*Proceedings of 4th International Conference CNDCGS'2024*
ISSN 2669-2023 (print) / ISSN 2538-8959 (on-line) / DOI 10.3849/cndcgs.2024.649

# Statistical Analysis of Youth Physical Fitness as an Important Factor for the Defence of the Czech Republic

**Veronika LACINOVÁ[1*], Lucie HAMPELOVÁ[1], Marek SEDLAČÍK[1], Petr HANÁK[2]**

[1]*Department of Quantitative Methods, Faculty of Military Leadership, University of Defence, Kounicova 65, 66210, Brno, Czech Republic*
[2]*Physical Training and Sport Centre, Faculty of Military Leadership, University of Defence, Kounicova 65, 66210, Brno, Czech Republic*

*Correspondence:* [*]veronika.lacinova.@unob.cz

**Abstract**

Physical fitness is an important part of military service and significantly affects the successful performance of combat tasks. The aim of the study is to determine the current state of physical fitness of adolescents so that the recruitment and training system of the Czech Army is prepared for the expectations of future participants and can be updated and supplemented with new elements.

For this purpose, physical fitness testing of 1,135 (699 males and 436 females) Czech secondary school students aged 15-18 was carried out in the period 2021-2023. The testing was conducted in the area of strength and endurance disciplines in 16 different secondary schools. The percentage of total body fat in relation to body weight was measured as an indicator of the morphological component of physical fitness. Respondents were categorically rated according to their physical performance and the amount of total body fat. The age and gender of the respondent were considered. The method and form of assessment was designed in accordance with European standards.

The findings will be used to develop adequate recruitment conditions, including the content and limits of relevant tests, and to modernize the overall recruitment policy.

**KEY WORDS:** *fitness testing; body composition analysis; adolescents; statistical evaluation; recruitment of soldiers*

**Citation**: Lacinová, V., Hampelová L., Sedlačík, M., Hanák, P. Statistical Analysis of Youth Physical Fitness as an Important Factor for the Defence of the Czech Republic. In Proceedings of the Challenges to National Defence in Contemporary Geopolitical Situation, Brno, Czech Republic, 11-13 September 2024. ISSN 2538-8959. DOI 10.3849/cndcgs.2024.649

## 1. Introduction

The Army of the Czech Republic replenishes its ranks with adult citizens of the Czech Republic with appropriate education, skills, age and health. Post-entry training requires the use of methods and means that are adequate to the level of the entering soldiers and ensure at least a minimum level of their overall readiness.

The Czech Republic, like other European countries, faces the problem of declining physical fitness of youths not only in the context of the COVID-19 pandemic in 2020-2021 [1–4]. The Army must respond to this situation by adjusting its approach. In order to make this adjustment systemic and to respond to the current state of the population in society, the BODY project (Physical fitness of the population as a risk factor for ensuring defensive capacity of the Czech Republic) included, among other things, testing the physical fitness and body composition of adolescents as potential candidates for entry into the army. The aim of this study is to determine the level of physical fitness of youths and to assess their current status in strength and endurance disciplines. This knowledge can be used to prepare adequate recruitment conditions, including the content and limits of relevant tests, as well as to modernize overall recruitment policies.

© 2024 The Authors.

Peer-review under responsibility of General Jonas Žemaitis Miltitary Academy of Lithuania and University of Defence, Czech Republic

## 2. Data and methods

The Body project tested the physical fitness of 1,135 Czech secondary school students aged 15-18 years (699 males: of which 15 years old: 66, 16 years old: 204, 17 years old: 211, 18 years old: 218 and 436 females of which 15 years old: 24, 16 years old: 125, 17 years old: 162, 18 years old: 125) between 2021 and 2023. The data were collected in such a way that the sample was sufficiently representative of the target population. Fifteen civilian and one military secondary school were included in the project in a systematic way to cover all regions of the Czech Republic. Physical testing consisted of endurance (W170/kg test, 4x10 m shuttle run) and strength disciplines (long jump from a standing position with push-off, handgrip strength). The disciplines used were chosen to sufficiently characterize the level of basic movement abilities and to be easy to learn and objective [5]. The disciplines included in the testing are used, for example, in the Eurofit or Unifittest test batteries.

