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Coexistence of obesity and sleep-disordered breathing in patients with suspected sleep apnea syndrome polysomnography referred by physicians of different specialties

Współistnienie otyłości i zaburzeń oddychania w czasie snu (ZOCS) u pacjentów kierowanych z podejrzeniem ZOCS

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S u m m a r y

Sleep-disordered breathing (SBD), particularly in the form of obstructive sleep apnea (OSAS), is highly prevalent in the general population. Obesity is a major risk factor for OSAS. BMI is the most frequently used obesity indicator. The aim of this study was to describe correlation between BMI and AHI in patients referred to sleep laboratory by physicians of different specialties because of suspicion of OSAS. 960 patients were included, all of them underwent polysomnographic evaluation. Polysomnographic parameters were judged in accordance with the recommendations. Mean BMI for the group with AHI < 5: 29.96 kg/m^2 – men; 33.63 kg/m^2 – women; for the group with AHI ≥ 5: 32.05 kg/m^2 – men; 36.38 kg/m^2 – women. The differences in BMI between healthy and patients groups were statistically significant for both sexes (women $p = 0.03$, men $p = 0.00036$). A significant positive correlation between AHI and BMI was found in women's groups of patients ($r = 0.168$, $p = 0.029$) and men's groups of patients ($r = 0.2571$, $p < 0.001$). No statistically significant correlations between AHI and BMI in healthy women and men were shown. We used also a division into three age ranges of patients: 35 y $\leq$ age $\leq$ 45 y; 45 y $<$ age $\leq$ 55 y; age $>$ 55 years. In both sex groups statistically significant positive correlation between BMI and AHI women ($r = 0.375$, $p = 0.007$) and ($r = 0.17$; $p = 0.041$) men ($r = 0.296$, $p = 0.0008$) and respectively for men patients in all age groups (35 y $\leq$ age $\leq$ 45 y: $r=0.27$, $p = 0.02$; 45 y $<$ age $\leq$ 55 y: $r = 0.28$, $p = 0.004$; age $>$ 55 y: $r = 0.166$; $p=0.015$). No statistically significant correlation between BMI and AHI for women in groups 45 y $<$ age $\leq$ 55 y and above 55 y. We conclude that in the general patients population with suspected SBD higher AHI is correlated with also higher BMI which is obesity indicator.

Key words: obesity, sleep-disordered breathing, BMI, OSAS, AHI, polysomnography

S t r e s z c z e n i e

Zaburzenia oddychania podczas snu (ZOCS), zwłaszcza w postaci obturacyjnego bezdechu sennego (OBS), są bardzo rozpowszechnione w populacji ogólnej. Otyłość to główny czynnik ryzyka. Najczęściej stosowanym wskaźnikiem oceny wielkości otyłości jest BMI (Body Mass Index). Celem tego badania było określenie związku między występowaniem zaburzeń oddychałnia w czasie snu a otyłością na podstawie oceny BMI i AHI u pacjentów, kierowanych do pracowni polisomnograficznej przez lekarzy różnych specjalności z powodu podejrzenia ZOCS. Poddano ocenie polisomnograficznej 960 pacjentów. Średnie BMI dla grupy z AHI < 5 (zdrowi): 29,96 kg/m^2 – mężczyźni; 33,63 kg/m^2 – kobiet, dla grupy z AHI ≥ 5 (chorzy): 32,05 kg/m^2 – mężczyźni, 36,38 kg/m^2 – kobiety. Różnice w BMI między zdrowymi a grupą pacjentów były istotne statystycznie dla obu płci (kobiety $p = 0{,}03$, $p = 0{,}00036$ mężczyźni). Istotną dodatnią korelację pomiędzy AHI i BMI stwierdzono w grupie kobiet chorych ($r = 0{,}168$, $p = 0{,}029$) i grupie chorych mężczyzn ($r = 0{,}2571$, $p < 0{,}001$). Nie wykazano natomiast istotnych statystycznie korelacji między AHI i BMI u zdrowych kobiet i mężczyzn. Dodatkowo podzielono pacjentów na trzy grupy wiekowe: 35 lat $\leq$ wiek $\leq$ 45 lat; 45 lat $<$wiek $\leq$ 55 lat, wiek$>$ 55 lat. U kobiet chorych jedynie w grupie 35 lat $\leq$ wiek $\leq$ 45 lat stwierdzono statystycznie istotną dodatnią korelację między BMI i AHI ($r = 0{,}369$ $p = 0{,}049$), wśród mężczyzn korelacje te stwierdzono we wszystkich grupach wiekowych (35 lat $\leq$ wiek $\leq$ 45 lat: $r = 0{,}27$, $p = 0{,}02$; 45 lat $<$wiek $\leq$ 55 lat: $r = 0{,}28$, $p = 0{,}004$; wiek$>$ 55 lat: $r = 0{,}166$, $p = 0{,}015$). Możemy stwierdzić, że w ogólnej populacji pacjentów z podejrzeniem zaburzeń oddychania w czasie snu o charakterze bezdechu sennego wyższe AHI jest skorelowane z wyższym BMI będącym wskaźnikiem otyłości.

