UNIVERSITY OF PÉCS

FACULTY OF HEALTH SCIENCES

DOCTORAL SCHOOL OF HEALTH SCIENCES

Leader of Doctoral school: Prof. Dr. Bódis József

Programme leader: Dr. Rétsági Erzsébet

Co-programme leader: Dr. Ács Pongrác

Supervisor: Prof. Dr. Ihász Ferenc

Co-supervisor: Dr. habil Balogh László

THE ANALYSIS OF PREDISPOSING FACTORS OF OBSTRUCTIVE SLEEP APNOEA SYNDROME (OSAS). THE POTENTIAL EFFECTS OF THE DISEASE ON HEART RATE VARIABILITY AND DEPRESSION.

Doctoral (Ph.D.) Thesis

Szabó Krisztina

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Introduction

The quantitative and qualitative characteristic features of our sleep have a great effect on the state of our health. They influence our daytime performance and sleep desire, through which they affect the occurrence of road and work-related accidents. The disfunction of the circadian rhythm shows demonstrative correlation with numerous chronic diseases, the occurrence of cardiovascular events and blood coagulation (Halmos, Suba, 2012). The public health significance of sleep apnoea syndrome which belongs to the group of dissomnias and can be characterized by nocturnal respiratory disorders, has been evidenced by several examinations. The disease confirms a high correlation with cardiovascular diseases, diabetes, metabolic syndrome and a number of psychiatric diseases. Two types of sleep apnoea syndrome are known – obstructive and central. The obstructive appearance is characterized by periodic pharyngeal occlusion, the central is caused by coordination failure of the respiratory centre. In case of mixed-type apnoea, the halt of both the airflow and the respiratory moves may be detected (Váradi Visy, 1996). Despite the disease being significant in public health care, the technological development and the extension of diagnostic facilities, it often remains unexamined and untreated. One reason for it is that the disease may be present even in the absence of strong symptoms. The development of apnoea may be triggered by several risk factors. High correlation between obesity and apnoea has been evidenced by numerous examinations. In addition, the disease shows increasing frequency with ageing. Simultaneously, the pathological neck circumference and gender prove to be strong predictors. Due to the significant effect the disease has on public health, the early recognition and therapy are of great importance. Simple and cost-effective methods are sufficient to define the risk factors that predispose sleep apnoea. Consequently, besides the more precise insight into the effects of the risk factors, applying a risk assessment method would also be reasonable, as it would help determine the probability of the development and the gravity of the disease by means of the major risk factors. Due to the high correlation between sleep apnoea, cardiovascular and psychiatric diseases, it is also vital to analyse, by means of risk factors, the probability of the intercurrent diseases. Besides, it is also important to be familiar with the correlation between the risk factors and the intercurrent diseases, as well as the cases that do not meet the diagnostic criteria of sleep apnoea, but are characterized by the reduction of oxygen saturation during nocturnal sleep. In a number of high-sample studies, in the course of analysing intercurrent diseases and risk factors, data have been revealed in the group of patients having sleep apnoea while meeting the diagnostic criteria. The reduction of nocturnal oxygen saturation, its rate and

the sleep time with reduced saturation may also be significant, as several other chronic diseases involve reduced nocturnal saturation.

Objectives

Although the sleep-related complaints appear to be more frequent in today's busy world, the vast majority of the patients rarely decide to turn to the health care system, purely becaue of these complaints. The decreased daytime vigilance has serious consequences regarding the frequency of both work-related and road accidents. Also, they affect the performance and the cognitive functions. The patients may get used to the symptoms caused by obstructive sleep apnoea, as the disease does not produce immediate symptoms that may make them turn to the health care system. Numerous examinations have proved that the disease shows correlation with cardiovascular diseases, the metabolic syndrome, psychiatric diseases and the sudden cardiac death. Based on the above mentioned, obstructive sleep apnoea must be considered a public health issue. It is important to gain deep insight into the processes leading to the development of the disease, the predisposing features, the patomechanisms and the intergrowths of the disease, as it may improve the chance of selection and therapy. Besides these, the examination of the nocturnal sleep oxygen saturation as a symptom of sleep apnoea is also vital. It is also the concomitant sign of several chronic diseases, due to which deeper knowledge of its reference with the risk factors and the intercurrent diseases is important.

