbances are more limited in daily physical activity, leading to a higher BMI. Namely, people who report more sleep disturbances are less active than people who experience fewer sleep disturbances, while a link between sleep duration and physical activity has not been determined[24]. Furthermore, sleep disturbances, leading to fragmented sleep and sleep with few REM stages, are associated with some adverse metabolic processes which may also explain the association with too high a BMI. For example, sleep disturbances have been found to lead to a decrease in insulin sensitivity and impaired glucose tolerance[3,25]. However, the exact mechanism behind the association between sleep disturbances and a high BMI is still unclear and requires further research[23].

Even though in this study older participants had, in more instances, a higher BMI than younger participants, age was not associated with sleep disturbances, thus it can be concluded that the determined correlation between sleep disturbances and BMI is not due to the older age of persons with a higher BMI. Previous findings regarding the association between age and sleep quality are inconsistent. In some studies, age was a predictor of poorer sleep quality [1, 13, 14], while in others it was not determined that healthy older participants reported poorer sleep quality than younger participants[15–16]. Hinz et al. found that the association between age and sleep disturbances was not the same for all age ranges[26]. In their study, age was negatively associated with sleep quality only in adult participants younger than 50 years, but after the age of 50, the age had no role in explaining sleep quality. Given these inconsistent findings, future research should, by using larger samples, examine the association between age and sleep disturbances at different age intervals.

The results also suggest that the association between BMI and sleep disturbances does not depend on the age of the participants. However, it should be noted that our results cannot provide a firm conclusion regarding sleep disturbances and BMI as a function of age for two reasons. Firstly, the sub-samples used were small which reduced the statistical power of the tests performed, and secondly, in this study, we had only two participants who were older than 60 years. Therefore, for a more valid conclusion about the association between sleep disturbances and BMI as a function of age, a larger, age-heterogeneous sample should be included, which would include a sufficient number of participants older than 60 years. For example, a study examining the association between sleep duration and BMI found a negative correlation between these two constructs in younger participants, while in participants older than 65, these two variables were not related[17].

The results obtained in this study indicate that in addressing excess weight and obesity, public health attention should also be given to sleep quality issues. This is even more important if we consider that in our sample almost half of the participants had a BMI value equal to or greater than 25 which poses a significant risk for developing cardiovascular, metabolic, and musculoskeletal disorders[27]. Physical exercise can be an alternative or complementary approach to existing therapies for sleep disorders. Namely, research shows that participation in an exercise program has moderate positive effects on sleep quality in middle-aged and elderly adults[28]. Furthermore, physiotherapy uses various exercise techniques for musculoskeletal issues[29] that can improve sleep quality and thus contribute to healthier body mass. Physical activity generally affects energy expenditure when sleeping, exercising, walking, and the like, which can result in a twofold positive change – both in the quality of sleep and in a person's body mass[30].

Finally, it should be noted that this study has certain limitations that should be taken into account when considering the results obtained and planning future research in this field, and we have already referred to them in the discussion. It should first be noted that although BMI is a good and frequently used measure of nutrition, it is not perfectly reliable as it depends on factors such as age, gender, and physique of the participants. In addition, height and mass measurements in our study were obtained by participants' self-assessment, which is not al-

ways accurate. Due to what was stated above, there is a possibility of incorrect categorization of participants in BMI categories, which may reduce the reliability of the obtained results. Furthermore, predominantly younger women participated in our study, so the possibility of generalizing the findings to both sexes and to younger and older people is limited.

Namely, it is known that women have more difficulty sleeping than men[26,31]. Also, by including more participants, it would probably be possible to reach a larger number of people whose BMI indicates malnutrition and a larger number of people classified as overweight and obese, which would allow more precise examination of the association between sleep quality and all categories of BMI. Finally, the study design does not allow conclusions to be drawn about causality, although sleep disturbances are thought to affect BMI[11]. However, in order to examine this direction of influence in more detail, longitudinal studies with multiple measurement points are needed to monitor sleep disturbances and BMI of participants.

Conclusion

The aim of this study was to examine the association of sleep disturbances, as an indicator of sleep quality, with BMI and age in adult participants. The results of the study showed that people who report frequent sleep disturbances are more likely to have too high a BMI (which indicates excess mass or obesity) than people who report rare sleep disturbances. Although older participants in most cases had too high a BMI compared to younger participants, no significant association was found between sleep disturbances and age, from which it can be concluded that a significant correlation between sleep disturbances and participant BMI cannot be attributed to the higher age of participants with an elevated BMI. Although the results also suggest that the association between sleep disturbances and BMI does not depend on the age of the participants, the final conclusion on this relationship should include a larger sample in future research that will evenly cover the entire adulthood and old age range.

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POVEZANOST POREMEĆAJA SPAVANJA S INDEKSOM TJELESNE MASE I DOBI KOD ODRASLIH OSOBA

S A Ž E T A K

Cilj ovog istraživanja bio je ispitati povezanost poremećaja spavanja kao pokazatelja kvalitete spavanja, indeksa tjelesne mase i dobi odraslih sudionika. U istraživanju je sudjelovalo 73 sudionika (62 žene i 11 muškaraca) prosječne starosti 35,74 godine. Kroz internetski upitnik prikupljeni su podaci o visini, tjelesnoj masi, spolu i poremećajima spavanja sudionika. Na temelju njihove visine i mase izračunali smo indeks tjelesne mase kao pokazatelj tjelesne masti za svakog sudionika. Za procjenu poremećaja spavanja koristili smo stavke iz kraće verzije Pittsburgh indeksa kvalitete spavanja. Sudionici su trebali odgovoriti koliko su često doživljavali različite smetnje dok su zaspali ili spavali u posljednjih mjesec dana. Rezultati studije ukazali su na povezanost poremećaja spavanja i indeksa tjelesne mase. U usporedbi sa sudionicima koji su rijetko imali poremećaja spavanja, sudionici s čestim smetnjama vjerojatnije su imali visok indeks tjelesne mase (što ukazuje na prekomjernu tjelesnu masu ili pretilost). Iako su stariji sudionici u većini slučajeva imali visok indeks tjelesne mase u usporedbi s mlađim sudionicima, nije pronađena značajna povezanost između poremećaja spavanja i dobi. Rezultati studije također sugeriraju da povezanost poremećaja spavanja i indeksa tjelesne mase nije ovisila o dobi sudionika. Nalazi istraživanja pokazuju da bi se u rješavanju problema pretilosti i prekomjerne tjelesne težine, pozornost javnog zdravstva trebala posvetiti i problemima kvalitete spavanja.