Słowa kluczowe: otyłość, zaburzenia oddychania podczas snu, BMI, OBS, AHI, polisomnografia

INTRODUCTION

Sleep-disordered breathing (SBD), particularly in the form of obstructive sleep apnea (OSAS), is highly prevalent in the general population. The term SBD has traditionally encompassed obstructive sleep apnea – OSAS.

Sleep-disordered breathing is characterized by repetitive periods of cessation in breathing (apneas) or reductions in the amplitude of a breath (hypopneas) that occur during sleep. These events are frequently associated with fragmentation of sleep, desaturations, and sympathetic nervous system activation with heart rate and blood pressure elevation. Obstructive sleep apnea, which represents cessation of airflow, develops because of factors such as anatomic obstruction of the upper airway related to obesity, excess tissue bulk in the pharynx, and changes in muscle tone and nerve activity during sleep. Repeated episodes of upper airway obstruction during sleep lead to significant hypoxemia.

Central sleep apnea represents cessation of airflow along with absence or significant reduction in respiratory effort during sleep and is more commonly present in case of congestive heart failure, neurologic disorders, or cardiopulmonary disease.

Mixed sleep apnea is a polysomnographic diagnosed type of apnea composed of central apnea in the beginning which changes to obstructive sleep apnea.

Obstructive sleep apnea syndrome (OSAS) is very prevalent especially amongst middle-aged men population, although increased recognition of the disease is observed also in women. According to epidemiological studies 2% of female and 4% men population are affected by OSAS (1).

Obesity is a major risk factor for OSAS, occurring in up to 50% of obese men (2-4) and this relationship has been confirmed in numerous studies in the world as well as performed at our institution (5).

As shown in epidemiological studies 70% of people who were diagnosed with OSA are obese (6). It is also specified that a weight gain by 10% increases the risk of developing OSAS 6 times. Weight loss in obese patients with OSAS were found to be part of OSAS reduction (7).

AIM OF STUDY

The aim of our study is to show how often diagnosis of sleep-disordered breathing coexists with obesity in male and female population diagnosed in our sleep laboratory.

MATERIAL AND METHODS

Patients

We examined retrospectively 960 (n = 960) polysomnograms recruited from patients (both sexes) referred to sleep laboratory for suspected sleep apnea. We included bariatric patients, patients before laryngological procedures, and patients who snored regularly. Patients were referred to sleep laboratory by physicians of many specialties: family doctors, surgeons, internists, otolaryngologists.

BMI (Body Mass Index) was used as the obesity indicator. BMI was calculated as weight in kilograms divided by the square of the height.

Using BMI value we describe as follows: overweight – BMI = 25 ÷ 29.9 kg/m^2; obesity of first degree BMI = 30 ÷ 34.9 kg/m^2; obesity of second degree BMI = 35 ÷ 39.9 kg/m^2 and obesity of third degree BMI > 40 kg/m^2.

Because of retrospective character of the study no written informed consent was needed, anyway we had ethical committee approval at The Centre of Postgraduate Medical Education.

Sleep Study

Overnight polysomnography (PSG) study was performed in all patients by computerized systems (SOMNOmedics and NICOLET systems).

PSG included the following variables: electroencephalograms, electrooculograms, electromyelograms of submental muscules, electrocardiogram, airflow (nasal and oral), chest and abdominal efforts, snoring (microphone) and arterial oxyhemoglobin saturation and pulse (finger probe).

