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# Assessment of the Severity of Depressive Symptoms in Patients over 65 Years of Age Using Removable Dentures

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## *Abstract*

***Background:*** *Depression is a common disorder among older adults, yet it is not a standard element of the aging process. Depression can affect oral health as a result of neglecting hygiene routines, poor nutrition, and avoiding necessary dental care, resulting in an increased risk of caries and periodontal disease. On the other hand, general health deteriorating with age and also poor oral health are not without their impact on mental state.*

***Objectives:*** *The aim of this study was to assess the prevalence of depression and its association with oral problems in patients over 65 years of age using removable prosthetic restorations.*

***Materials and methods:*** *Ninety-eight elderly patients (over 65 years of age) using removable prosthetic restorations were studied. The study variables included sociodemographic data (age, gender), and variables describing general health status included smoking and systemic diseases. The association of oral health parameters with depression was assessed using the following variables: missing teeth, duration of prosthetic restoration use, prosthetic inflammation, and dry mouth.*

***Results:*** *Depression is significantly more frequently diagnosed among elderly patients (median age 72 years) with the evidence of a nervous system disease, denture wearers diagnosed with prosthetic ground inflammation, patients with dry mouth (according to the FOX test), and among patients using removable dentures for more than 10 years. Additionally, in the assessment of the risk of depression, age, cardiovascular disease, nervous system disease, duration of denture use of more than 10 years, prosthetic base inflammation and dry mouth according to the FOX test were found to statistically significantly increase the chance of developing depression.*

***Conclusion:*** *The above data should be taken into account in the daily dental care of the elderly, and interdisciplinary care should be considered in elderly patients at risk of depression.*

***Key words:*** *depression, removable dentures, dry mouth*

## Introduction

The demographic ageing of the population of Europe, including Poland, is a progressive and irreversible process. It is forecasted that in the perspective of the coming decades this trend will continue or intensify, leading to a significant increase in the number of people over 65 years of age. These changes are associated with a growing number of persons suffering from age-related diseases. Multidirectional health changes, deterioration of physiological functions, reduced mental performance, increased susceptibility to stress cause many diseases to occur simultaneously.

Ageing is not only associated with the occurrence of somatic disorders. Physical deterioration, social isolation, loneliness, and lack of self-esteem are also common. Such a multitude of problems in elderly people often causes the occurrence of mental disorders, especially depression [1–3]. Progressive ageing is in itself one of the factors determining the occurrence of depressive disorders. Late-life depression (LLD) usually appears after the age of 65 and is a serious public health problem. It is estimated to occur in about 15–20% of people in this age group [1]. Studies conducted in Poland to assess the prevalence of depression among the elderly indicate that it occurs in 25% of the study population [4]. The PolSenior project (a publicly funded research project commissioned by the Ministry of Science and Higher Education to assess the health and social situation of older people in Poland) found that the incidence of depressive disorders increases with age (20% in the 55–59 age group, 25% in the 65–79 age group, and 33% in those aged 80 and over) [5].

Depression is a complex set of symptoms of emotional disorders, negatively influencing mood, motivation, way of thinking and acting. It often accompanies many other somatic complaints. Depressive state often overlaps with other illnesses, intensifying them andmaking their diagnosis or treatment more difficult. It contributes to worsening of the quality of life, which usually also deteriorates in old age. It can be as well a significant risk factor for other systemic diseases. Depression is often associated with bad

habits such as eating disorders, smoking and alcohol consumption. Loss of interest in daily activities can reduce concern for general health and thus oral health.

Depression as a mental health disorder is also often a predictor of many general health as well as oral health problems. On the other hand, general health deteriorating with age, the presence of many chronic diseases and often poor oral health that accompanies these changes are not without their impact on mental health.

As far as oral health status is concerned, depression is correlated with it. It is often associated with a lack of care for the condition and health of the oral cavity, avoidance of adequate dental care, fear of dental visits [6], poor hygiene, and subsequent advanced periodontal disease, extensive caries, and eventually tooth loss [7–10]. Depression is additionally accompanied by reduced salivary flow, often associated with the use of antidepressants, which are considered a group of drugs that can cause or exacerbate dry mouth and promote the development of carious bacteria [7]. Recent studies confirm the association of poor oral health due in large part to dysbiosis in the oral microflora caused by the aforementioned factors with anxiety and depressive behavior [8–11].

Unsatisfactory condition of oral cavity, caries, chronic inflammatory changes of periodontium, and loss of teeth impact the whole organism. Extensive missing teeth, incorrect occlusion, and problems in the use of prosthetic restorations may lead to difficulties in performing daily activities such as speaking or eating, which, in turn, may result in various limitations, discomfort, deterioration of the broadly defined quality of life, or even emotional disorders [12, 13].

## Objectives

The aim of this study was to evaluate the association of oral health parameters with depression in patients over 65 years of age using removable prosthetic restorations.

## Material and methods

The study was conducted on 98 elderly patients (over 65 years of age) using removable prosthetic devices who attended the General Dentistry Outpatient Clinic of the Medical University of Lodz, Institute of Dentistry in Lodz, for dental treatment. The study was approved by the Bioethics Committee of the Medical University of Lodz (RNN/340/18/KE).

Sociodemographic variables included age and gender. Patients were asked to rate their general health status. The presence of systemic diseases and medication intake were also recorded. Diseases were assigned to the cardiovascular, respiratory, gastrointestinal, and skeletal systems, and several groups of conditions were distinguished, such as diabetes, thyroid disease, nervous system disease, dementia, and depression. Addictions (smoking) were also considered in the study.

The study included questions concerning the time elapsed since the use of the first prostheses and the length of the use of the current prostheses. Patients were divided into 2 groups: those using dentures for up to 10 years vs those using dentures for over 10 years.

During physical examination, the dental status for missing teeth was assessed. Patients were divided into two groups: those with up to 10 missing teeth and those with more than 10 missing teeth.

In the group of patients using removable prosthetic restorations, the condition of the oral mucosa was assessed on physical examination according to the criteria of the Newton's classification, in which three degrees of inflammation are distinguished. For the purposes of the study, patients with active inflammation (in this case, patients with all inflammation classes) vs. patients without inflammation (class 0) were selected due to the small size of the groups with each inflammation class. As for the prosthetic treatment needs, the respondents were asked to subjectively assess such needs.

The assessment of dry mouth during the physical examination was based on the Fox et al. test. The test contains 10 questions on the quality of life of patients with reduced saliva production. Positive answers to the questions suggest the presence of dry mouth. Answering 'yes' to 3 of the 4 most salient

questions indicating dry mouth, and one more affirmative answer to another question in the questionnaire, was considered a diagnosis of dry mouth in the study. In order to assess the presence of dry mouth, the amount of unstimulated saliva secretion was also examined. Saliva was collected by patients spitting into a disposable cup within 1 minute. The volume was measured using an automatic pipette fitted with single-use tips. The value of 0.3–0.4 ml/min was taken as the norm for unstimulated saliva secretion [14].

The presence of depressive symptoms was examined using the Geriatric Depression Scale (GDS). The Geriatric Depression Scale is a commonly used screening tool to assess the severity of depressive symptoms in the elderly. The study used an abbreviated version of the questionnaire, consisting of 15 questions. Each question had to be answered 'yes' or 'no'. Possible scores range from 0 to 15 points. The interpretation of the abbreviated version is based on the number of points obtained: 0–5 points mean no risk of depression, 6–10 points mean moderate depression, and 11–15 points mean severe depression [15, 16].

In the statistical analysis, $Chi^2$ tests with appropriate corrections were used to assess the frequency of occurrence of a given phenomenon for nominal variables. For continuous variables, with a distribution other than normal, the Mann-Whitney U test was used to assess the differences between groups. The median along with the 25% and 75% quartiles were applied to describe continuous variables. The distribution of continuous variables was examined using Shapiro-Wilk's W test. A univariate and multivariate regression model was applied to assess factors that may influence the occurrence of the endpoint. The effect of factors in the model was assessed using the odds ratio (OR) and its 95% confidence interval (95% CI). Statistical significance for the analyses was assumed at $p<0.05$. The STATISTICA version 13.3 software (TIBCO, Poland 2022) was used for the analyses.

## Results

As a first step, the prevalence of depression was compared against sociomedical and dental factors. The analysis showed that depression was much

more frequently diagnosed among elderly patients (median age 72 years, p=0.003) who demonstrated the symptoms of nervous system diseases (37.00%, p=0.005). Depressive states were much more frequently discovered among patients using prosthetic restorations diagnosed with prosthetic-related inflammation (56%, p=0.014), dry mouth according to the FOX test (51%, p=0.001), and among patients using removable dentures for more than 10 years (Table 1).

The second stage of the analysis focused on finding factors that may be predictors of depression using univariate and multivariate logistic regression analysis. Univariate logistic regression analysis showed that age (OR=1.16, 95% CI: 1.03-1.29), cardiovascular disease (OR=2.89, 95% CI: 1.07-7.84), nervous system disease (OR=7.22, 95% CI: 1.58–32.99), duration of denture use >10 years (OR=3.38, 95% CI: 1.26–9.07), prosthetic-related inflammation (OR=3.69, 95% CI: 1.38–9.83) and dry mouth according to the FOX test (OR=5.91, 95% CI: 1.86–18.85) statistically significantly increase the chance of developing depression. The inclusion of statistically significant factors in the multivariate model showed that only nervous system diseases (OR=6.89, 95% CI: 1.33–35.75) and the presence of dry mouth as assessed by the FOX test (OR=3.80, 95% CI: 1.05–13.73) significantly increased the chance of developing an endpoint (Table 2).

