

Body mass index levels in students living in areas of military conflict

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Abstract

Background and Study Aim At present, human health and related elements face ongoing risks from environmental conditions. Thus, regular tracking of health metrics gains significant importance. The research objective is to assess the BMI level of students residing in areas affected by the extended military conflict in Ukraine.

Material and Methods The study involved students from three universities in Ukraine (96 men and 160 women). Prior to the experiment, these students had been living a sedentary life due to the worldwide COVID-19 pandemic (beginning in 2020) and the ongoing war in Ukraine (starting February 24, 2022). They spent a cumulative total of three and a half years in this challenging setting. Data gathering was carried out through a Google Form, which comprised details such as the student's name or alias, gender, height, weight, academic year, field of study, and university association. The PyCharm CE platform and a range of Python programming libraries were employed for the statistical analysis of the data.

Results The study revealed that the mean Body Mass Index (BMI) values are 22.73 kg/m² in males and 21.20 kg/m² in females. Among women, the BMI breakdown is: 73.75% normal weight, 17.5% underweight, 7.5% overweight, and 1.25% obese. For men, the figures are: 69.79% normal weight, 20.83% overweight, 5.21% underweight, and 4.17% obese.

Conclusions The outcomes stress the necessity of a tailored approach to body mass control, considering gender-specific, educational, and societal-cultural factors.

Keywords: health, physical activity, young people, environment

Introduction

Nowadays, the physical health of individuals and related elements face ongoing threats from their habitats. Thus, consistent observation of health indicators is essential. The Body Mass Index (BMI) is a fundamental indicator of a person's physical state. At present, a more in-depth examination and comprehension of BMI disparities between males and females in hazardous environments, like conflict areas, is essential. This is especially true for university students, who are less equipped to handle such dangers.

Many studies have already confirmed that BMI parameters can be used as a criterion for health level [1, 2, 3]. Authors use BMI to analyze health level in interaction with other indicators:

- body balance [4];
- prenatal testosterone level [5];
- blood pressure, physical activity [6, 7, 8, 9];
- dissatisfaction with one's body [10, 11];
- the conscious importance of health for health-related behavior [12];

- eating behavior and sleep quality [13, 14];
- health standards [1, 15].

Research results from different countries indicate some differences in BMI among both men and women. Nuttall et al. [1] determined that in Western population studies, the average BMI ranges from 24 to 27 kg/m². Nowak and Zanevskyy [16] identified BMI values for Polish physical education students at 22.9±2.6 kg/m². Similar results were obtained for students from Saudi Arabia, with an average BMI of 22.75±1.91 kg/m² [17]. Wang et al. [15] identified an optimal BMI of 23.53 kg/m² for male and 23.41 kg/m² for female Chinese students. Arslan et al. [18] defined the average BMI for students from Turkey: 22.94±3.30 kg/m².

These research findings indicate differences in BMI levels depending on the country of residence. Therefore, such facts can be valuable and useful in studies of BMI among students in Ukraine.

Ivanyshyn et al. [19] note that students from India are characterized by a very low level of relative body fat, while the majority of individuals from Egypt (61.4%) and Jordan (50.9%) are characterized by moderately high fat content. Ofori et al. [20] showed that 31.7% of students from Ghana were overweight

and 21.7% of students were obese. Bailey et al. [21] determined that approximately 40% of college/university students in the USA are overweight/obese. Nakhoda and Wiles [22] found that 64.9% of students from South Africa have a normal BMI.

Researchers from Saudi Arabia determined that 53.6% of students have a BMI within the normal range [23].

Overall, the results of these studies highlight the need for continued research into various aspects of the relationship and assessment of parameters that influence the BMI of students.

The hypothesis of the study is that there are statistically significant differences in BMI between men and women, and these differences may have practical implications for health assessment and the development of recommendations for improving the physical condition of participants.

The research objective is to assess the BMI level of students residing in areas affected by the extended military conflict in Ukraine.