Polysomnographic recordings were evaluated with respect to:

- amount of disordered breathing during sleep,
- type disorders: obstructive sleep apnea, mixed, central, hypopnea,
- AHI (Apnea hypopnea Index),
- disease severity based on AHI: (a mild form of 5 <= AHI <= 15, moderate 15 < AHI <= 30; severe AHI > 30),
- the number of desaturations,
- the average oxygen saturation (Sa av),
- minimum oxygen saturation (Sa min),
- the length of non REM (non-rapid eye movement) sleep composed of light sleep stages 1 and 2 (1 + 2), and composed of deep sleep stages 3 and 4 (3 + 4),
- the length of REM (ang. rapid eye movement).

Definitions

Obstructive apnea was defined as a cessation of airflow for at least 10 seconds. The event is obstructive if during apnea there is effort to breathe.

Central apnea was defined as a cessation of airflow for at least 10 seconds. The event is central if during apnea there is no effort to breathe.

Hypopnea is an abnormal respiratory event with at least a 30% reduction in thoracoabdominal movement or airflow as compared to baseline lasting at least 10 seconds, and with ≥ 4% oxygen desaturation, or less than 50% reduction baseline in the breathing amplitude with oxygen desaturation of 3% or an arousal. Obstruction is often inferred from thoracoabdominal paradox (8).

Apnea Hypopnea Index (AHI) was defined as the number of apneas and hypopneas per hour of sleep.

Patients with AHI ≥ 5 were considered as sleep apnea (OSAS) patients (9-12).

All statistical analyses were carried out using statistical software STATISTIKA version 6.

Differences were considered significant at $p < 0.05$.

RESULTS

Based on polysomnography (AHI ≥ 5) sleep apnea syndrome was diagnosed in 61.46% of participants (n = 590), respectively in 63.1% (n = 424) of male and 57.65% (n = 166) of female adults targeted in this study (n = 960) by physicians of various specialties. In patients with AHI ≥ 5 the average age of men was 53.5 years, for women 55 years, in people without the disorder with AHI < 5, the average age was 49.3 years for men, 47.9 years for women.

The calculated mean BMI for the study population was as follows:

- The group with AHI < 5 (healthy female and male): 31.17 kg/m^2.
- The group with AHI ≥ 5 (patients female and male): 33.27 kg/m^2.

The statistically significant difference in BMI between healthy and patients was found (p = 0.000247):

- The group with AHI < 5 (healthy): 29.96 kg/m^2 – men; 33.63 kg/m^2 – women.
- The group with AHI ≥ 5: 32.05 kg/m^2 – men; 36.38 kg/m^2 – women.

We found statistically significant difference in BMI between healthy and women patients (p = 0.03) and in men group (p = 0.000363).

We found statistically significant positive correlations between AHI and BMI in women's groups of patients (r = 0.168, p = 0.029) and men's groups of patients (r = 0.2571, p < 0.001). See figure 2 and table 2 (women) and figure 4 and table 4 (men).

No statistically significant correlations were found between AHI and BMI in healthy women and men groups. See figure 1 and table 1 (women) and figure 3 and table 3 (men).

In addition in both groups of patients (women and men) we identified for which age range of patients correlation between BMI and AHI is the strongest and statistically significant.

We used a division into three age ranges of patients:

1. 35 years ≤ age ≤ 45 years;
2. 45 years < age ≤ 55 years;
3. age > 55 years.

In woman patients group we have found statistically significant positive correlation between BMI and AHI (r = 0.369, p = 0.049; see table 5 and figure 5) for group 35 y ≤ age ≤ 45 y.

No statistically significant correlation between BMI and AHI for the group 45 y < age ≤ 55 y and above 55 years (see table 6, 7 and figure 6, 7).

Slightly different correlations were observed in men patients groups.

Statistically significant correlation between BMI and AHI were found for all age groups in men patients, respectively for the youngest group 35 y ≤ age ≤ 45 y (r = 0.27, p = 0.02; see table 8 and figure 8), for middle age 45 y < age ≤ 55 y (r = 0.28, p = 0.004; see table 9 and figure 9) and for the oldest one age > 55 y (r = 0.166, p = 0.015; see table 10 and figure 10).

Table 1. The correlation between AHI and BMI in healthy women.