## Discussion

Depression is one of the most important and yet least frequently diagnosed health problems in the elderly. By interfering to a significant extent with daily functioning, it negatively affects health behaviors, including those related to oral hygiene, which means that it can have a detrimental effect on oral health.

Older people are more likely than younger people to suffer from chronic somatic and cognitive disorders leading to disability with consequent development of depression Progressive ageing is one of the risk factors for depression [1, 5]. The results obtained in this study confirm the higher prevalence of depression in elderly patients.

Depression, as a complex syndrome, often accompanies many other conditions. It may also be a significant risk factor for other systemic diseases, and, on the other hand, the occurrence of depression is also conditioned by comorbidities [17].

Our own research shows that nervous system diseases (OR=7.22, p=0.011) and cardiovascular diseases (OR=2.89, p=0.037) in univariate logistic regression significantly increase the odds of developing depressive states, which is confirmed by some studies where more advanced depression has been shown in 20% to 25% of people with cardiovascular diseases [18], and similarly in patients after stroke [19].

Statistical significance for cardiovascular disease was not demonstrated in multivariate logistic regression analysis, which may be related to the unevenness of the study groups and the small study population (depression vs none: 59 (83.00%) vs 17 (63.00%), p=0.062).

Depression, as a mental health disorder, may also be a contributing factor to neglecting preventive behaviors confirmed in many studies, and, on the other hand, poor oral hygiene and poor oral health correlate with depressive-like disorders [9–11, 20].

There is also a proven link between missing teeth and depression and anxiety disorders. With extensive missing teeth, problems in the use of prosthetic restorations can lead to difficulties with eating, speaking, laughing, or even sleeping. Yang et al. estimated that the highest levels of anxiety/depression were found in a group of patients after the loss of 8 to 28 teeth [21].

Our study did not show a significant statistical association between missing teeth and depressive states (depression vs. missing: 54 (76.06%) vs. 18 (66.67%, p=0.494), although many studies confirm that the loss of natural teeth can affect the occurrence of depression [12, 22, 23].

Dental status and, at the same time, the associated prosthetic status are not without influence on the quality of life related to the oral cavity and thus on psychological state. The study confirms that the duration of the use of removable prosthetic devices and the status of the prosthetic base are correlated with the occurrence of depression. Depressive states are significantly more common among patients using prosthetic devices for more than

10 years with a diagnosis of inflammation on the prosthetic base, and statistically significantly increase the chance of developing depression.

In a group of elderly patients using removable dentures, especially complete dentures, the problem of dry mouth arises. Xerostomia can compound the negative impact of poor oral health on older people's quality of life and psychological state.

Chou et al. show a significant association between dryness symptoms and mild and severe depression [24]. Subjective feeling of dry mouth may also lead to the development of depressive states [25]. It is supported by the results of our study, which showed a more frequent high score on the GDS among patients who had dry mouth assessed by the FOX test (p=0.001). Additionally, xerostomia as assessed by the FOX test (OR=3.80, p=0.042), together with the presence of nervous system diseases (OR=6.89, p=0.022), statistically significantly increase the chance of developing depressive states among patients above 65 years of age. These factors may be significant predictors of depression among patients; however, the study should be repeated on a much larger study group.

## Conclusions

The results of the study showed that there is a significant association between depression and oral health and oral health-related behaviors. There is a correlation between the occurrence of depression and factors related to general health (association with nervous system diseases), as well as the state of the stomatognathic system (association with mucositis under the used prostheses or xerostomia). The study also found that certain factors related to oral health (duration of denture use of more than 10 years, prosthetic mucositis, or dry mouth according to the FOX test) could be the predictors of depression.

Given the high prevalence of depression, it seems crucial to better understand how depression may affect oral health and, on the other hand, which factors related to oral conditions may be associated with the development of depressive conditions [26].

Future research should take a more comprehensive look at the complex group of factors that may moderate the impact of depression on oral health, and at the same time seek to further understand which factors increase the chance of developing depression.

For dentists, it is crucial to consider the role of depression in dental health and overall oral health, while also becoming aware of the impact of oral health on overall mental health. At the same time, interdisciplinary care in elderly patients at risk of depression should be considered.

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## TABLES

Table 1. Distribution of GDS scale scores according to sociodemographic and dental data

| Factor | | Depression based on GDS scale | | p |
|---|---|---|---|---|
| | | Yes (N=71) | No (N=27) | |
| Age [years] | | 72.00 (69.00–76.00) | 69.00 (66.00–73.00) | 0.003* |
| Gender | Female | 40 (56.00%) | 17 (63.00%) | 0.715 |
| | Male | 31 (44.00%) | 10 (37.00%) | |
| Smoking | | 23 (32.00%) | 5 (19.00%) | 0.268 |
| Diseases | Cardiovascular | 59 (83.00%) | 17 (63.00%) | 0.062 |
| | Nervous system | 26 (37.00%) | 2 (7.00%) | 0.005* |
| | Gastrointestinal system | 26 (37.00%) | 7 (26.00%) | 0.446 |
| | Osteoarticular system | 16 (23.00%) | 10 (37.00%) | 0.231 |
| | Thyroid | 10 (14.00%) | 5 (19.00%) | 0.818 |
| | Diabetes | 14 (20.00%) | 5 (19.00) | 0.880 |
| Interest in prosthetic treatment | | 31 (44.00%) | 8 (30.00%) | 0.299 |
| Missing teeth | ≤10 teeth | 17 (23.94%) | 9 (33.33%) | 0.494 |
| | >10 teeth | 54 (76.06%) | 18 (66.67%) | |
| Inflammation on the prosthetic base | | 40 (56.00%) | 7 (26.00%) | 0.014* |
| Service life of dentures | >10 years | 59 (83.00%) | 16 (59.00%) | 0.026* |
| | ≤10 years | 12 (17.00%) | 11 (41.00%) | |
| Unstimulated saliva production in 1 minute | Incorrect | 28 (39.44%) | 6 (22.22%) | 0.173 |
| | Correct | 43 (60.56%) | 21 (77.78%) | |
| Assessment of dry mouth by the Fox test | | 36 (51.00%) | 4 (15.00%) | 0.001* |

*p values<0.05

Table 2. Univariate and multivariate logistic regression versus association with depression

| Factor | | Logistic regression | | | |
|---|---|---|---|---|---|
| | | Single-factorial | | Multi-factorial | |
| | | OR (95% CI) | p | OR (95% CI) | p |
| Age [years] | | 1.16 (1.03–1.29) | 0.014* | 1.14 (0.99–1.30) | 0.063 |
| Gender | Female vs Male | 0.76 (0.31–1.89) | 0.553 | — | — |
| Smoking | Yes vs No | 2.11 (0.71–6.28) | 0.180 | — | — |
| Cardiovascular diseases | Yes vs No | 2.89 (1.07–7.84) | 0.037* | 1.73 (0.50–5.96) | 0.386 |
| Nervous system diseases | Yes vs No | 7.22 (1.58–32.99) | 0.011* | 6.89 (1.33–35.75) | 0.022* |
| Gastrointestinal diseases | Yes vs No | 1.65 (0.62–4.43) | 0.319 | — | — |
| Osteoarticular diseases | Yes vs No | 0.50 (0.19–1.29) | 0.150 | — | — |
| Thyroid diseases | Yes vs No | 0.72 (0.22–2.35) | 0.587 | — | — |
| Diabetes | Yes vs No | 1.08 (0.35–3.36) | 0.893 | — | — |
| Service life of dentures | >10 vs ≤10 | 3.38 (1.26–9.07) | 0.016* | 2.21 (0.66–7.41) | 0.198 |
| Interest in prosthetic treatment | Yes vs No | 1.84 (0.71–4.76) | 0.208 | — | — |
| Inflammation on the prosthetic base | Yes vs No | 3.69 (1.38–9.83) | 0.009* | 3.08 (0.99–9.60) | 0.053 |
| Unstimulated saliva production in 1 minute | Incorrect vs Correct | 2.28 (0.82–6.35) | 0.115 | — | — |
| Assessment of dry mouth by the Fox test | Dryness vs lack of dryness | 5.91 (1.86–18.85) | 0.003* | 3.80 (1.05–13.73) | 0.042* |

*p values<0.05

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# Aqua Jogging Moderate Intensity Training is Conditioning a Sense of Well-being in Seniors

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***Abstract***

*Hypokinesia in seniors reduces mobility, which results in a decrease in their general well-being and quality of life. In this study, changes in blood pressure and saturation values in seniors after aqua jogging training were assessed. In addition, the subjective average level of fatigue and its impact on $HR_{MAX}$ were analysed. Quality of life was also assessed in the study group of seniors.*

*In a group of 49 people attending aqua jogging classes (66.3±5.4yr; F:39; M:10), the values of pressure and saturation were measured in 4 subsequent measurements (before and immediately after training, as well as 1 min. and 5 min. after training). The Rating of Perceived Exertion scale (RPE), the SF-36v.2 quality of life questionnaire and the WHO-5 Good Feeling Index were used to assess the level of fatigue during training. Blood pressure measurements were highest immediately after the exercises and thereafter decreased. $HR_{MAX}$ at the fifth minute after the exercise increased significantly (r=0.3) following increasing fatigue (RPE) (p=0.017). A satisfactory level of quality of life in seniors was recorded at 71.1±18.0% [WHO–5] and 59.0±13.0% [SF–36v.2]. A higher level of quality of life was recorded in the psychological sphere (SF-36v.2 MCS:61.1%±7.7%). The greater physical exertion felt by a studied individual resulted in a slower pulse decrease after the exercise.*

***Key words:*** *quality of life, physical activity, active aging in place*

## Introduction

According to the Central Statistical Office data, the average life expectancy of an individual in Polish society increased for men to 73.8 years, and for women to 81.7 years in 2018. This increases the need for older people to perform activities to maintain their health [1]. The literature on the subject confirms the impact of physical activity on the health of elderly people. After just two weeks, regular endurance training based on swimming, walking, nordic walking and others improves the metabolic stability of muscles and accelerates the kinetics of $VO_2$. In addition, it results in an improvement in general well-being, an increase in self-esteem, and an improvement in the psychological sphere, leading to an improvement in the overall quality of life. The appearance of these training effects is still the subject of much research. It is believed that the improvement of brain perfusion and the increase in brain and peripheral concentration of brain derived neurotrophic factor (BDNF) is conducive to improving the cognitive function of the elderly [2].