1. The examination of the risk factors of obstructive sleep apnoea

From risk factors, it is the neck circumference, the BMI, the age and the gender that will be analysed. The aim of the examination is to select the strongest predictor from the predisposing features listed, as well as the examination of risk factors regarding the gravity of the disease.

2. Examination of obstructive apnoea and the intercurrent diseases

- **Examination of heart rate variability**

Our aim was to examine the cardiovascular health by analyzing the time and frequence parameters of heart rate variability on the members of the apnoea and the control groups. Regarding the HRV parameters, the average standard deviation of the length of consecutive periods and the rate of low and high frequencies have been analysed.

- **The relationsip of depression and OSAS**

The other intercurrent disease is depression whose incidence rate has been aimed to be examined in the sick and the control groups. The results of the validated questionnaire on depression has been analyzed and compared with the hourly number of respiratory disorder incidents, as well as the average oxygen saturation and the length of the sleep time with reduced saturation.

3. Examination of OSAS symptoms

Our aim was to examine both the daytime sleepiness, as the major symptom of OSAS and the importance of nocturnal oxygen saturation. In addition, the length of sleep time with less than 90% oxygen saturation has been examined.

Hypotheses

Examination of the risk factors of obstructive sleep apnoea

H1: The major risk factor for men is the pathological neck circumference, which also affects the gravity of the disease.

H2: On the basis of comparison of genders, males are more likely to develop the disease than females.

H3: In the female group the main risk factor is the pathological BMI, which affects the gravity of the disease.

Examination of obstructive sleep apnoea and the intercurrent diseases

- **Examination of heart rate variability**

H4. Considering both time and frquency parameters, there is a significant difference between the values of the control group and the apnoea patients. The gravity of the disease also affects the HRV indicators.

- **The reference between depression and OSAS**

H5. The occurrence of depression is more frequent among the members of the apnoea group than the control group. It also increases the probability of the gravity of depression.

Examination of OSAS symptoms

H6. The daytime sleepiness and its gravity are major symptoms of OSAS.

H7. The reduction of the average oxygen saturation measured during sleep increases the probability of the development of depression and it also acts as a risk factor in the gravity of depression.

H8. The increase of the length of sleep time with reduced oxygen saturation affets the development of depression and its gravity.

Materials and methods

Examination of risk factors of the obstructive sleep apnoea

Two examinations have been carried out on this topic. We have examined the reference between OSAS and its main risk factors – neck circumference, BMI, age, gender – as well es the role of certain risk factors in the gravity of OSAS. Data of (n=90) females and (n=210) males have been analyzed.

We have analyzed:

- The values of **neck circumference** (cm).

- BMI data have been set to diagnose the **nutrition level.**
- **Gender**, as a risk factor has been analyzed in dichotom division.
- **The age** has been examined by means of Scammon's age group division. (Scammon, 1930)
- The members of **OSAS group** have been selected by the recommendation of the professional protocol. (Ádám Á, Böszörményi NG., 2008) The data of the participants having fewer than 5 respiratory disorder periods per hour have been selected into one group, while in case of AHI <= 5, the data have been selected into the sick group.
- When examining the correlation of risk factors and the **gravity of the disease**, the rate of the clinical gravity of OSAS has been analysed according to the professional protocol (Ádám Á, Böszörményi NG., 2008)