Materials and Methods

Participants

The study was conducted among students from three Ukrainian universities, faculties of physical education (n=96 - men, n=160 - women). The entire territory of Ukraine is constantly subjected to air attacks from Russia, and its southeastern part is occupied by Russian troops. Therefore, as part of the study, students were advised to follow safety rules in case of an air raid alert in the city. They were also encouraged to use a special mobile application called 'AirAlert' which warns of the threat of a missile attack.

Living Conditions and Environment for Students

The total duration of online education, initially caused by the COVID-19 pandemic and then extended due to the war, amounted to [3 years and 6 months] at the start of the study. In two universities (1 and 2), located in Kharkiv and close to the war zones, the need to ensure safety led to a complete transition to online education. This is due to frequent shelling and air raids in the region.

At the university located in the western region of Ukraine (Ivano-Frankivsk), a hybrid educational model was implemented, involving both in-person and online classes. This allowed the university to adapt to the intensification of military actions and emergencies, including the possibility of transitioning to fully remote learning.

Study Design

The study utilized data provided from a source that will not be disclosed in order to maintain confidentiality. The research was conducted in accordance with the principles and standards of scientific ethics and data confidentiality.

Data collection was carried out using structured questionnaires, which allowed respondents to provide their personal characteristics such as age, height, weight, level of education, specialty, and university. BMI measurement was conducted based on the height and weight data obtained from the respondents. The calculation of BMI was performed using the standard formula, defined as the ratio of mass (in kilograms) to the square of height (in meters).

Statistical analysis

For statistical processing of the results, the PyCharm CE development environment and various Python programming language libraries were used. For data analysis and testing of statistical hypotheses about differences in BMI between groups, the following approaches were utilized:

1. To test for normality of data distribution, the Shapiro-Wilk test was used.
2. To compare the average BMI values between two groups (men and women), the Mann-Whitney U test was applied. This non-parametric test helps to determine whether there are statistically significant differences between the BMI distributions in different groups.

To compare the average BMI values among participants from different universities, the Kruskal-Wallis test was used. This non-parametric test is applied to determine whether there are statistically significant differences in BMI among different universities. All three criteria were used with a significance level of $\alpha=0.05$.

Results

Table 1 presents the data of the experiment participants. Based on the analysis conducted, the following was obtained. The results of the Shapiro-Wilk test showed that the data distribution is statistically significantly different from a normal distribution. The results of the Mann-Whitney U test revealed a statistically significant difference in BMI values between men and women ($p < 0.05$). This confirms that the average BMI values differ between these two groups. The results of the Kruskal-Wallis test also showed a statistically significant difference between the groups ($p < 0.05$), further confirming the differences in BMI between men and women.

Further analysis of the average BMI values showed that men have an average BMI of 22.73 kg/m², while women have an average BMI of 21.20 kg/m². The difference in average BMI values between the groups is 1.52 kg/m². This also confirms the presence of differences in BMI between men and women (Figure 1).

Comparison of the average BMI values for students from different universities shows (Table 2) that they are almost identical (21.84 kg/m² for University 1; 21.68 kg/m² for University 2; 21.83 kg/