Muscle contraction increases muscle metabolism. The following increase in oxygen demand generates an increase in the volume of the heart, which then directly affects the increase in systolic pressure. For people at age 65, the American Heart Association recommends a heart rate for exercise in the range of 78–132 (HR x min-1) [3]. However, systematic training regulates blood pressure.

Prevention of hypokinesia during aging is important due to the progressive effects of the reduction of locomotor system activity observed in the body and the reduction of the ability to perform endurance efforts, changes in the stimulation of the nervous system and higher content of connective tissue in muscles [2]. The ageing process involves a decrease in muscle quality (MQ) in the upper and lower limbs in a similar percentage in men, while in the group of women, it is observed more often in the lower limbs. The effect of reduced physical activity of the elderly is a decrease in the subjectively felt level of quality of life [4]. While exercising the upper limbs, a significant increase in the frequency of heart contractions has been observed to

directly impact blood pressure compared to when exercising the lower limbs and achieving the same frequency of heart contractions [2].

Training conducted in the aquatic environment relieves pressure on the structures of the joints. The value of hydrostatic water pressure is a kind of resistance when performing underwater movements, both in terms of limb movement and in the inspiration phase. Its value increases in proportion to the density of the environment [5].

The purpose of the study was to assess changes in blood pressure and saturation values in seniors after aqua jogging training, to analyse the subjective average level of fatigue and its impact on $HR_{MAX}$, and to assess the quality of life in the study group.

## Materials and methods

### Participants

The study was performed at the School of Swimming and Aqua Fitness in the period from January to March 2019. The study group consisted of 49 people participating in Aqua jogging classes. Most of them lived in urban areas (83.7%) and had secondary education (59.2%). The age of the studied people was 66.3±5.4 years on average. The average BMI value was 27.7±2.96. The average time of attending aqua jogging classes was 17.2±13.4 months (Table 1).

### Questionnaire

A standardised questionnaire was used to assess the level of fatigue during the exercise, i.e. the RPE (Rating of Perceived Exertion) scale. It was applied to subjectively measure the feeling of physical effort exerted by the studied people in the exercises. The scale included levels from 0 to 10, where 0 indicated no fatigue, 5 indicated heavy but pleasant activity, and 10 indicated activity with maximum effort. Quality of life was assessed using two questionnaires, the Well-being index (WHO-5) and SF-36v.2 Quality of Life

Questionnaire, which analysed quality of life in the mental (MCS) and physical dimension (PCS), indicating an overall index of quality of life (ILQ). The raw results of both standardised questionnaires were transformed in accordance with the key into a percentage result [%].

The blood pressure value assessed in the next 3 measurements as well as the pulse and saturation values of the studied seniors before and after the training with intensity of 30–75% of maximum heart rate were also analysed. The assessment of training load due to the obtained percentage of $HR_{MAX}$ was determined using the $HR_{MAX}$=208-0.7 x age in years. The studies of Tanaka et al. show that this factor is a better indicator of $HR_{MAX}$ in elderly people. The commonly known form, $HR_{MAX}$=220-age in years, according to the researchers, underestimates $HR_{MAX}$ for the elderly [6].

The study methodology was planned in accordance with the principles indicated in the Helsinki Declaration [7]. The study based on completing the questionnaire, measurement of blood pressure and pulse did not cause any risk. In addition, it was anonymous and voluntary.

**Organisation of training and study methodology**

The training started with putting on buoyancy belts and entering the water (time:5 min.). Then there was a warm-up: rocking hands sideways, rocking hands forward, rocking hands down, jumping jacks, flutter kicks, torso turns (time:5 min.). Having warmed up, the study group proceeded to the main part (time: 30 min.). The studied participants performed: jogging 4x25m, jogging with a 4x25m hand load, jogging with a 4x25m leg load, jogging with a 4x25m hand and leg load.

At the end of the training, the study group performed stretching exercises at the pool wall for 5 minutes. The total training time was 40 minutes. The studied participants fully completed the training described above.

Blood pressure, pulse and saturation were measured before and immediately after training. Within 1 minute after the exercise, heart rate and saturation were measured. Within 5 minutes after the exercise, blood pressure, pulse and saturation were measured.

### Statistical analysis

Qualitative and quantitative variables were presented using basic descriptive statistics (number, percentage, mean, reference, median, lower and upper quartile). The database was analysed in terms of statistics using the t test for dependent samples. The normality of the distribution of measurable variables was assessed using the W Shapiro-Wilk test. The difference in mean values was also assessed. The studies were performed once in five groups of respondents. Statistical dependences were significant if their level of significance was $p<0.05$.

## Results

### Analysis of the subjective level of fatigue and quality of life of seniors

The average level of fatigue in the study group was 4.0±2.2 on a scale of 0 to 10, which indicates the assessment of physical activity performed by seniors, from light activity to demanding activity, posing a certain challenge to the body. The lowest scale value was 0, while the highest was 7.0. The assessment of quality of life was performed with two questionnaires, SF-36v.2 and WHO-5, which indicated a satisfactory level of subjectively assessed quality of life. In the WHO-5 analysis, the average was 71.1%±18.0%, which confirms the satisfactory level of perceived quality of life in seniors. The SF-36 analysis showed an average level of perceived quality of life: 59.0%±13.0%. A worse average quality of life was recorded in the physical sphere (PCS:56.8%±20.9%) compared to the mental sphere (MCS:61.1%±7.7%) of the studied seniors. However, the highest maximum percentage indicated by seniors was recorded in the sphere of physical quality of life – the highest measurement was 93.8%, which means a very high level of quality of life. The character of the distribution of $HR_{MAX}$ variables was also recorded, considering 3 subsequent measurements. The studied participants obtained average $HR_{MAX}$ percentages after approx. 50% effort, but not less than 31% and not more than 73% $HR_{MAX}$ in the measurements after training (Table 2).

Analysing the average $HR_{MAX}$ value in the study group, it was indicated that the lower the RPE value, i.e. the lower the subjective degree of fatigue, the clearer the difference between $HR_{MAX}$ measurement performed in the first and the fifth minute after the exercise. The $HR_{MAX}$ value measured in the fifth minute after the exercise increased significantly (r=0.3) with an increasing value on the RPE scale (p=0.018). This means that the subjectively heavier the physical effort was, the slower the pace of the pulse after exercise. In the study group, lower resting heart rate values were found among persons indicating higher values on the RPE scale after physical effort (r=-0.19). However, this relationship was not statistically significant (p=0.15) (Figure 1).

**Analysis of pressure, pulse and saturation parameters in subsequent measurements**

Having analysed the differences between the three measurements of systolic pressure (SP), a significant difference was found between the pressure value before and immediately after the training. Pressure values averaged 135.2 and 145.1 (p<0.000). Diastolic blood pressure values were significantly different in each of the analysed variable pairs (p <0.05). The largest difference was recorded in two consecutive measurements before and immediately after the exercise. The pressure increased by 11.3 mmHg (p<0.001). The differences between successive heart rate measurements were assessed. Apart from one pair of analysed measurements, a significant difference was confirmed in each case. In the analysis of the pulse measurement immediately after and 1 minute after the exercise, no statistically significant difference was noted (p=0.258). The measurement average was respectively 89.6 and 87.3 HR/min. The largest significant difference between the measurements was recorded before and immediately after the exercise. The post-exercise heart rate compared to resting heart rate increased by 13.8 HR/min. (p<0.001) (Table 3).

The mean pre-training blood pressure was 135.2/80.5 mmHg, increasing to 145.1/91.8 mmHg just after the exercise. In the last measurement performed in the fifth minute after the training, the total pressure decreased to 134.1/87.7 mmHg, which was close to the measurement of the pressure before the training (135.2/80.5 mmHg). The analysis of the saturation level in the next

4 measurements did not show significant differences (p=0.785). The saturation value remained almost at one level of SP $O_2$ 96.1 - 96.6. The above graph of means confirms the lack of significant differences in the level of saturation in subsequent measurements before and after the training. The value of the saturation measurement remained at the level of general norms for the population (Figure 2).

Analysing the time of attending aqua jogging classes and % $HR_{MAX}$ values, no significant relationships were found (p>0.05). Therefore, the time of exercising aqua jogging did not significantly affect the recorded value of $HR_{MAX}$ in the study group. The studied people did not exceed 75% of $HR_{MAX}$ assessed using the form $HR_{MAX}$=208-0.7 x age [in years].