X & Y	Average	SD	r (X,Y)	r²	t	p	N
BMI	33.636	11.034					
AHI	1.423	1.421	0.1584	0.0251	1.757	0.0815	122

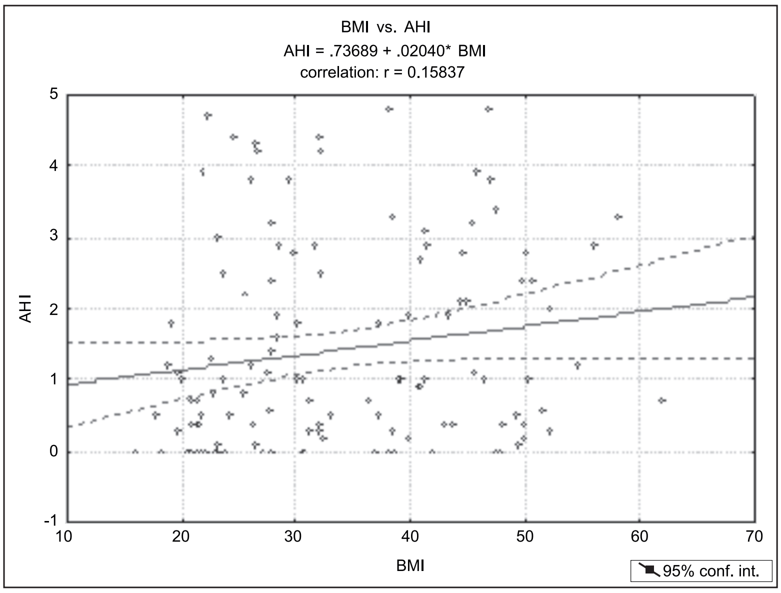

Fig. 1. The correlation between AHI and BMI in healthy women.

Table 2. The correlation between AHI index and BMI in women patients.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	36.376	10.129					
AHI	24.746	21.086	0.1695	0.0287	2.202	0.0290	166

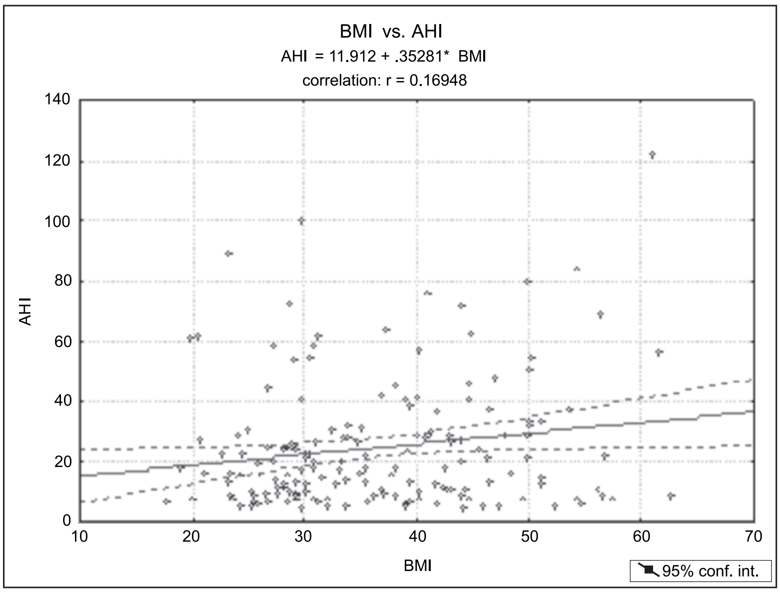

Fig. 2. The correlation between AHI index and BMI in women patients.

Table 3. The correlation between AHI and BMI in healthy men.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	29.962	7.169					
AHI	1.683	1.430	0.00737	0.000054	0.11561	0.908	248