An important part of the fitness evaluation of the test subjects was the W170 endurance test, which determines the power (W) that the test subject is able to achieve at a heart rate of 170 beats/min. For interpersonal data comparisons, power was converted to kilograms of weight (W/kg). The test was performed on a Cycle Ops - Phantom 5 bicycle ergometer (USA). The subject pedalled for 13 min in varied load mode and their heart rate was monitored by a sensor placed on the chest. The heart rate dynamics are used to infer the level of endurance. The second endurance discipline measured was a 4x10m shuttle run, in which the subject runs repeatedly and as fast as possible through marked sections. Time achieved, speed of movement and agility are measured. Explosive leg strength and a certain level of agility was determined by a long jump from a standing position. The jump was performed 3 times and the best performance was counted. Using an electronic force meter Multi Myometer (manufactured by Medical Research Ltd), left- and right-handgrip strength was tested and the average grip was calculated. As an indicator of the morphological component of physical fitness, the percentage of total body fat in relation to weight was measured on a special body composition analyser TANITA - BC 601.

Respondents were categorically rated on their performance in each sport discipline, but also on the percentage of body fat. The age and gender of the respondent were taken into consideration. The categorization allows comparison of results between genders, different age groups and within years. In individual analyses, the numbers of categorized students do not always match completely due to mismeasurements or non-participation in a given test. The assessment was designed by the Physical Training and Sport Centre at the University of Defence, in accordance with European standards [6, 7] see Tables 1 and 2. Statistical analysis of the survey data was performed using IBM SPSS version 28 and Matlab software.

Consider a general table of size $r \times s$ and denote the marginal row and marginal column frequencies sequentially $n_{i.}, n_{.j}$. Pearson chi-square test was used to detect differences in scores between genders, but also between years. In addition, the Eta coefficient $\eta = \sqrt{\chi^2/n}$ was calculated, the square of which indicates the strength of the effect of gender or the period of observation on the scores obtained. Adjusted residuals

$$Res = \frac{n_{ij} - \frac{n_{i.}n_{.j}}{n}}{\sqrt{\frac{n_{i.}n_{.j}}{n}\left(1-\frac{n_{i.}}{n}\right)\left(1-\frac{n_{.j}}{n}\right)}} \; \forall i = 1, \dots, r, j = 1, \dots, s,$$

were calculated to get a better idea of which category contributed most to rejecting the hypothesis of equality of distribution. These show the differences between the expected and observed frequencies. The larger the absolute value of the adjusted residual, the more significant the difference. A negative sign indicates a decrease, a positive sign an increase in frequencies compared to the expected frequencies [8].

Individuals participated in this study voluntarily and signed an informed consent form if they were 18 years old. For the minors, the consent was signed by their legal representative. Respondents were also assured of the confidentiality of the information obtained.

Table 1.

Performance evaluation for discipline W170/kg

| C | Men 15–18 years | Men over 18 years | Women 15–18 years | Women over 18 years |
|---|---|---|---|---|
| 1 | < 1.96 | < 2.28 | < 1.3 | < 1.63 |
| 2 | [1.96,2.28) | [2.28,2.61) | [1.3,1.63) | [1.63,1.96) |
| 3 | [2.28,2.61) | [2.61,2.94) | [1.63,1.96) | [1.96,2.28) |
| 4 | [2.61,2.94) | [2.94,3.26) | [1.96,2.28) | [2.28,2.61) |
| 5 | ≥ 2.94 | ≥ 3.26 | ≥ 2.28 | ≥ 2.61 |

Legend: C 1-5 – Performance categories: 1 – poor; 2 – medium; 3 – good; 4 – very good; 5 – excellent

Table 2.

Performance evaluation of the handgrip strength, standing long jump, shuttle run and assessment of the morphological component of physical fitness through body fat %

| | | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C | 15 years | 16 years | 17 years | 18 years | 15 years | 16 years | 17 years | 18 years |
| Handgrip strength | 1 | < 28.1 | < 33.0 | < 37.4 | < 41.8 | < 20.7 | < 21.2 | < 22.2 | < 23.2 |
| | 2 | [28.1,32.5) | [33.0,37) | [37.4,40.9) | [41.8,44.7) | [20.7,23.2) | [21.2,23.6) | [22.2,24.6) | [23.2,25.5) |
| | 3 | [32.5,43.1) | [37,46.9) | [40.9,49.6) | [44.7,52.2) | [23.2,29.5) | [23.6,30) | [24.6,31.2) | [25.5,32.5) |
| | 4 | [43.1,47.9) | [46.9,51.5) | [49.6,53.7) | [52.2,55.9) | [29.5,32.6) | [30,33.2) | [31.2,34.8) | [32.5,36.4) |
| | 5 | ≥ 47.9 | ≥ 51.5 | ≥ 53.7 | ≥ 55.9 | ≥ 32.6 | ≥ 33.2 | ≥ 34.8 | ≥ 36.4 |
| Standing jump | 1 | < 151.9 | < 162.2 | < 169.4 | < 176.6 | < 111.6 | < 114.8 | < 118.6 | < 122.4 |
| | 2 | [151.9,170.1) | [162.2,180.6) | [169.4,189.1) | [176.6,197.6) | [111.6,127.2) | [114.8,130.1) | [118.6,133.5) | [122.4,136.9) |
| | 3 | [170.1,208.6) | [180.6,217.4) | [189.1,225.5) | [197.6,233.6) | [127.2,163) | [130.1,165) | [133.5,168) | [136.9,170.9) |
| | 4 | [208.6,224.4) | [217.4,231.8) | [225.5,239) | [233.6,246.2) | [163,179) | [165,180.4) | [168,183.4) | [170.9,186.4) |
| | 5 | ≥ 224.4 | ≥ 231.8 | ≥ 239 | ≥ 246.2 | ≥ 179 | ≥ 180.4 | ≥ 183.4 | ≥ 186.4 |
| Shuttle run | 1 | ≥ 12.7 | ≥ 12.3 | ≥ 12.4 | ≥ 12.5 | ≥ 14.4 | ≥ 14.2 | ≥ 14 | ≥ 13.8 |
| | 2 | [12,12.7) | [11.6,12.3) | [11.6,12.4) | [11.6,12.5) | [13.5,14.4) | [13.4,14.2) | [13.4,14) | [13.3,13.8) |
| | 3 | [10.7,12) | [10.4,11.6) | [10.3,11.6) | [10.3,11.6) | [12,13.5) | [11.9,13.4) | [12,13.4) | [12,13.3) |
| | 4 | [10.2,10.7) | [9.9,10.4) | [9.9,10.3) | [9.9,10.3) | [11.4,12) | [11.3,11.9) | [11.4,12) | [11.5,12) |
| | 5 | < 10.2 | < 9.9 | < 9.9 | < 9.9 | < 11.4 | < 11.3 | < 11.4 | < 11.5 |
| Body fat % | I | ≥ 25 | ≥ 24.3 | ≥ 23.9 | ≥ 23.6 | ≥ 33.8 | ≥ 34.1 | ≥ 34.4 | ≥ 34.8 |
| | II | [20.7,25) | [20.3,24.3) | [20.1,23.9) | [20.1,23.6) | [29.9,33.8) | [30.1,34.1) | [30.4,34.4) | [30.8,34.8) |
| | III | [10.4,20.7) | [10.1,20.3) | [9.8,20.1) | [9.6,20.1) | [15.7,29.9) | [15.5,30.1) | [15.1,30.4) | [14.7,30.8) |
| | IV | < 10.4 | < 10.1 | < 9.8 | < 9.6 | < 15.7 | < 15.5 | < 15.1 | < 14.7 |

Legend: C 1-5 – Performance categories: 1 – poor; 2 – medium; 3 – good; 4 – very good; 5 – excellent; C I-IV– Evaluation of body fat %: I – obese; II – overweight; III – normal; IV – undernourished

## 3. Results and discussion

Statistically significant differences in results between men and women were found in all sports disciplines (p-values<0.01), with women performing better in all sports disciplines in comparison to standards presented in Tables 1 and 2. Test results along with frequencies and values of adjusted residuals for performance categories 1-5 are presented in Table 3. Cases that were statistically significantly different from the expected frequencies using the Bonferroni correction, i.e. those that contributed most to rejecting the hypothesis of a matching distribution, are highlighted in green. For example, in the hand grip, males have a statistically significantly higher proportion of poor ratings (25.8%) compared to females (13.8%), and in the W170/kg performance test, males have a statistically significantly lower proportion of excellent ratings (30.7%) compared to females (41.5%).

The results of the physical performance assessment for both men and women for the years 2021-2023 are presented in Tables 4 and 5. Statistically significant differences were found in the handgrip strength and shuttle run during the study period. No statistically significant differences were found in the disciplines of standing long jump and W170/kg. In the hand grip, there was a statistically significant worsening in the results of both women ($\chi^2$=19.465, df=8, p-value=0.013) and men ($\chi^2$=33.873, df=8, p-value<0.001) over the three years. However, it was not as pronounced for women as for men. On the other hand, an improvement of the results during the period of conducting the study occurred in the discipline of the shuttle run. For men, a statistically significant increase in the proportion of excellent results and a decrease in the proportion of good results was found in 2023 ($\chi^2$=63.907, df=8, p-value<0.001). Women also improved in the shuttle run discipline, but due to the low frequencies in the medium and poor results categories, it was not possible to perform a Pearson chi-square test.