## Discussion

The aquatic environment is not a natural environment for the human body. However, the physical properties of water allow for an effective use of the aquatic environment for physical activity. Studies confirming the effective process of recovering lost functions at the level of the musculoskeletal system are known [8, 9, 10, 11]. While shortening the recovery process in a group of patients after an injury, it is possible to introduce exercises in water earlier than exercises on land. The correctly chosen exercises allow us to regulate the functions of the nervous and cardiovascular systems, while exercising in water reduces the risk of falling, especially in the elderly group [12].

Fully completed aqua jogging training performed by the study group allowed them to obtain a heart rate not exceeding 75% $HR_{MAX}$. Blood pressure values, not only during exercise, but also at rest, allow us to assess the risk of cardiovascular health [13]. The conclusion from the obtained values of % $HR_{MAX}$ is that aqua jogging training is safe for a group of seniors and does not indicate high intensity exercise. The highest blood pressure values were recorded just after aqua jogging, while in subsequent measurements, according to physiological processes occurring in the body, the pressure values significantly decreased.

The $SpO_2$ value did not exceed the normal value. Therefore, aqua jogging training does not cause the risk of hypoxia. In the studies comparing haemoglobin values in the group of people training in the aquatic environment and on land and in the control group (without training), the value of haemoglobin increased significantly in the group of people doing aqua jogging ($p=0.001$) [14]. An increase in haemoglobin parameters increases the level of tissue oxygenation by binding haemoglobin to oxygen molecules. Therefore, training in water deepens breathing and increases breathing capacity.

The studies of many authors point to the high therapeutic value of training in water, especially in the elderly group [13]. The literature indicates that there are many studies comparing training in water with training on land. The authors' study covers only a group of people training through aqua jogging. In addition to the measurement of pressure, pulse and saturation, the study used questionnaires to assess RPE fatigue and the SF-36 questionnaire assessing the quality of life. In the study group, it was shown that lower resting $HR_{MAX}$ values significantly determined a higher RPE after the training ($r=0.34$; $p<0.05$). However, according to those studied, the total average rating of aqua jogging indicated the intensity of the training from light to demanding (4.0±2.2 RPE points).

The quality of life of the seniors assessed by two independent questionnaires indicated that it was at a satisfactory level – an average of 59.0±13% [SF-36] and 71.7±18.0% [WHO-5]. Similar values for quality of life as indicated through the SF-36 questionnaire were shown in the study of a group of women with obesity. In the study group of women, a higher average level of perceived quality of life in the physical sphere of SF-36 was noted [15], which was not confirmed in the authors' study. The mental sphere of life was rated higher [MCS]. The exercises in the aquatic environment significantly increase the elasticity of musculoskeletal tissues [16]. People participating in classes in the aquatic environment emphasise the positive impact of the exercises on the physical sphere [17].

The exercises in the aquatic environment minimize the risk of falling and the risk of injuries to the musculoskeletal system. In addition, they allow participants to feel relief from resistance. However, in the literature there are

a small number of publications indicating the possibility of inducing pneumothorax by training in the aquatic environment or aqua jogging [18, 19].

Training in water and the use of hydrostatic properties of water stimulates the musculoskeletal system, relieving pressure and increasing mobility. However, studies should be conducted to verify the impact of training in water on the human body, especially in seniors, since they often have cardiovascular and respiratory comorbidities.

## Conclusions

- → The general indicator of quality of life in the study group was rated at an average level. The seniors assessed the mental dimension of quality of life slightly better than in the physical dimension.
- → The higher the subjective level of fatigue on the RPE scale after the training, the lower the difference in the $HR_{MAX}$ measurements in the first and the fifth minute after the exercise and the lower $HR_{MAX}$ values before the training.
- → Having analysed the differences between the three measurements of systolic pressure, a significant difference was found between the pressure value before and immediately after the training. Pressure values increased significantly.
- → The largest significant difference between the pulse measurements was recorded before and immediately after the exercise. The post-exercise heart rate compared to resting heart rate increased by 13.8.
- → The pulse value between the first and the fifth minute after the exercise decreased significantly.
- → There were no significant changes in the saturation index in any of the performed measurements.
- → The seniors emphasised a satisfactory level of well-being.

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Table 1. General characteristics of the research group of the respondents

| Characteristic | | n | | % | | |
|---|---|---|---|---|---|---|
| Gender (n – 49) **– female/male** | | 39/10 | | 79.6/20.4 | | |
| Place of residence (n – 49) **– village/city** | | 8/41 | | 16.3/83.7 | | |
| Education (n – 49) **– higher/secondary/vocational/lack of education** | | 17/29/1/2 | | 34.7/59.2/2.0/4.1 | | |
| Variable | **M** | **SD** | **Reference** | **Me** | **Q1** | **Q3** |
| **Age** (n – 49) [years] | 66.3 | 5.4 | 52.0–81.0 | 67.0 | 63.0 | 70.0 |
| **BMI** (n – 49) | 27.7 | 2.96 | 22.7–35.8 | 27.5 | 25.3 | 29.4 |
| **Time to attend aqua jogging classes** [in months] (n – 49) | 17.2 | 13.4 | 1–52 | 15.5 | 5.50 | 24.0 |

Note. M – mean; SD – standard deviation; Reference – minimum to maximum; Me – median; Q1 – lower quartile; Q3 – upper quartile.

Table 2. Analysis of RPE scale results, SF – 36v.2 questionnaire, WHO – 5 and HRMAX

| Variable | N | X | SD | Reference | Me | Q1 | Q3 |
|---|---|---|---|---|---|---|---|
| **RPE Scale** [n] | 49 | 4.0 | 2.2 | 0,0–7.0 | 4.0 | 2.0 | 6.0 |
| SF – 36v2. | | | | | | | |
| **PCS** [result in %] | 49 | 56.8 | 20.9 | 20.0–93.8 | 58.8 | 37.5 | 72.9 |
| **MCS** [result in %] | 49 | 61.1 | 7.7 | 39.5–75.0 | 62.0 | 58.5 | 66.6 |
| **ILQ** [result in %] | 49 | 59.0 | 13.0 | 32.7–81.9 | 59.8 | 49.9 | 68.5 |
| WHO – 5 | | | | | | | |
| [result in %] | 49 | 71.1 | 18.0 | 32.0–100 | 72.0 | 60.0 | 84.0 |
| **%$HR_{MAX}$ [$HR_{MAX}$=208 – 0,7 x age in years]** [result in %] | | | | | | | |
| $HR_{MAX}$ BEFORE | 49 | 47 | 6 | 37–59 | 47 | 42 | 52 |
| $HR_{MAX}$ AFTER 1 min | 49 | 54 | 9 | 35–73 | 53 | 49 | 60 |
| $HR_{MAX}$ AFTER 5 min | 49 | 50 | 8 | 31–68 | 49 | 45 | 55 |

Note. M – mean; SD – standard deviation; Reference – minimum to maximum; Me – median; Q1 – lower quartile; Q3 – upper quartile.

Table 3. Analysis of differences in systolic pressure and pulse values in subsequent measurements in the study group

| Variables | Averages of subsequent analyzed pairs of measurements | | | | | |
|---|---|---|---|---|---|---|
| | $\bar{x}_1$ | SD | $\bar{x}_2$ | SD | $\bar{x}_1$ vs $\bar{x}_2$ | p |
| **SP before x SP after** | 135.2 | 13.4 | 145.1 | 14.4 | **9.9** ↑ | **0.000** |
| **SP before x SP 5min** | 135.2 | 13.4 | 134.1 | 16.2 | **1.0** ↓ | **0.634** |
| **SP PO x SP 5min** | 145.1 | 14.4 | 134.1 | 16.2 | **11.0** ↓ | **0.000** |
| **DP before x DP after** | 80.5 | 9.8 | 91.8 | 13.0 | **11.3** ↑ | **0.000** |
| **DP before x DP 5min** | 80.5 | 9.8 | 87.7 | 12.9 | **7.2** ↑ | **0.000** |
| **DP after x DP 5min** | 91.8 | 13.0 | 87.7 | 12.9 | **4.2** ↑ | **0.026** |
| **HR before x HR after** | 75.8 | 9.8 | 89.6 | 15.6 | **13.8** ↑ | **0.000** |
| **HR before x HR 1 min** | 75.8 | 9.8 | 87.3 | 13.8 | **1.5** ↑ | **0.000** |
| **HR before x HR 5 min** | 75.8 | 9.8 | c | 13.2 | **4.6** ↑ | **0.015** |
| **HR after x HR 1 min** | 89.6 | 15.6 | 87.3 | 13.8 | **2.3** ↓ | **0.258** |
| **HR after x HR 5 min** | 89.6 | 15.6 | 80.4 | 13.2 | **9.2** ↓ | **0.000** |
| **HR 1 min x HR 5min** | 87.3 | 13.8 | 80.4 | 13.2 | **6.9** ↓ | **0.000** |

Note. SP before– systolic pressure before aqua jogging; SP after – systolic pressure after aqua jogging; SP 5min – systolic pressure 5 min after aqua jogging; DP before – diasystolic pressure before aqua jogging; DP after – diasystolic pressure after aqua jogging; DP 5min – diasystolic pressure 5 min after aqua jogging; HR before – heart ratio before aqua jogging; HR after – heart ratio after aqua jogging; HR 1 min – heart ratio 1 min after aqua jogging; HR 5min – heart ratio 5 min after aqua jogging; $\bar{x}$ – average, t – Student t test; p – level of significance; SD – standard deviation; $\bar{x}_1$ vs $\bar{x}_2$ – difference between the measurements of the mean.