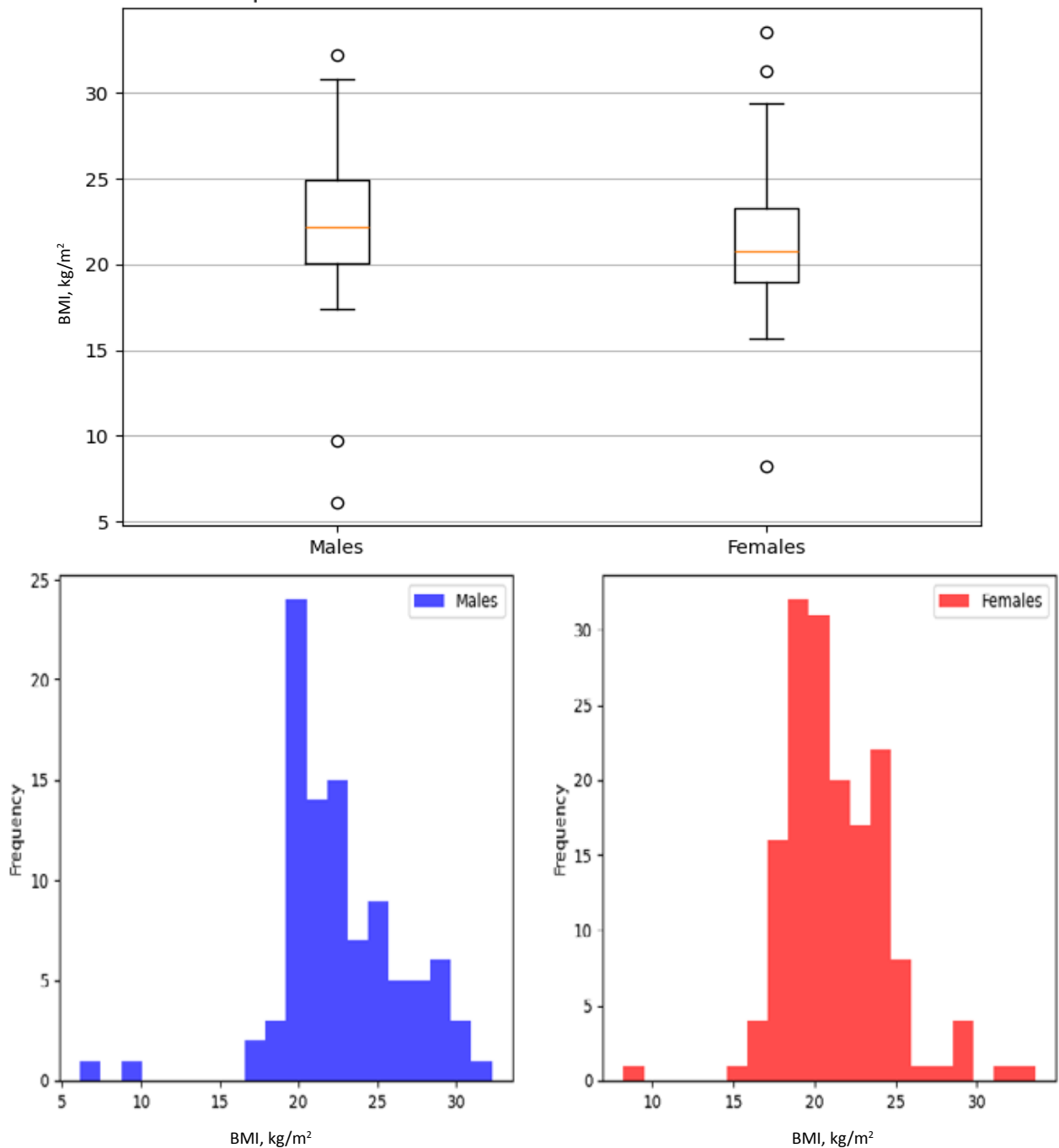


Figure 1. Histograms of BMI distributions for each group (male and female)

Table 1. Statistical data of participants (n=96 - male, n=160 - female).

Gender	Age (years)		Height (cm)		Weight (kg)		BMI (kg/m ²)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Male	20.73	4.68	179.74	7.4	73.67	14.96	22.73	4.03
Female	19.08	3.2	165.64	6.21	58.25	9.56	21.2	3.18
Total	21.78	3.2	165.64	6.21	58.25	9.56	21.78	3.18

Table 2. Statistical data of BMI results by universities

University	Mean, kg/m ²	Std Dev
University 1	21.84	3.54
University 2	21.68	3.68
University 3	21.83	3.56

Note. University 1, University 2 – located in the eastern part of Ukraine, recognized as a war zone; University 3 - located in Western Ukraine, subjected to constant military attacks.