Examination of obstructive sleep apnoea and the intercurrent diseases

Examination of heart rate variability

The indicators of heart rate variability have been examined on the the data of individuals whose OSAS axamination and diagnosis involved a 24-hour HOLTER EKG (Schiller Medilog Holter, 8000 Hz sampling frequency, HRV:1000Hz frequency) monitoring. The HRV indicators of individuals whose not having OSAS has been verified during the examination have been selected into the control group. The sick group has been assembled from the HRV indicators of OSAS patients. The exclusion criteria of the data excluded from the analysis will be summarized in section 4. 5. 2. Thus, taking the exclusion criteria into consideration, data of 20 subjects in the control group and 20 in the OSAS sick group have been analysed. Examining the gravity of OSAS and HRV indicators, grouping of OSAS has been examined on the basis of criteria described in 4.1. Considering the HRV frequency indicators, the proportion of low and high frequencies (LF/HF) has been analysed. Regarding the time parameters, the standard deviation (SDNN) of the differences of the consecutive period lengths have been analysed (Chart 8). The selection of the above mentioned indicators has been done by the recommendation of Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology.

Examination of depression

The data related to depression symptoms, have been collected from the scores of a validated questionnaire (Hamilton depression scale) (Hamilton M, 1960), data of (n=91) females and (n=210) males have been analysed.

Examination of the symptom of OSAS

- **The daytime sleepiness, as the major symptom of OSAS**, has been analysed by the scores of a validated questionnaire, the Epworth sleepiness test. (Epworth Sleepiness Scale-ESS) (Johns, M. W. , 1991)
- **Examining the significance of oxygen saturation measured during nocturnal sleep time**, the average oxygen saturation measured during nocturnal sleep time and the sleep time with lower than 90% oxygen saturation have been examined. The data were gained by a polysomnographic device (Somno Screen Plus (PSG) Somno Medics GmbH).

Sampling

In the course of the research, anonymous data were gained from databases stored and managed by the National Health Care System and from closed down institutes. In case of purposeful sampling the subjects' characteristic features necessary for carrying out the examination are known. In the course of our work, the data of patients have been analysed, in case of whom the sleep diagnostic examination was carried out in circumstances that met the professional criteria of the sleeping laboratories. Earlier, the institutes received patients from any regions of the country, thus, the members of the sample have been selected randomly from all over Hungary. No copies from the archives of the institutes have been used, merely anonymously collected and analysed data are referred to.

Selectional criteria

The documentation of the patients who were involved in sleep diagnostic examination in sleep laboratory circumstances. According to the provisions of law regarding the minimum conditions of sleep laboratories, twol levels may be distinguished. Sleep medicine centres are positioned on the higher level that are all provided with infrastructural, instrumental

(polysomnograph, polygraph, sleep analyzing softwares, video monitoring), staff conditions and competences.

Criteria of exclusion

Documentation of patients who participated in CPAP (Continuous Positive Airways Pressure) therapy due to OSAS diagnois has been excluded. The therapy focuses on providing pressure in the upper respiratory tract through nose masks to prevent the respiratory tracts from being blocked. It is the only effective, verified method to treat OSAS (Ádám Á, Böszörményi NG., 2008).

Examination of OSAS and heart rate variability

- The data of the patients who were diagnosed with acute myocardial infarction, stroke or unstable angina within three months have not been analysed. Those patients were also excluded, who were verified to have (atrial flatter, atrial fibrillation, paroxyzmal supraventricular tachycardia, supraventricular extrasystole, ventricular tachycardia. ventricular fibrillation) documented cardiac arrhytmias or cardiac failure.

Examination of OSAS and depression

- Documentation of patients diagnosed with depression due to which they were to receive medicinal treatment has not been analysed.

Ethical autorization

The professional – ethical authorization No.: 41717-2019/EKU of Medical Research Council, Committee of Science and Research Ethics will be presented, attached to the appendix of the 'THESIS'

Statistical methods

The variables analysed in the examination (mean, standard deviation, CI) have been analysed by decriptive statistics. The analyses have been carried out with the help of Statistica for

Windows 13. 2 and Excel, the differences having less than p <0.05 value were considered significant with 95% CI. The continuous variables have been analysed by variance analysis (ANOVA). The strength of the correlation between the variables has been analysed by correlation calculation and will be presented in scatter plot figures. (Prohászka Z. et al, 2013) The discrete variables have been analysed in contingency tables using odds ratio (OR) calculations (Dinya E., 2017). With regard to the case control character of our examination, we had no chance for risk assessment, thus we have done a collateral risk proportion assessment by means of the following formula: $JKH\ (\%) = \frac{OR-1}{OR} * 100$ (Boncz I. , 2015).