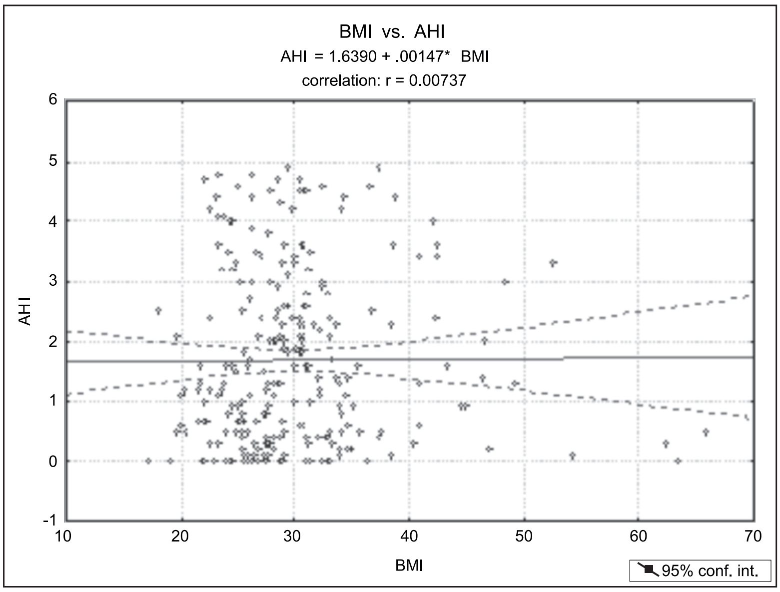

Fig. 3. The correlation between AHI and BMI in healthy men.

Table 4. The correlation between AHI and BMI in men patients.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	32.05	7.37					
AHI	30.26	22.21	0.2572	0.0661	5.467	0.0000	424

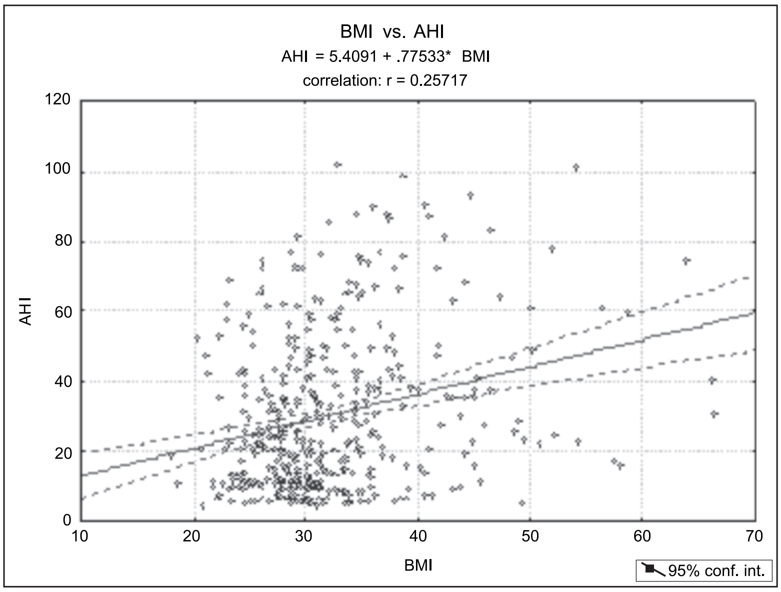

Fig. 4. The correlation between AHI and BMI in men patients.

Table 5. Correlation between BMI and AHI in women patients 35 y ≤ age ≤ 45 y.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	42.30	10.39					
AHI	28.36	26.29	0.3690	0.1361	2.063	0.0489	29

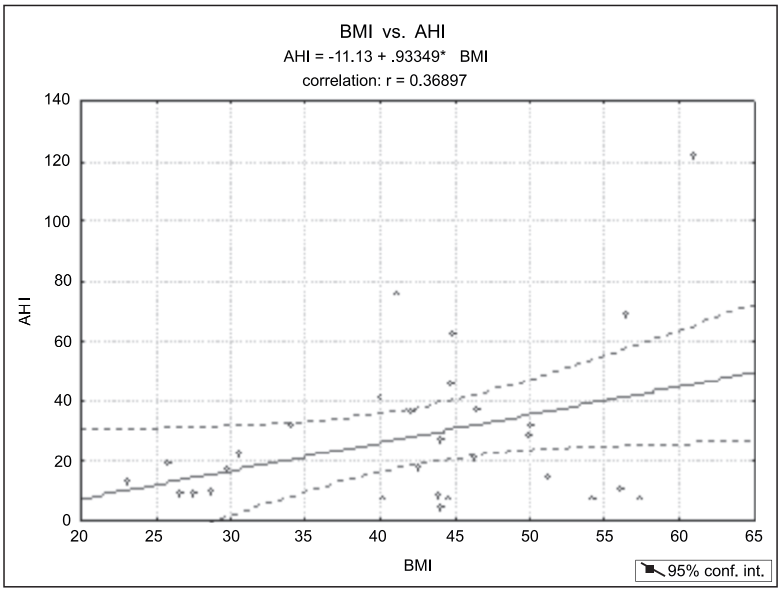

Fig. 5. Correlation between BMI and AHI in women patients 35 y ≤ age ≤ 45 y.