The frequencies of performance categorised for age and for each year of measurement are shown in Figure 1. Over the measurement period, both males and females in all age categories performed better in the W170/kg test than in the shuttle run. The sum of very good and excellent results exceeds 50% of all scores in the W170/kg stress test in most cases for all years and age categories. In the strength disciplines, both males and females achieved better results in the standing long jump than in the handgrip strength in all age categories.

Table 3.

Performance evaluation of the handgrip strength, standing long jump, shuttle run and W170/kg test by gender

| | | Handgrip strength $\chi^2$=29.21, df=4, p<0.001, Eta=0.161 | | | | | | Standing long jump $\chi^2$=23.24, df=4, p<0.001, Eta=0.149 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| Men | N | 180 | 89 | 259 | 87 | 83 | 698 | 22 | 41 | 231 | 133 | 203 | 630 |
| | % | 25.8 | 12.8 | 37.1 | 12.5 | 11.9 | 100 | 3.5 | 6.5 | 36.7 | 21.1 | 32.2 | 100 |
| | Res | 4.8 | - 1.0 | - 3.6 | - 0.8 | 1.4 | | 2.6 | 1.9 | 2.7 | - 2.9 | - 1.8 | |
| Women | N | 60 | 65 | 209 | 61 | 40 | 435 | 4 | 16 | 121 | 122 | 158 | 421 |
| | % | 13.8 | 14.9 | 48.0 | 14.0 | 9.2 | 100 | 1.0 | 3.8 | 28.7 | 29.0 | 37.5 | 100 |
| | Res | - 4.8 | 1.0 | 3.6 | 0.8 | - 1.4 | | - 2.6 | - 1.9 | - 2.7 | 2.9 | 1.8 | |
| Total | N | 240 | 154 | 468 | 148 | 123 | 1133 | 26 | 57 | 352 | 255 | 361 | 1051 |
| | % | 21.2 | 13.6 | 41.3 | 13.1 | 10.9 | 100 | 2.5 | 5.4 | 33.5 | 24.3 | 34.3 | 100 |
| | | Shuttle run $\chi^2$=58.231, df=4, p<0.001, Eta=0.235 | | | | | | W170/kg $\chi^2$=15.476, df=4, p=0.004, Eta=0.117 | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| Men | N | 37 | 76 | 371 | 92 | 57 | 633 | 77 | 101 | 141 | 161 | 213 | 693 |
| | % | 5.8 | 12.0 | 58.6 | 14.5 | 9.0 | 100 | 11.1 | 14.6 | 20.3 | 23.2 | 30.7 | 100 |
| | Res | 0.7 | 3.0 | 4.7 | - 3.7 | - 5.7 | | - 0.3 | 1.5 | 1.2 | 2.0 | - 3.7 | |
| Women | N | 20 | 27 | 183 | 98 | 90 | 418 | 50 | 49 | 75 | 78 | 179 | 431 |
| | % | 4.8 | 6.5 | 43.8 | 23.4 | 21.5 | 100 | 11.6 | 11.4 | 17.4 | 18.1 | 41.5 | 100 |
| | Res | - 0.7 | - 3.0 | - 4.7 | 3.7 | 5.7 | | 0.3 | - 1.5 | - 1.2 | - 2.0 | 3.7 | |
| Total | N | 57 | 103 | 554 | 190 | 147 | 1051 | 127 | 150 | 216 | 239 | 392 | 1124 |
| | % | 5.4 | 9.8 | 52.7 | 18.1 | 14.0 | 100 | 11.3 | 13.3 | 19.2 | 21.3 | 34.9 | 100 |

Legend: % – percentage representation; N – absolute (empirical) frequencies; Res – values of adjusted residuals; Performance categories: 1 – poor; 2 – medium; 3 – good; 4 – very good; 5 – excellent

Table 4.