Results

Presentation of the data of the examined subjects

The average age of the examined females and males is similar, two third of them are males. Obesity, the parhological neck circumference and, on the basis of the average AHI index, the serious OSAS are typical mainly for the males. Although in the female group AHI shows a lower value, the sleep time with less than 90% saturation scarcely differs from the data of the male group. The scores of the questionnaire on depression may be ranked into moderate depression category in both groups. On the basis of the questionnaire on daytime sleepiness, the average of both males and females falls into the normal range.

Examination of risk factors

The pathological nutrition index typical for males whose expected value is to grow with the gravity of the disease is (r=0,33; R^2= 10,8%; p=0,000; AHI = -22,9284+1,6363x; 0,95 CI); the expected value of the neck circumference is slightly higher than 43 cm in the non-apnoea group as well and it is also to grow with the gravity of the disease (r=0,55; R^2= 30%; p=0,000; AHI = -147,1447+3,9153x; 0,95 CI.). The expected age in the group of serious apnoea shows a decrease, the correlation between the two examined features is not real, the (correlation value r= - 0,01, R^2 = -0,0111; p=0,87; AHI = 33,9183-0,022x; 0,95 CI.). The reference between the two genders shows negative significant correlation (r=-0,24; p=0,00), nevertheless, the covariance is little, owing to the lower sample number of females. The pathological nutrition index is also typical of the female group, however, it is less than in case of males. Its expected value is higher than 30 kg×m² n the non-apnoea group and it is to grow with the gravity of the

disease. (r=0,15; R^2= 2%; p= 0,15; AHI = 2,1766+0,5167x; 0,95 CI.). Considering the neck circumference, the expected value is still below 41 cm in the non-apnoea group, however, increase can be detected here as well with the gravity of the disease (r= 0,26; R^2= 6%; p=0,01; AHI = -54,0962+1,7721x; 0,95 CI.). The expected age in the non-apnoea female group is 50 years, which shows increase with the gravtiy of the disease, their correlation is not significant. (r=0,16; R^2=2%; p= 0,11; AHI = 0,3682+0,3241x; 0,95 CI.).

The odds ratio and collateral risk rate of the risk factors in the male group

Comparing the OR of certain risk factors, the pathological neck circumference appears to be the major risk factor, which plays a significant role in the gravity of the disease. In case of the neck circumference's returning to normal, both OSAS and the probability of a moderate or a serious OSAS would decrease by 80%. The second major risk factor is the pathological BMI. In case a normal nutrition index, OSAS could be reduced by 70%, while the chance of a moderate or a serious OSAS by 80%. The third risk factor is gender. Males are nearly three times more likely to have OSAS or to develop a moderate or a serious disease as compared to females. Among the examined risk factors, it was the age that produced the lowest OR regarding both the development and the gravity of the disease.

The odds ratio and collateral risk rate of the risk factors in the female group

Analysing the risk factors of the female group, in terms of the development of the disease the age proves to be the major risk factor, whose OR is four times higher, while producing a five-time higher chance to increase the probability of the development of a moderate or a serious disease. The second risk factor is the pathological nutrition index. In case of its returning to normal, the probability of OSAS would decrease by 70%. Pathological BMI has a significant role with regard to the gravity of OSAS, as the OR was eleven times higher with respect to the development of OSAS. Normal BMI would decrease the probability of the development of moderate of serious OSAS by 90%. The lowest OR in the female group was produced in case of the examination of the neck circumference. The pathological neck circumference for females produces one and a half time higher value regarding the development of the disease. Its normal state would decrease the probability of OSAS by 34%. With regard to the development of moderate or serious OSAS, the OR was more than double. In case of a normal neck circumference, the probability of the development of a moderate or serious OSAS would decrease by 50%.