Table 3. Statistical data of BMI results by years of study

Course	Female		Male	
	Mean, kg/m ²	Std Dev	Mean, kg/m ²	Std Dev
1	21.34	2.85	22.6	3.16
2	21.47	3.17	22.27	4.89
3	19.99	2.94	24.43	3.27
4	21.2	3.41	21.83	1.52
5	24.37	3.99	22.68	6.19
6	-	-	19.72	-

Note. 5, 6 - Master's degree

Table 4. Statistical data of BMI results by BMI categories

BMI Category	Female		Male	
	Count	Percentage (%)	Count	Percentage (%)
Normal weight	118	73.75	67	69.79
Underweight	28	17.5	20	20.83
Overweight	12	7.5	5	5.21
Obesity	2	1.25	4	4.17
Total	160	100.0	96	100.0

m² for University 3). The standard deviations are also similar, indicating a similarity in data variability between the universities. Based on these data, it can be concluded that the average BMI among students from the three universities is approximately the same, and there are no significant differences between them.

In this study, data on the average BMI value and standard deviation for women, grouped by years of study (courses) in 3 universities, were analyzed (Table 3). The table shows that the average BMI values vary depending on the year of study. The highest average BMI value is observed among master's degree students, which may be related to the dietary habits and lifestyle of senior students. The lowest average BMI value is found among third-year students. The standard deviation of BMI also varies between years of study, indicating variability in weight among students in each group.

In this study, data on the average BMI value and standard deviation for men, grouped by year of study (courses) in three universities, were analyzed. The analysis shows that the average BMI values vary depending on the year of study among men. For instance, third-year students have a higher average BMI compared to students from other years of study. It is also noteworthy that the standard deviation of BMI varies across different years of study, indicating variability in weight among men in each group.

The analysis of BMI distribution among women shows (Table 4) that the majority of participants have a normal weight (73.75%). 17.5% are underweight, and 7.5% fall into the overweight category. Signs of obesity are found in only 1.25% of women. These

data indicate that normal weight also predominates among women, but there is a proportion with low and excess weight, as well as obesity.

The analysis of BMI distribution among men in three universities shows (Table 4) that the majority of participants have a normal weight (69.79%). Overweight is observed in 20.83% of men. Low weight is noted in 5.21% of men, and signs of obesity are found in 4.17% of men. These data allow us to conclude that the majority of men have a normal weight, but there is also a proportion with overweight and signs of underweight or overweight.

Discussion

The aim of our study is to assess the BMI levels of students living in the conditions of a prolonged military conflict in Ukraine. It can be assumed that the extended duration (3 years and 6 months) of living in the conditions of the COVID-19 pandemic and the subsequent military conflict may have impacted the BMI of students. In this context, the obtained results allow us to assert the following. The majority of men have a normal weight, however, there is also a proportion with overweight and signs of underweight or overweight. Among women, normal weight also predominates, but there is a proportion with low and excessive weight, as well as obesity. The average BMI among students from the three universities is approximately the same, and there are no significant differences between them. Also, it can be assumed that the year of study may influence the BMI of students. However, to determine specific trends by year of study, a more detailed investigation is required.

The comparison of the obtained BMI results with previous studies and its correlation with gender, years of study, and universities suggests the following. The total number of participants in the study is important for identifying patterns of change in students' BMI depending on various factors.

In our study, 286 students participated, including 96 men and 160 women. Similar studies have involved varying numbers of participants. Overall, such studies can be presented as follows:

- Category 1 with a small number of participants: the range for men is 42-205 and for women - 59-720 [6, 13, 24, 25, 26].

- Category 2 with a medium number of participants: the range for men is 137-326 and for women - 167-540 [16, 27, 28].

- Category 3 with the largest number of participants: the range for men is 684-2040 and for women - 1254-2095 [14, 29].

From these data, it can be concluded that our study falls into category 2. Compared to studies in category 1, our study has a more balanced sample size and can provide more reliable results. Compared to studies in category 3, our study has a more limited number of participants, which may limit the overall representativeness of the results. Nevertheless, it still falls into the medium-sized category, and its results can be valuable for analysis and comparison in the context of studies with a similar number of participants.