Table 6. Correlation between BMI and AHI in women patients 45 y < age ≤ 55 y.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	40.78	10.40					
AHI	28.29	22.94	0.0201	0.000404	0.1138	0.9101	34

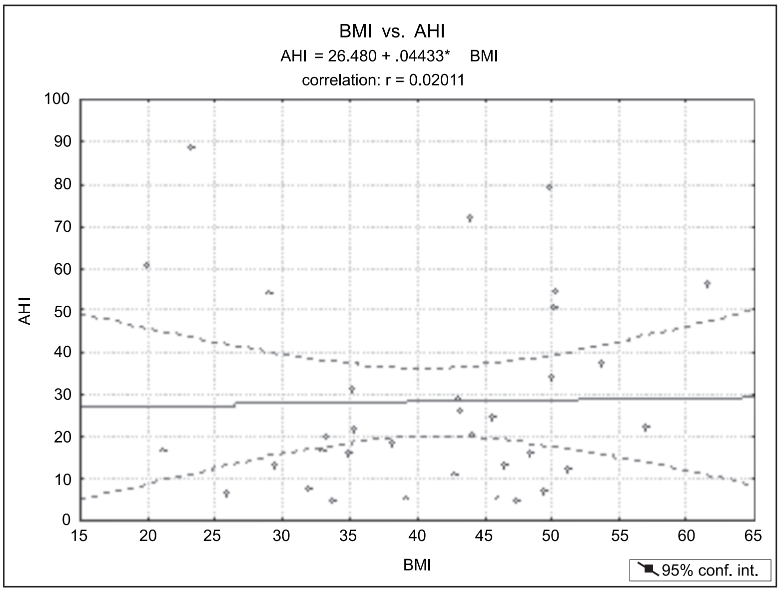

Fig. 6. Correlation between BMI and AHI in women patients 45 y < age ≤ 55 y.

Table 7. Correlation between BMI and AHI in women patients in age > 55 y.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	33.44	7.85					
AHI	23.19	19.28	0.0998	0.0100	0.9572	0.3410	93

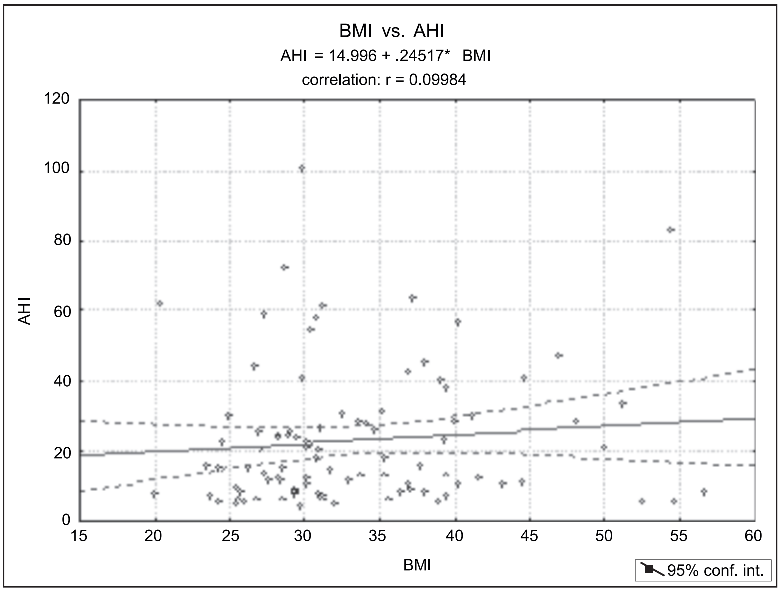

Fig. 7. Correlation between BMI and AHI in women patients in age > 55 y.

Table 8. Correlation between BMI and AHI in men patients 35 y ≤ age ≤ 45 y.