Examination of the intercurrent diseases

Examination of the heart rate variability and OSAS

For the examination of heart rate variability indicators, time and frequency domains registered by HOLTER monitor have been analysed in daytime and nocturnal segregation. In the sleep apnoea patients' group (2) and the healthy group (1) the time parameter of HRV showed a significant difference during nocturnal sleep. SDNN nocturnal [(1)=44,32, CI=37.2 – (2)=56.77; CI=47.8; F(1;38) = 5,1543]; p = 0,0289, SDNN daytime: [(1)=48.92, CI=37.68 – (2)=53.11, CI=45.19; F(1;38) = 0,4057]; p = 0,5280. Comparing the vegetative balance rates, significant difference occurred at night among the results of the patients having nocturnal respiratory disorders and the healthy ones. LF/HF nocturnal [(1)=2,37; (CI=1,56) - (2) = 3,83; (CI=5,15); F(1;38) = 4,0228] p = 0,0500]. No real difference has been detected in the daytime activities: AHI <5 LF/HF daytime [(1)= 3,13; (CI=2,19) – (2) = 4,21; (CI=2,74) F (1;38) = 1,7099; p = 0,1989.

The data of OSAS patients have been divided into two groups according to the clinical gravity level of the disease. The sleep with 5-15 AHI (1) was ranked into the moderate, with 15-30 AHI (2) into the medium OSAS group. Comparing the average of time and frequency indicators of HRV in daytime and nocturnal segregation, no significant difference was revealed. However, with the increase of the number of the hourly respiratory disorder periods, narrowing of the time parameters of HRV may be observed both daytime and at night. SDNN nocturnal: [(1)= 60,07, CI= 48,62 – (2) =43,29; CI=28,6); F (1;17) = 3,0031]; p = 0,1012; SDNN daytime: [(1)=54,08, CI=43,38- (2) =46,91, CI=33,7; F(1;17) = 0,7172]; p = 0,4088. The daytime vegetative balance rate of the patients in the medium OSAS group shows a considerable increase compared to the values of the ones in the moderate OSAS group. . LF/HF daytime [(1)=3,97, CI=1,93 – (2)=3,71, CI=1.65; F (1;17) = 1,5526]; p = 0,2297. LF/HF nocturnal [(1)=3.82, CI=1.94 – (2)=5.79, CI=9.12; F (1;17) = 0,0273]; p = 0,8706.

Examination of depression and OSAS

The expected values of the questionnaire on the symptoms of depression of males in the non-apnoea group fall into the normal range, their values is to increase with the gravity of the disease (r=0,29; R^2=8%; p=0,00; AHI = 21,9071+1,0477x; 0,95 CI.). The expected scores of the members of the control group in the female group are higher than the normal range and the scores of the male group. With the increase of the number of nocturnal respiratory disorder

periods the scores given to the questionnaire also increase (r= 0,28; R^2=7%; p=0,00; AHI = 8,7567+0,798*x; 0,95 CI.).

The existence of OSAS in the male group increases the chance for depression adding about half of its probability, while the rate is more than four and a half times higher in case of moderate and serious depression. In case of OSAS ceased to exist as an exposition, the probability of the development of depression would decrease by over 40%, while that of moderate and serious depression by 78%. The rate of the development of depression is lower for females than males and the rate calculated for the gravity of depression showed slight increase. As for the female group, in case of OSAS ceased to exist as an exposition, the probability of the development of depression would decrease by over 20%, while that of moderate and serious depression by 40%.

Examination of the symptoms of OSAS

Daytime sleepiness

The rate of the moderate daytime sleepiness proves to be higher for males, however, the rate of stronger daytime sleep desire is lower than that of the moderate syndrome group. For females, the probability of the development of strong daytime sleep desire is increased by two and a half times by the nocturnal respiratory disorder periods. The reduction of AHI index below 5 would result in the males' moderate daytime sleep desire by approximately 50%, while that of females by 40%. With the nocturnal respiration returning to normal, the serious sleepiness would decrease by 60% for females and by13% for males. On the basis of the scores gained from the questionnaire on measuring the daytime sleep desire, 128 subjects do not feel any daytime sleep desire. For 81 of them tha AHI > 15 and according to the data of 47 males the AHI <=15. As for the female group, 20 of the subjects who had no complaints about sleepiness the AHI > 15 and for 41 females AHI <= 15.