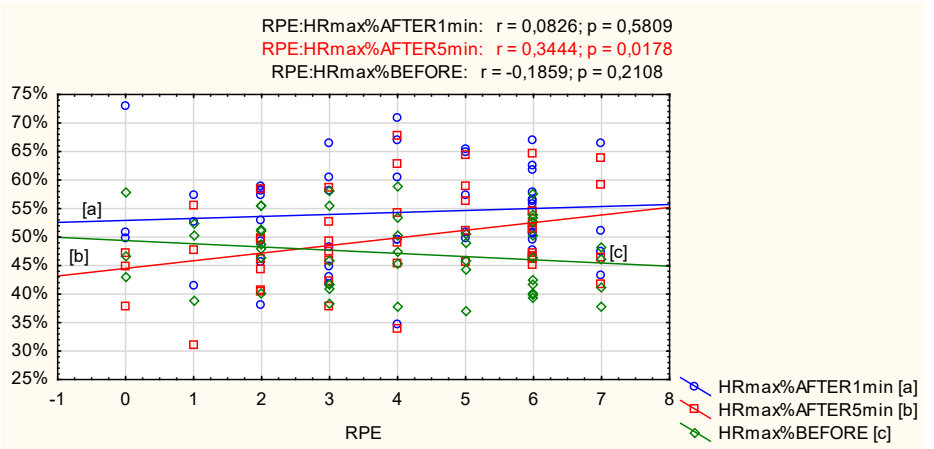


Figure 1. Average HRMAX value in 3 measurements considering the RPE fatigue scale value

Note. RPE – Rating of Perceived Exertion scale; $HR_{MAX}$%BEFORE – maximum heart rate before aqua jogging; $HR_{MAX}$%AFTER1min – maximum heart rate 1 min after aqua jogging; $HR_{MAX}$%AFTER5min – maximum heart rate 5 min after aqua jogging.

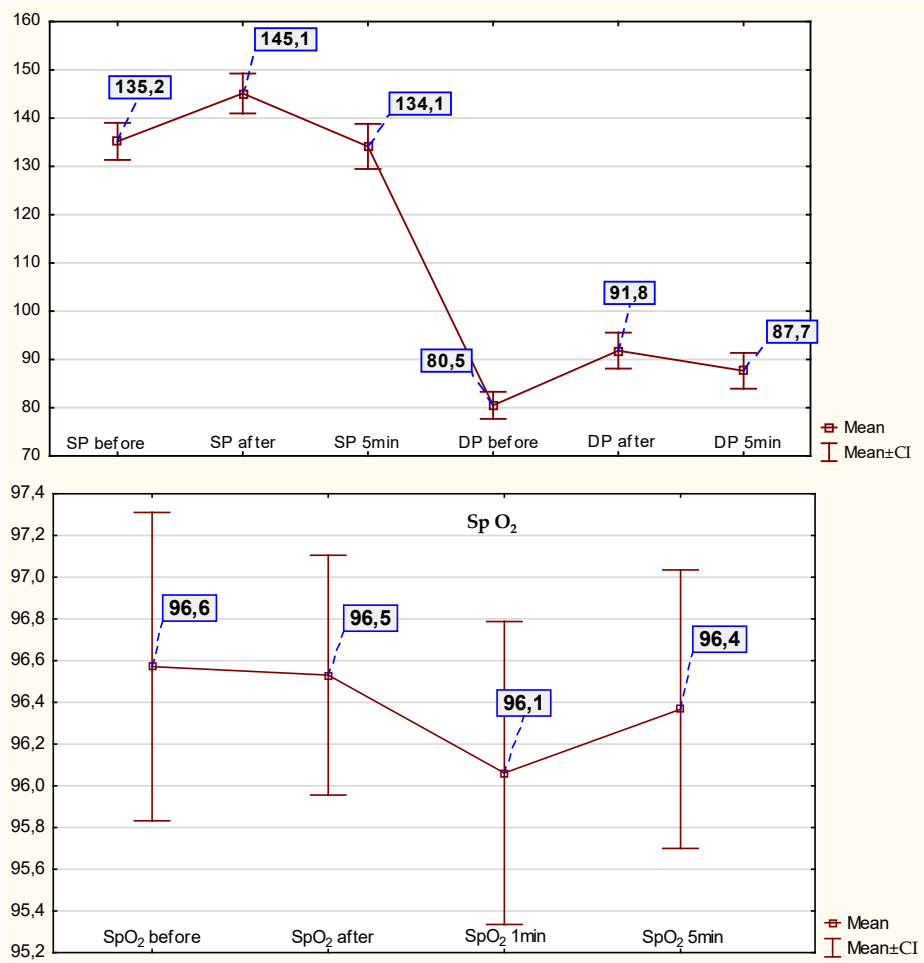


Figure 2. Average blood pressure and saturation level in subsequent measurements in the study group

Blood pressure: SP before – systolic pressure before aqua jogging; SP after – systolic pressure after aqua jogging; SP 5min – systolic pressure 5 min after aqua jogging; DP before – diasystolic pressure before aqua jogging; DP after – diasystolic pressure after aqua jogging; DP 5min – diasystolic pressure 5 min after aqua jogging; b) $SpO_2$ – Blood Oxygen Saturation; $SpO_2$ before - Blood Oxygen Saturation before aqua jogging; $SpO_2$ after – Blood Oxygen Saturation after aqua jogging; $SpO_2$ 1min – Blood Oxygen Saturation 1 min after aqua jogging; $SpO_2$ 5min – Blood Oxygen Saturation 5 min after aqua jogging.

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# A Case Study of Child with Acute Lymphoblastic Leukemia Treated in Intensive Care

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***Abstract***

*The most common childhood cancer is acute lymphoblastic leukemia, which, thanks to medical progress, achieves up to 95% of complete remission and 80% of cures with appropriate treatment among patients diagnosed with ALL.*

*A less than three-year-old boy treated for an infectious disease and progressively worsening symptoms was transferred by the Emergency Department to the Department of Hematology and Oncology of Children after revealing leukocytosis and thrombocytopenia. In a short time, the child's condition deteriorated, and it was decided to transfer the patient to the Children's Intensive Care Unit. Due to respiratory failure, the boy was intubated, and mechanical ventilation was started. Catecholamines and sedatives were introduced. Due to increasing edema and anuria, diuretics were administered without diuresis. Hemodialysis was used. In spite of transfused group compatible blood products and exchange transfusion, coagulation disorders occurred. On the tenth day of hospitalization in the intensive care unit, the procedure of confirming brain death was performed.*

*Both the prevention and treatment of hyperleukocytosis syndrome and the development of treatment methods do not reduce the risk of this syndrome among children diagnosed with acute lymphoblastic leukemia. The determination of permanent and irreversible cessation of brain function is possible only after the proper execution of the procedure for determining brain death.*

***Key words****: Acute lymphoblastic leukemia, T-cell leukemia, hyperleukocytosis syndrome, neurological disorders, declaration of brain death, brain death, death*

## Introduction

Acute lymphoblastic leukemia is considered the most common childhood cancer. The peak incidence of ALL is between 2 and 5 years of age [1–5]. Despite the high progress of medicine, which achieves even 95% of complete remission and as much as 80% of cures with appropriate treatment [2, 6, 7, 8], such a result cannot always be expected. When using anticancer treatment, one should take into account the high risk of complications, including the serious ones, such as hemorrhagic episodes, thromboembolic episodes, systemic disorders, or death [9, 10, 11].

This article describes the case of a child, from the first symptoms, through the diagnosis and treatment due to acute lymphoblastic leukemia, who developed significant hemostatic disorders which led to a quick death.

### A case report

Due to the suspicion of otitis, the parents brought their 33-month-old son to the outpatient clinic, where laboratory tests (morphology, iron, IgE, giardia) were performed as a standard. A few days later, swelling of the parotid area appeared on both sides, as well as enlarged retroauricular and cervical lymph nodes, and fever up to 38.2°C. On the first day, tonsillitis was diagnosed, and antibiotics were administered. At the next visit, the child was consulted in the infectious diseases ward and diagnosed with mumps, and the antibiotic was changed. The boy began to be sleepy and lethargic, without fever during the day. In the following days vomiting occurred, and the parents noticed petechiae on the left upper eyelid and a crack in the upper lip. The parents brought the child to the ER, where laboratory tests were performed, showing significant leukocytosis 212,000/ul and thrombocytopenia 84,000/ul. As a matter of urgency, the child with a suspected hematopoietic proliferative disease was referred for further treatment to the Department of Pediatric Hematology and Oncology.

The boy was admitted to the Department of Hematology and Pediatric Oncology in a serious condition, with increasing shortness of breath. On

admission, the child was pale, sleepy, apathetic, dehydrated, with enlarged cervical nodes, with significant hepatosplenomegaly with single petechiae on the mucosa and skin, and with severe abdominal pain. Laboratory test results showed hemoglobin 9.3 g/l, platelets 74,000/µl, leukocytes undetectable in the apparatus, after dilution 1,300,000, lactate dehydrogenase (LDH) 4,900, high uric acid, elevated creatinine, normal urea, elevated liver tests, coagulation disorders, hypoxia with hypercapnia and hypokalemia. Hydration with alkalization and potassium was started, as well as antibiotic therapy; analgesics were administered, and due to the increasing shortness of breath, and shallow and heavy breathing, passive oxygen therapy was implemented.