Comparing the BMI results of Ukrainian students with students from other populations suggests the following. In our study, the following BMI results were obtained: 22.73 ± 4.03 kg/m² for men and 21.2 ± 3.18 kg/m² for women, as well as 21.78 ± 3.18 kg/m² for the overall group of students. These data are particularly important given the conditions of the military conflict in the eastern part of Ukraine, where two of the three universities are located (zone of active military operations). For 1.5 years, students lived and studied under the constant threat of shelling. Compared to data from other studies, the following BMI results can be noted:

- Students from Poland had an average BMI of 22.9 ± 2.6 kg/m² [16];

- Students from India and Saudi Arabia showed average BMIs of 22.75 ± 1.91 kg/m² [17];

- For Chinese students, the optimal BMI was 23.53 kg/m² for men and 23.41 kg/m² for women [15];

- Students from Turkey had an average BMI of 22.94 ± 3.30 kg/m² [30];

- The average BMI for Chinese students was 22.12 ± 2.39 kg/m² for men and 20.55 ± 2.21 kg/m² for women [31].

- For students from Chile, the average BMI was 28.13 ± 6.19 kg/m² for men and 27.25 ± 4.47 kg/m² for women [11].

Our results enrich this dataset by providing

comparative data on BMI among students, taking into account the peculiarities of their living in a war conflict zone. This allows for a deeper understanding of the impact of external factors on the physical condition of the youth.

In our study, the following results were obtained for BMI categories: 1) women: 73.75% - normal weight; 17.5% - underweight; 7.5% - overweight; 1.25% - obesity; 2) men: 69.79% - normal weight; 20.83% - overweight; 5.21% - underweight; 4.17% - obesity. Comparing these results with data from other studies, the following outcomes can be highlighted:

- Pakistan [6]: 28% of students were underweight, while 17.4% were overweight.

- Pakistan [32]: 21.4% of students were underweight, 15.1% - overweight.

- Saudi Arabia [7]: 26.4% of students were underweight, 22.1% - normal weight, 26.4% - obese, 25% - class III obesity.

- Egypt, Jordan [19]: 50.9% - 61.4% - characterized by moderately high fat content.

- USA [21]: 40% of college/university students are overweight/obese.

- South Africa [22]: 64.9% of students have normal weight.

- Ghana [20]: 31.7% of students were overweight, 21.7% - obese.

The analysis of BMI levels among students from countries with different living standards allows us to better understand how socioeconomic factors can impact the health of students in a war zone. Our results show that the BMI level among students from the conflict zone is close to the average value or even slightly higher. This may indicate that even under the conditions of military conflict, the BMI level in our group of students does not differ significantly from the BMI level of students from countries with more stable situations

These results may suggest that students from the war zone are paying attention to their health and maintaining a normal weight, despite the challenging conditions. However, to fully understand the impact of socioeconomic factors on BMI levels, further research and analysis of other aspects such as dietary behavior, physical activity, and access to healthcare will be required.

Conclusions

Based on the results of the study and considering the conditions of the military conflict and its impact on students' health, the following conclusions can be drawn:

It is important to encourage physical activity among students from the war zone. Organizing sports events and physical activities can help students maintain a normal weight and BMI.

It is evident that there is a need to educate students about healthy eating and providing access

to wholesome and balanced food products will help them control their weight and BMI level.

Considering the stressful conditions of the military conflict, it is important to provide psychological support to students to prevent potential disorders in eating behavior.

Recommendations

This study can serve as a starting point for further research in the field of health and lifestyle of students in conditions of military conflict.

Potential research directions include:

Conducting more long-term studies to more accurately identify the impact of military conflict on the health and lifestyle of students.

Exploring psychological factors affecting the eating behavior of students under stress.

Comparing results with students from other regions of Ukraine and the world to gain a more comprehensive understanding of student lifestyles in conflict conditions.

Further research can provide deeper insights and recommendations for improving the health of students and the general population in conditions of military conflict.

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