The expected nocturnal oxygen saturation value for the males having no complaints about daytime sleepiness is above 90%, however, the sleep time with reduced saturation period is over 24%. In the female group similar values may be expected. As for them, the sleep time with saturation period is over 22%.

The importance of the nocturnal average oxygen saturation considering depression

In the male group, the reduction of the nocturnal average oxygen saturation plays siginificant role in the development and gravity of depression. With the saturation value returning to normal, for males depression would decrease by 80%, while serious depression by over 86%. The reduction of saturation during sleep is also expressive for females, as its returning to normal would cause a 40% reduction in the probability of depression and 60% in serious depression.

The examination of sleep time with reduced oxygen saturation

Our findings suggest that in the male group the sleep time with low oxygen saturation is a strong predictor of both the development of depression and its serious form as well. With normal oxygen saturation during sleep, the probability of the development of depression would decrease by 81,8% and serious depression's by 88%. For females, with normal nocturnal oxygen saturation, the reduction would be 81,8% considering serious depression and 57,2% for the depression.

The results gained considering our hypotheses in the course of our work

H1: The major risk factor for men is the pathological neck circumference, which also affects the gravity of the disease

Our first hypothesis has been verified. The pathological neck circumference is of high OR in the development of the disease and the OR calculated for the moderate or serious OSAS is even more significant. Obesity is also a strong predictor of OSAS and its gravity. For males, the least significant risk factor is the ageing.

H2: On the basis of comparison of genders, males are more likely to develop the disease than females.

Our second hypothesis has been verified. Males have more chance to develop OSAS and its moderate or serious form than females.

H3: In the female group the main risk factor is the pathological BMI, which affects the gravity of the disease.

Our third hypothesis has partly been verified. In the female group, the main risk factor is ageing, which, compared to the seriousness of the disease, has resulted in a higher OR. The second risk

factor is the pathological BMI, which, conversely, produced the highest OR considering the seriousness of OSAS.

H4. Considering both time and frequency parameters, there is a significant difference between the values of the control group and the apnoea patients. The gravity of the disease also affects the HRV indicators.

Our fourth hypothesis has also partly been verified. Comparing the members of the sick and the control groups, a significant difference has been detected among the nocturnal time and frequency parameters of HRV. Although no statistic difference has been found regarding the gravity of the disease, the values of the members of the sick group have narrowed down compared to the apnoea group.

H5. The occurrence of depression is more frequent among the members of the apnoea group than in the control group. It also increases the probability of the gravity of depression.

Our fifth hypothesis has been verified. OSAS is a major risk factor in the development and gravity of depression. It was particularly the apnoea male group where increased OR for the development of moderate or serious depression could be detected.

H6. The daytime sleepiness and its gravity are major symptoms of OSAS.

The sixth hypothesis has partly been verified. In the female group, the OR of strong daytime sleep desire is increased by OSAS by two and a half times, yet only low OR was produced considering the moderate daytime sleepiness both for females and males. Besides the above mentioned, 81 males and 20 females do not complain about daytime sleep desire, in spite of the fact that their hourly respiratory disorder periods are higher than 15. 47 males and 41 females belong to the group of those subjects who may not be categorized to have sleep apnoea (they feel no daytime sleep desire and the AHI is between 5-15).

H7. The reduction of the average oxygen saturation measured during sleep increases the probability of the development of depression and it also acts as a risk factor in the gravity of depression.

Our seventh hypothesis has been verified. In the examined female group, it was dominantly the development of moderate and serious depression whose OR was two and a half times higher. For males the reduction of oxygen saturation during sleep proved to be a strong predictor regarding both the development and the gravity of depression.

H8. The increase of the length of sleep time with reduced oxygen saturation affets the development of depression and its gravity.

Our eighth hypothesis has been verified. The saturation periods reduced below 90% significantly affect the development and the gravity of depression. High ORs were produced in the female group as well, but the occurrence of moderate and serious depression appears increased mainly in the male group.