A chest X-ray was performed (at the Th4 level, the mediastinal shadow was enlarged with nodules, especially on the left side) and an abdominal ultrasound (hepatomegaly, thickened gallbladder wall, spleen enlargement with a polycyclic internal contour or with hypertrophied accessory spleens present), and later, under general anesthesia, also a myelogram and lumbar puncture were performed. This was followed by high non-invasive blood pressure (148/81 mmHg) and anuria; despite being highly hydrated, only small amounts of urine were obtained from the patient. Due to the very serious condition, increasing shortness of breath, life-threatening hyperleukocytosis in the course of T-cell leukemia, and the need to perform a life-saving procedure, i.e., exchange transfusion, it was decided to transfer the child to the Pediatric Intensive Care Unit.

On admission to the intensive care unit, the boy's condition was severe; his breathing was spontaneous with significant respiratory effort on passive oxygen therapy, and shallowing of consciousness was observed. Asymmetric vesicular murmur over the lung fields with numerous wheezes and crackles was also noticed. On the neck, large bundles of lymph nodes were located laterally symmetrically. The oral mucosa was dry with petechiae and hemorrhagic changes. Abdomen was soft with organomegaly. Intestinal peristalsis was audible. The results of additional tests showed massive leukocyturia (717,000), thrombocytopenia, hypokalemia and coagulation disorders (mainly prolonged PT, high d-dimers). The child was intubated, and mechanical

ventilation of the lungs was started. Due to significant coagulation disorders, blood products (FFP, NuRBCz) were transfused, and exchange transfusion was performed according to hematological indications. The procedure was repeated the following day. In the first days, the boy's condition was metabolically and hemodynamically unstable. He required pharmacological support of the circulatory system, kidneys, compensation of electrolyte and coagulological disorders. On the next day, hemodialysis was performed. The incorporation of steroids brought a positive effect in the treatment of leukemia – organomegaly disappeared, and the lymph nodes decreased. Unfortunately, neurological disorders progressed. Sedation and painkillers were discontinued. Despite this, the boy was still unconscious (GCS 3 points). The absence of trunk reflexes and self-respiratory drive was observed. The pupils were equal, wide, and unresponsive to light. Magnetic resonance imaging of the head was performed to establish the diagnosis. The examination showed invagination of the cerebellar tonsils into the foramen magnum and changes suggesting irreversible brain damage. Considering the clinical condition – apnea, areflexia, lack of trunk reflexes, difficulties with maintaining a normal body temperature – brain death was suspected. Preparations for tests confirming the diagnosis were initiated. Two tests were performed that confirmed the suspicion. The child was pronounced dead by the commission, and he was disconnected from the ventilator. The autopsy results confirmed cerebral edema with almost complete softening of the brain tissue and intussusception of the brain stem into the foramen magnum, i.e. changes in the course of acute leukemia.

## Discussion

The most common cause of failure in the treatment of acute lymphoblastic leukemia in children is the recurrence of the disease, which occurs in about 20–30% of patients, but death rarely occurs shortly after such a diagnosis is made [14].

Hyperleukocytosis syndrome among patients treated for acute lymphoblastic leukemia occurs in about 9-13% of patients with a white blood cell

count greater than 300,000/µl. The syndrome is more common among male children, as in the case described above [15].

In the course of ALL, the incidence of CNS involvement is more frequent than in the course of acute myeloid leukemia, both in children and adults [11–13]. In the case discussed above, the symptoms that grew the fastest were breathing disorders, shortness of breath (asymmetrical vesicular murmur with numerous wheezes and crackles in the auscultation examination over the lung fields) resulting in shallowing of consciousness. These are the features of hyperleukocytosis syndrome [16]. Later on, in addition to the lungs, other parenchymal organs such as the liver and kidneys became inefficient due to the increased number of white blood cells. In the case discussed, the kidneys ceased to function, which could be observed by anuria, which resulted in the use of hemodialysis. In this case, other characteristic symptoms indicating the occurrence of leukostasis in the child could also be observed, such as: increasing circulatory failure (tachycardia, high blood pressure), central nervous system disorders, and organomegaly [4, 8].

In acute lymphoblastic leukemia, the disease process is the main cause of the increased risk of thromboembolic complications. This is due to the stimulation of the coagulation system [17]. Treatment in intensive care is dictated by quick and often long-term medical assistance to patients diagnosed with an acute or chronic, but also often incurable disease entity. It should be remembered that the indications for hospitalization and the treatment itself at each stage of the disease should not take on the characteristics of persistent therapy. Therefore, children in particular should be protected, as far as possible, from inflicted and prolonged suffering resulting from the disease itself, but also from the applied therapy [18, 19]. Due to the deteriorating clinical condition of the boy, sedatives were discontinued, and despite this, the lack of consciousness, breathing and trunk reflexes persisted, which was confirmed by the results of magnetic resonance imaging of the head.

Establishing brain death diagnosis depends on the patient's age group. The first age group comprises newborns – up to 28 days of age, and the second – children between 29 days of age to the age of 18 years. In the case discussed, it was of course the second age group that was taken into account.

The initial observation time was not less than 24 hours from the moment of finding the basic trunk areflexia. The first stage (initial observation) was performed after the appropriate patient's temperature had been reached (external active heating) due to difficulties in maintaining the proper body temperature. The second stage was attended by a specialist in anesthesiology and intensive care, and a doctor specializing in pediatric neurology, who independently performed the analyses of statements and exclusions twice using the tests confirming trunk areflexia and persistent apnea. Electrophysiological tests (electroencephalography and multimodal evoked potentials/ auditory brainstem response and SEP – somatosensory evoked potentials) and cerebral blood flow tests were performed. Due to the patient's age (below 12 years), computed tomography angiography were not performed. The clinical examination was carried out in accordance with the regulations [18, 19]. Brain areflexia was confirmed on the basis of two examinations, where the following were not observed: pupillary reaction to light, corneal reflex, spontaneous eye movements, eye movements during the caloric test, motor reactions to a pain stimulus, vomiting and cough reflexes, and oculocerebral reflex. At the end of each series of examinations, an apnea test was performed with the use of CPAP using a ventilator. After the stabilization of the partial pressure of carbon dioxide in the arterial blood, a 10-minute ventilation of the patient with 100% oxygen was introduced, and then arterial blood samples were collected for gasometric examination according to recommendations. Before returning to baseline ventilation, an alveolar recruitment maneuver was performed. In the case discussed, and thus in children over 28 days of age, both series (analysis of findings and exclusions and clinical trials) must be performed after the initial observation period at intervals of at least 24 hours (if instrumental tests are not performed), or of at least 3 hours (if instrumental examination was performed). In newborns, instrumental examination does not shorten the period between the series, and it should be 24 hours [18, 19]. After confirming brain death, a Brain Death Protocol is issued and signed by physicians actively participating in the procedure. On the basis of the protocol, a death certificate is then issued [18–20].

## Conclusions

Both the prevention and treatment of hyperleukocytosis syndrome and the development of treatment methods do not reduce the risk of the syndrome in children diagnosed with acute lymphoblastic leukemia. It is one of the most serious reasons for patients being transferred to the intensive care unit with a hematological diagnosis, and their death. The determination of permanent and irreversible cessation of brain function is possible only after the proper execution of the procedure for determining brain death.

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# Selected Health Behaviors among Medical Students of the Medical University of Lodz

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## *Abstract*

***Background:*** *Health is a state of complete physical and mental well-being, and the right of every individual. Its presence is influenced by various factors. It is well known that early prevention, aimed at avoiding disease, has a greater impact on quality of life and longevity than disease treatment. Through their behavior, young people determine the development of diseases in the future. Medical students are a special group in that respect. They should be more aware of the need to lead a healthy lifestyle, but they are at risk of chronic stress and other disorders due to strenuous studies.*

***Objectives:*** *Learning about selected health behaviors of medical students of the Medical University of Lodz.*

***Material and methods:*** *Medical students of the Medical University of Lodz; form of the study: original online questionnaire.*

***Results:*** *76.6% of the respondents were physically active. The favorite form of physical activity of medical students in Lodz were exercise in the gym (57.1%), walking (36.7%), and running (28.6%). 67.3% of the interviewees had normal body weight. 33.6% of the respondents admitted to smoking. 0.9% of the respondents drank alcohol daily, 28% at least once a week, 57.9% at least once a month, and 13.1% did not drink alcohol at all. Only about every third student did not drink energy drinks (34.6%). 35.5% of the respondents reported sleeping problems.*

***Conclusions:*** *Medical students of the Medical University of Lodz were physically active: most often they exercised in the gym and walked. Men were overweight and obese more often than women. Greater physical activity and a lower percentage of smokers in the students of higher years of study may indicate an increase in the healthy lifestyle awareness. In universities, there is a need for activities aimed at students to raise their knowledge about prevention and healthy lifestyle.*


***Key words:*** *health behaviors, medical students*

## Introduction

Health, as defined by the World Health Organization (WHO), is a state of complete well-being (physical, mental, and social, not just the absence of disease). It is also a fundamental right of the individual [1]. Health is conditioned by many factors. According to M. Lalonde, there are 4 types of health determinants, i.e.: lifestyle (53% of the impact), physical environment (21%), human biology (16%) and healthcare organization (10%) [2]. On this basis, it was determined that lifestyle in its broad sense affects health the most.