X & Y	Average	SD	r (X,Y)	r²	t	p	N
BMI	34.50	9.68					
AHI	33.60	27.35	0.2736	0.0748	2.430	0.0175	75

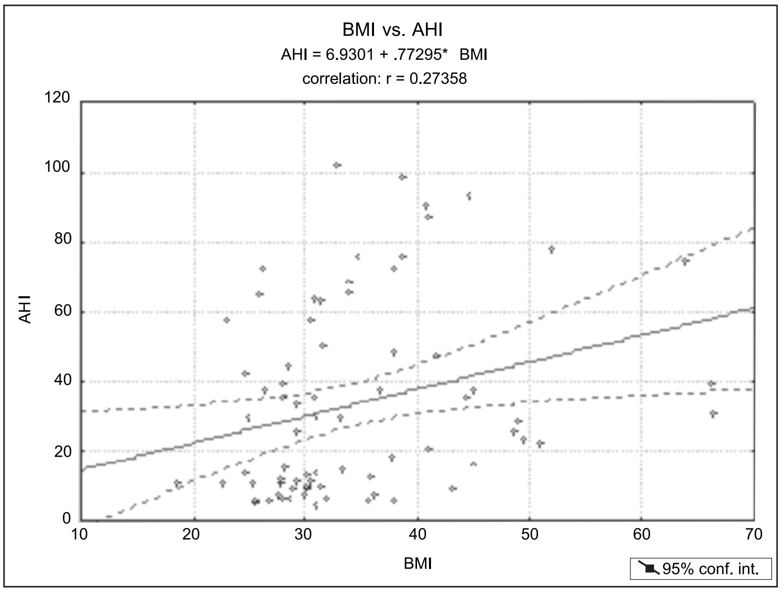

Fig. 8. Correlation between BMI and AHI in men patients 35 y ≤ age ≤ 45 y.

Table 9. Correlation between BMI and AHI in men patients 45 y < age ≤ 55 y.

X & Y	Average	SD	r (X,Y)	r²	t	p	N
BMI	32.65	6.88					
AHI	28.57	20.51	0.2812	0.0790	2.915	0.0044	101

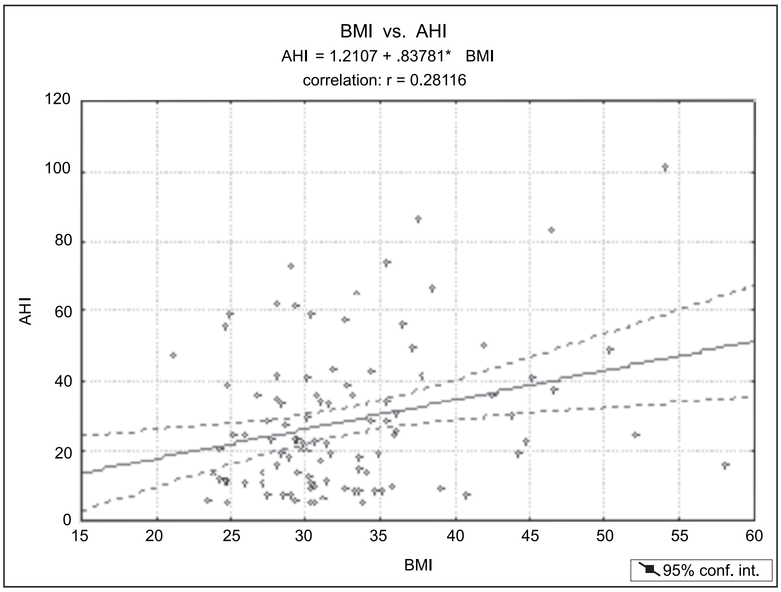

Fig. 9. Correlation between BMI and AHI in men patients 45 y < age ≤ 55 y.

Table 10. Correlation between BMI and AHI in men patients in age > 55 y.

X & Y	Average	SD	r (X,Y)	r^2	t	p	N
BMI	30.61	5.90					
AHI	29.49	20.10	0.1660	0.0276	2.452	0.0150	214