New findings of our work

- The reduction of oxygen saturation during nocturnal sleep and the sleep time spent with it are significant risk factors of depression.
- The nocturnal reduced oxygen saturation average and the sleeping time spent with it proved to be more conductive predictors of depression and its moderate or serious form than AHI.
- The daytime sleep desire experienced by OSAS patients is considered a weak predictor regarding the disease and its gravity.
- Patients not meeting the diagnostic criteria of OSAS (daytime sleepiness and AHI > 15) may spend most of their night with reduced oxygen saturation.

Practical utilization

- In case of patients having the symptoms of depression, medical check-up of nocturnal oxygen saturation would be reasonable.
- In case of medicinal therapy, relaxants should be avoided.
- In case of patients not meeting the diagnostic criteria of OSAS (daytime sleepiness and AHI > 15), medical check-up for depression would be reasonable.
- Further research are required to verify whether adding oxygen at night may decrease the occurence of the symptoms of depression.

Publications and presentations

Publications related to this research

Journals

1. Szabó, K. (2015). Az obstruktív alvási apnoe szindróma hajlamosító tényezőinek és diagnosztikai paramétereinek összehasonlítása. In: Szmodis, M. – Szőts, G. (eds.) (2016). *Sokszínű sporttudomány,* Budapest p.279-290.

2. Szabó, K. – Ihász, F. (2015). Az obstruktív alvási apnoe szindróma (OSAS) hajlamosító tényezőinek és diganosztikai paramétereinek összehasonlítása. *Magyar Sporttudományi Szemle* (16) (64, 2015/4) p. 53-54.

3. Szabó, K. – Ihász, F. (2017). Az alvási apnoe szindróma vezető rizikótényezőinek esélyhányadosai. [The probability of obstructive sleep apnea disorders emergence by odds ratio of main risk factors]. *Orvosi Hetilap*, Budapest, 158, (21) 823-828.

4. Szabó, K. – Ihász, F. (2018). Az alvás ideje alatt jelentkező oxigén szaturáció csökkenés és a BMI kapcsolata. *Magyar Sporttudományi Szemle*, (19) p. 75.

5. Szabó, K.- Ihász, F. (2019). Az alvás alatt jelentkező oxigén-szaturáció csökkenés hatása a depresszióra. [The Effect of Reduced Oxygen Saturation on Depression] *Orvosi Hetilap*, 160 (20),780-783.

6. Éjszakai légzészavar epizódok és a szívfrekvencia variabilitás kapcsolata. Vol 3, No 1 Stadium -Hungarian Journal of Sport Sciences, 2020. https://ojs.lib.unideb.hu/SJSC/issue/view/348

Conference presentations

1. Szabó, K. (2015). Az obstruktív alvási apnoe szindróma hajlamosító tényezőinek és diagnosztikai paramétereinek összehasonlítása, Sporttudományi Konferencia, Szombathely.

2. Szabó, K. (2016). Az alvási apnoe szindróma kialakulásának valószínűsége a vezető rizikótényezők esélyhányadosain keresztül, Sport és Egészségtudományi Konferencia, Budapest.

3. Szabó, K. (2017). Az alvási apnoe szindróma kialakulásának valószínűsége a vezető rizikótényezők esélyhányadosain keresztül, National Conference od Scientific Students' Association, 2nd place, Győr

4. Szabó K. (2018). Az éjszakai alvás ideje alatt fellépő légzészavar epizódok hatása a depressziós tünetekre és a testtömeg indexre. Medical Conference for PhD Students and Experts of Clinical Sciences, Pécs

Other publications

Szabó, K. – Ihász, F. (2018). Az éjszakai alvás ideje alatt fellépő légzészavar epizódok hatása a depressziós tünetekre és a testtömeg indexre. In: Bódog, F.-Csiszár, B. – Pónusz, R. eds.) Medical Conference for PhD Students and Experts of Clinical Sciences: *Book of Abstracts*, Pécs p. 8.