Public health, on the other hand, is generally understood as referring to a population rather than to a specific individual [3].

The term "prophylaxis" concerns actions aimed at preventing diseases, minimizing the impact of diseases and disabilities, or delaying their progression. The so-called primary prevention, i.e., the first phase, covers actions aimed at healthy people [4]. Examples include pro-health behaviors such as avoiding stimulants, proper eating habits, physical activity, or protective vaccinations.

It is well known that early prevention has a greater impact on the quality of life and longevity than disease treatment. Young people are already determining the development of diseases in the future by their behavior. Improper lifestyle leads to the occurrence of the so-called metabolic syndrome, which includes hypertension, abdominal obesity, insulin resistance and hyperlipidemia. With the successful defeat of infectious diseases, this new non-communicable disease has become a major threat to the health of the modern world [5].

Medical students are a specific group. On the one hand, they should be more aware of the need to lead a healthy lifestyle, but on the other hand, they are exposed to stress and sleep disorders due to strenuous studies.

Moreover, at the time of the COVID-19 pandemic, having health knowledge has been shown to have a protective effect on medical students and reduce feelings of fear, while smoking and drinking appear to have a negative effect on the fear of COVID-19 [6]. Health-promoting behaviors, and in particular positive mental attitudes, can play a protective role with regard to the symptoms of anxiety and depression in a stressful situation [7].

Objective: The aim of the study was to learn about selected health behaviors of medical students of the Medical University of Lodz.

Material and methods: The study was conducted from November to December 2022. An original online survey questionnaire was used. The study group consisted of students of all years (1–6) at the Medical University of Lodz. The study involved 107 participants (50.5% men and 49.5% women). The data contained in the surveys were entered into an MS Excel spreadsheet, and then the collected empirical material was analyzed. To develop the material, descriptive methods and statistical inference methods were used. A $chi^2$ test of independence was used to compare the prevalence of individual trait varieties in the study groups, and to test the relationship between qualitative traits. Those differences between frequencies and the correlations between traits for which the calculated value of the $chi^2$ test turned out to be equal to or greater than the critical value read from the tables for the corresponding number of degrees of freedom with a probability of error of $p<0.05$ were considered statistically significant.

## Results

76.6% respondents (82 persons) were physically active. 48.6% exercised at least 3 times a week. The favorite form of physical activity of medical students in Lodz were exercise in the gym (57.1%), walking (36.7%), and running (28.6%). Slightly less popular forms of exercise were swimming (23.5%), team games (19.4%), yoga and pilates (16.3%), and other sports (18.4%). Physically active students accounted for 53.8%, in the second year – 50%, in the third year – 57.1%, in the fourth year – 77.2%, in the fifth year – 75.9%, and in the sixth year – 85%. High school students were more physically active.

67.3% of the subjects had a normal body weight, with a BMI between 18.5 and 24.9 $kg/m^2$. Among women, normal-weight subjects accounted for 77.3% of the respondents' group, while men accounted for 57.4%. The observed differences were found to be statistically significant – $p<0.05$, $chi^2=23.82$ (Fig. 1). Among the respondents, 100% of the underweight (BMI<18.5 $kg/m^2$) were women. Obese people (BMI>30 $kg/m^2$) accounted for 1.9% of all respondents.

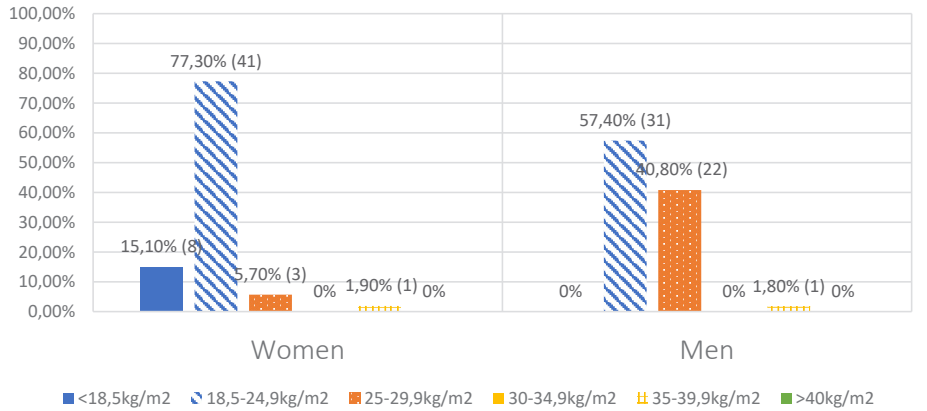


Figure 1. BMI value among students by gender

44.5% of the respondents ate 3 or more servings of fruit and vegetables per day. 51.5% consumed them 1–2 times a day. Only 5.9% of the respondents did not consume fast-food products. 43.6% of the respondents ate them once a week, 43.6% once a month, and 5% consumed them daily. The percentage of women eating fast-food at least once a week was about 32% of the subjects, and for men the value was 59.3%. Therefore, men consumed such products more often than women. The observed differences were found to be statistically significant – $p<0.05$, $chi^2=17.84$ (Fig. 2).

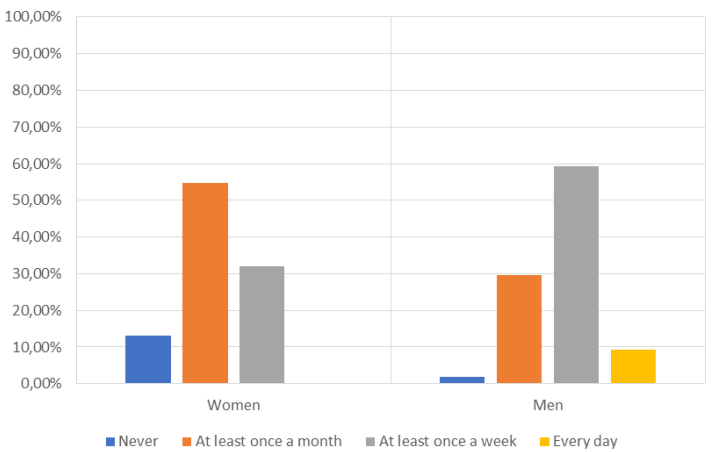


Figure 2. Frequency of consumption of fast-food products among students by gender

33.6% of the respondents smoked tobacco. Among them, 73.5% were daily smokers, and 26.5% smoked occasionally, mainly during social gatherings. Female smokers accounted for 20.8% and male smokers for 42.6%. The observed differences were found to be statistically significant – $p<0.05$, $chi^2=5.884$ (Fig. 3).

As for the first year students, 53.8% of them smoked, while in the group of the sixth year students the value was 15%. The tobacco product most often used by medical students were electronic tobacco heaters – 50%, followed by traditional cigarettes and e-cigarettes (30% each).

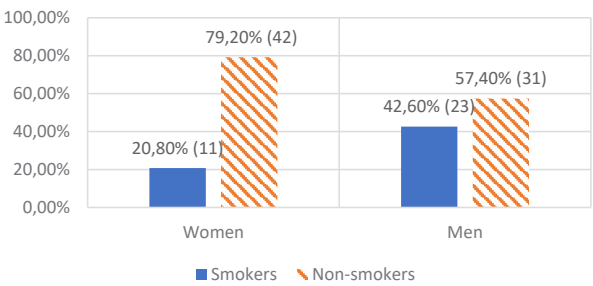


Figure 3. Smoking among students by gender

Alcohol consumption: 0.9% of the subjects drank daily, 28% at least once a week, 57.9% at least once a month, and 13.1% did not drink at all. Differences in the frequency of alcohol consumption by women and men turned out to be statistically insignificant – p. 0.05 (Fig. 4).

The most popular alcoholic beverages among the interviewees were beer (52.7%), followed by wine (44.1%), and vodka (38.7%). Women were more likely to reach for wine, and men were more likely to drink beer and vodka.

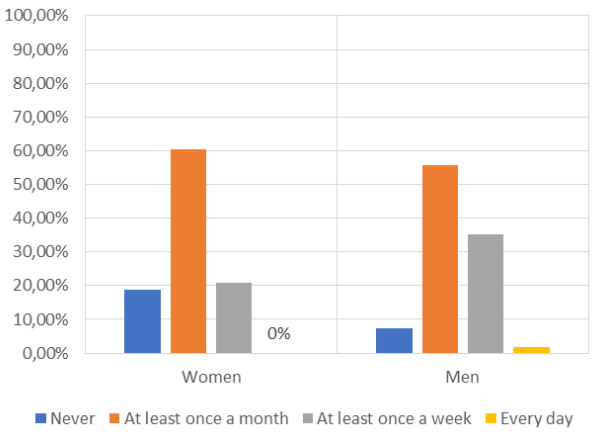


Figure 4. Frequency of alcohol consumption among students by gender

Only about every third student did not drink energy drinks (34.6%). 27.1% of the students consumed energy drinks at least once a week, and 7.5% of the respondents admitted to consuming them every day. 49.1% of women and 18.5% of men said they never consume energy drinks. According to the study results, 32.1% of women and 27.8% of men had energy drinks at least once a month, while 15.1% of women and 37% of men consumed them at least once a week. Daily drinking of energy drinks was reported by 14.8% of men and 0% of women. The observed differences were found to be statistically significant, $p<0.005$, $chi^2=20.348$ (Fig. 5).