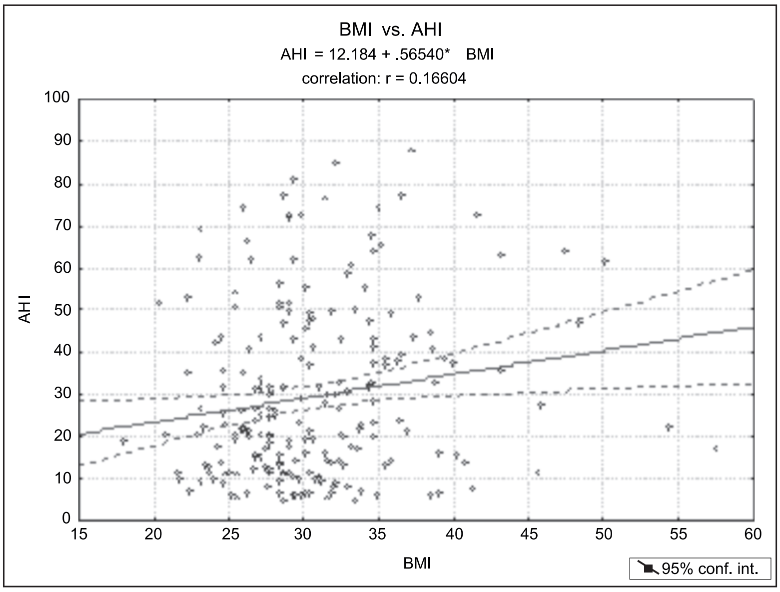

Fig. 10. Correlation between BMI and AHI in men patients in age > 55 y.

DISCUSSION

This study is a part of a large retrospective study conducted on a group of 960 patients referred with suspected sleep-disordered breathing to PSG laboratory. Two other parts of the study have been accepted as a presentation at the conference ERS Sleep & Breathing in Berlin and will be a separate publication. A retrospective study with a part of the research on the impact of reducing obesity in bariatric surgery on polysomnographic parameters of SBD is the subject of the author's doctoral dissertation.

This group was not a homogeneous group, however their common feature, was the suspicion of OSAS. Limitation of the study related to the retrospective nature is certainly a lack of clinical data of patients, except for age, sex, and BMI. On the other hand, the size of the group makes it possible to draw certain conclusions. It is well known that obesity is the major risk factor for OSAS, and correlation between weight gain and risk of the development of disease was confirmed in many studies which were published many years ago (13-18).

BMI is commonly used as an exponent of overweight and obesity. Severity of obesity is determined based on BMI. In addition to BMI to assess obesity the other indicators are also used: waist circumference (WC), neck circumference (NC). The increase of these three indicators determines the significant risk of OSAS (19). However in the other publication evaluating on the accuracy of obese indices in predicting obstructive sleep apnea-hypopnea syndrome in male adults BMI seemed better in predicting OSAS than NC < WC, and WHR (waist-to-hip ratio) (20). In previously published Polish studies researchers also looked for a relationship between AHI or RDI (Respiratory Disturbances Index) and BMI. They observed a positive correlation between RDI and BMI in obese people. The authors concluded that BMI may be considered as a predictor of the OSAS in the group of obese patients. However, no correlation between the severity of OSAS and BMI in individuals with overweight (21).

In the other published studies the different groups of patients were compared. All of them had the same OSAS level (equal AHI) but one group (normal weighted patients) was with BMI ≤ 25 kg/m² the second one (obese) with BMI ≥ 25 kg/m². Obesity and overweight have not be distinguished but showed that normal weighted patients had a higher number of apnea and smaller of hypopnea and vice versa obese (22).

In our study, in addition to the correlation between AHI and BMI we showed the distribution of this correlation for both sexes. As it turned out a positive correlation between these parameters occurs in both men and women suffering from OSAS. Our studies imply somewhat the opposite starting point we have examined the correlation between disease severity based on AHI, thus dividing the study population into two groups with AHI ≥ 5, which is a group of sick and healthy group with

AHI < 5. In both groups we took into account the sex of the patient, in order to show the correlation between AHI and BMI is different for both sexes. AHI and BMI correlation is different for female and male. In our discussion we have to remember that OSAS is a disease primarily affecting men. A positive correlation between AHI and BMI was found but different for male 0.257 vs 0.169 for female. These results are more relevant to the occurrence of OSAS in obese men. In addition, when we considered the correlations for the three age groups of patients women and men (35 y ≤ age ≤ 45 y, 45 y < age ≤ 55 y and age > 55 y) was noticed that in women the correlation was observed only for the youngest group. In men patients positive and statistically significant correlation between AHI and BMI was described for all ages.

CONCLUSIONS

In conclusion our study confirms the association of obesity with impaired breathing during sleep mainly OSAS. This study shows that the correlation exists not only for men but also for women. As demonstrated by our results this correlation focuses on young women and men of all ages.

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