As many as 35.5% of the respondents reported sleeping problems. 52.3% of the students slept 6–7 hours a day, 14% – 8 hours or more, and 33.6% of the respondents slept only 4–5 hours a day.

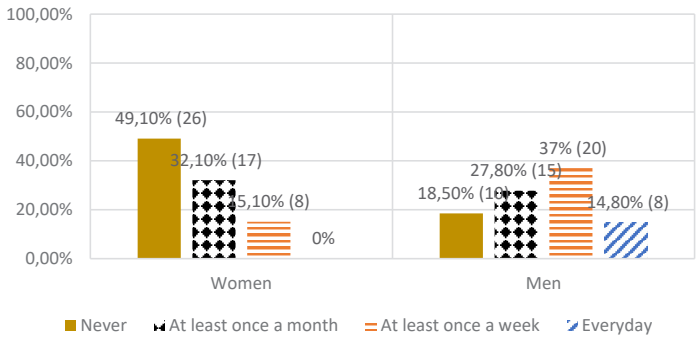


Figure 5. Frequency of students' energy drinks consumption by gender

97.2% of the subjects were vaccinated against COVID-19 – 96.2% of women and 98.1% of men (Fig. 6, Fig. 7). Most of them (78.6%) received three doses of the vaccine, and 12.6% received four doses. In contrast, only 17.8% of all subjects were vaccinated against the influenza virus.

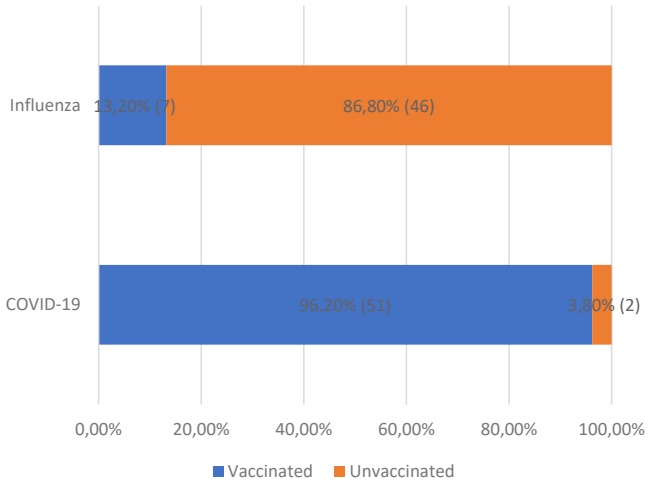


Figure 6. Vaccination against influenza and COVID-19 among female students

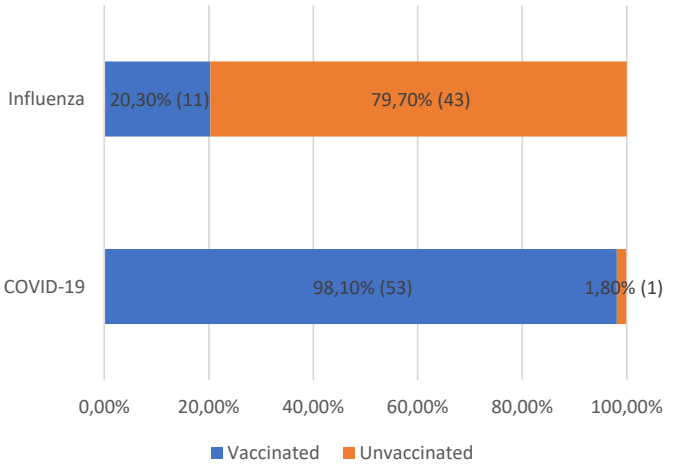


Figure 7. Vaccination against influenza and COVID-19 among male students

## Discussion

A healthy lifestyle can be understood as maintaining physical activity, a proper diet rich in vegetables and fruit, ensuring a good quality of sleep, or avoiding obesity or stimulants. Another element of a healthy lifestyle is vaccination, which is the primary prevention of many diseases. Young adults leading a healthy lifestyle are hypothetically able to extend their years of health. WHO studies show that up to 70–80% of deaths in developed countries and 40–50% in low- and middle-developed countries are due to diseases caused by the lack of healthy lifestyles [8]. On the one hand, medical students, as a group with greater awareness of the etiopathogenesis of many diseases, should follow the rules of a healthy lifestyle, but on the other hand, due to burdensome studies, they are exposed to chronic stress, lack of sleep, or lack of free time. Obesity is a disease that predisposes to other diseases, e.g., cardiovascular ones and cancer, and it undoubtedly shortens life. In the study discussed in this paper, obese students accounted for 1.9% of the study group. 76.6% of the students counteracted obesity through physical exercise, with more active students in the higher years of study, which may indicate an increase in the awareness of older students. Similar conclusions were

drawn from a Lublin study checking the knowledge on the complications of obesity among students of the Medical University of Lublin and the Maria Curie-Skłodowska University. Nearly half (49%) of the medical students interviewed showed moderate or high awareness of the effects of obesity, while the majority of the UMCS students exhibited low awareness in this respect. In addition, it was shown that at the Medical University, fifth-year students showed a higher level of knowledge compared to first-year students [9]. Researchers from Wroclaw studying health behaviors among the students of the Mustafa Kemal University in Hatay (Turkiye) concluded that women exhibited a higher level of health-friendly behaviors than men, whereas the opposite was true as far as physical activity was concerned. In the studied environment, it was possible to notice positive correlations between the field of studies related to health issues and health behaviors and physical activity of the students in this field. Students of other majors showed lower levels of health-friendly behaviors and physical activity [8]. As for the comparison of medical students to students of teacher education programs, as the ones who should also promote a healthy lifestyle with their attitude, a study from Lublin of 2019 showed that 14% of the students surveyed had never played sports, and less than 20% of the respondents declared undertaking daily physical activity [10]. According to the Lublin study, students regularly sleeping 6–7 hours a day accounted for about 39% of the respondents, and in the case of the study discussed in this paper it was about 52.3%. According to the 2021 study on the mental well-being of medical students, 75% of the respondents had sleep disorders [11]. In the study analyzed, 35.5% of the respondents declared sleep problems. As far as the results on alcohol consumption are concerned, the majority of the students drank it at least once a month (57.89%); men accounted for a higher percentage of drinkers. Similar results were obtained in the aforementioned to the Lublin study, where female students drank less than male students. On average, alcohol consumption at least once a month is declared by 48% of women and 33% of men [11]. Students often resorted to energy drinks. According to the world literature, the most common stimulant used by students is coffee, followed by other forms of caffeine, such as energy drinks [12].

A study conducted in 2020 among students of physiotherapy, nursing and obstetrics showed that the study group leads an average healthy lifestyle; the most physically active are future physiotherapists (about 90% of them do sports in their free time). Among the studied groups, most students did not smoke cigarettes [13]. According to the results of this study, it can be also noted that the percentage of smokers among medical students decreases with the duration of their studies. On the other hand, a study conducted by researchers from Szczecin showed that students of medical and non-medical universities differed in terms of the declared health behaviors. Medical college students had a higher severity of health behaviors [14]. A study comparing the health behaviors of first-year students living in family homes and moving from home to study was also conducted. The results showed that people living in the family home made healthier food choices, such as eating more vegetables and homemade sandwiches. In addition, female students made healthier choices than male students, as they were less likely to consume fast food or sugary drinks [15], the consumption of which is known to contribute to the development of obesity, already among children [16]. According to this study, about 45.8% of the respondents consumed fast-food products at least once a week, and these were more often men than women (59.3% vs 32%). Physical education students exhibited poor health behaviors, but still better than those studying at non-health faculties [17]. In addition, most studies have shown that women were more likely to perform better in terms of health behaviors than men [17]. As far as the analysis of primary prevention in the form of protective vaccinations is concerned, in the study conducted in Egypt in 2021 on medical students most respondents (90.5%) considered the COVID-19 vaccine important [18]. The results obtained in this study also indicated high immunization against SARS-COV-2. Among the subjects, 97.2% were vaccinated; those with 3 doses accounted for 78.6%, and those with 4 doses – 12.6%. In comparison, only 17.8% of the subjects were vaccinated against influenza. However, this result was significantly higher than in the general population – Poland has been experiencing low acceptance of influenza vaccinations for years, which is illustrated by the vaccination rate of the whole population of approx. 4%.

In terms of the flu vaccination status, Poland ranks among the last in Europe. In the 2019/2020 season, 4.12% of Poles were vaccinated against influenza, while in the 2018/2019 season the percentage was only 3.9% [19]. According to the reports of Israeli researchers, a healthy lifestyle is abandoned or significantly discontinued when doctors start residency training. Given the workload and emotional stress associated with the profession, it is recommended that curricula provide students with the means to help them adopt healthier lifestyles [20].

## Conclusions

1. Medical students of the Medical University of Lodz were physically active: most often they exercised in the gym and walked. Among the active people, students of higher grades predominated.
2. Men were overweight and obese more often than women. Underweight was more typical of women. Fast-food products consumption in the medical student community was high, and higher among men. Numerous medical students drank energy drinks, and some of them even consumed them on a daily basis.
3. The percentage of students smoking cigarettes and other tobacco products decreased with the duration of their studies.
4. Greater physical activity and a lower percentage of smokers in the higher years of study may indicate an increase in the awareness of healthy lifestyle.
5. Most students were vaccinated against COVID-19. The flu vaccination rate was low.
6. In universities, there is a need for activities aimed at students to increase their knowledge about prevention and healthy lifestyle.

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