Performance evaluation of the handgrip strength, standing long jump, shuttle run and W170/kg for men from 2021-2023

| | | Handgrip strength $\chi^2$=33.873, df=8, p<0.001, Eta=0.186 | | | | | | Standing long jump $\chi^2$=8.854, df=8, p=0.355, Eta=0.085 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| 2021 | N | 52 | 28 | 87 | 33 | 53 | 253 | 8 | 13 | 87 | 51 | 61 | 220 |
| | % | 20.6 | 11.1 | 34.4 | 13.0 | 20.9 | 100 | 3.6 | 5.9 | 39.5 | 23.2 | 27.7 | 100 |
| | Res | - 2.4 | - 1.0 | - 1.1 | 0.3 | 5.6 | | 0.1 | - 0.4 | 1.1 | 0.9 | - 1.8 | |
| 2022 | N | 68 | 31 | 95 | 29 | 15 | 238 | 11 | 15 | 72 | 39 | 68 | 205 |
| | % | 28.6 | 13.0 | 39.9 | 12.2 | 6.3 | 100 | 5.4 | 7.3 | 35.1 | 19.0 | 33.2 | 100 |
| | Res | 1.2 | 0.2 | 1.1 | - 0.2 | - 3.3 | | 1.8 | 0.6 | - 0.6 | - 0.9 | 0.4 | |
| 2023 | N | 60 | 30 | 77 | 25 | 15 | 207 | 3 | 13 | 72 | 43 | 74 | 205 |
| | % | 29.0 | 14.5 | 37.2 | 12.1 | 7.2 | 100 | 1.5 | 6.3 | 35.1 | 21.0 | 36.1 | 100 |
| | Res | 1.3 | 0.9 | 0.0 | - 0.2 | - 2.5 | | - 1.9 | - 0.1 | - 0.6 | - 0.1 | 1.4 | |
| Total | N | 180 | 89 | 259 | 87 | 83 | 698 | 22 | 41 | 231 | 133 | 203 | 630 |
| | % | 25.8 | 12.8 | 37.1 | 12.5 | 11.9 | 100 | 3.5 | 6.5 | 36.7 | 21.1 | 32.2 | 100 |
| | | Shuttle run $\chi^2$=63.907, df=8, p<0.001, Eta=0.297 | | | | | | W170/kg $\chi^2$=9.08, df=8, p=0.336, Eta=0.089 | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| 2021 | N | 14 | 26 | 159 | 20 | 2 | 221 | 31 | 27 | 50 | 54 | 85 | 247 |
| | % | 6.3 | 11.8 | 71.9 | 9.0 | 0.9 | 100 | 12.6 | 10.9 | 20.2 | 21.9 | 34.4 | 100 |
| | Res | 0.4 | - 0.1 | 5.0 | - 2.9 | - 5.2 | | 0.9 | - 2.0 | - 0.1 | - 0.6 | 1.6 | |
| 2022 | N | 18 | 27 | 109 | 35 | 16 | 205 | 28 | 38 | 46 | 62 | 64 | 238 |
| | % | 8.8 | 13.2 | 53.2 | 17.1 | 7.8 | 100 | 11.8 | 16.0 | 19.3 | 26.1 | 26.9 | 100 |
| | Res | 2.2 | 0.6 | - 1.9 | 1.3 | - 0.7 | | 0.4 | 0.8 | - 0.5 | 1.3 | - 1.6 | |
| 2023 | N | 5 | 23 | 103 | 37 | 39 | 207 | 18 | 36 | 45 | 45 | 64 | 208 |
| | % | 2.4 | 11.1 | 49.8 | 17.9 | 18.8 | 100 | 8.7 | 17.3 | 21.6 | 21.6 | 30.8 | 100 |
| | Res | - 2.6 | - 0.5 | - 3.2 | 1.7 | 6.0 | | - 1.3 | 1.3 | 0.6 | - 0.7 | 0.0 | |
| Total | N | 37 | 76 | 371 | 92 | 57 | 633 | 77 | 101 | 141 | 161 | 213 | 693 |
| | % | 5.8 | 12.0 | 58.6 | 14.5 | 9.0 | 100 | 11.1 | 14.6 | 20.3 | 23.2 | 30.7 | 100 |

Legend: % – percentage representation; N – absolute (empirical) frequencies; Res – values of adjusted residuals; Performance categories: 1 – poor; 2 – medium; 3 – good; 4 – very good; 5 – excellent

Table 5.

Performance evaluation of the handgrip strength, standing long jump, shuttle run and W170/kg for women from 2021-2023

| | | Handgrip strength $\chi^2$=19.465, df=8, p=0.013, Eta=0.2 | | | | | | Standing long jump | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| 2021 | N | 17 | 17 | 84 | 26 | 20 | 164 | 0 | 5 | 50 | 46 | 59 | 160 |
| | % | 10.4 | 10.4 | 51.2 | 15.9 | 12.2 | 100 | 0.0 | 3.1 | 31.3 | 28.8 | 36.9 | 100 |
| | Res | - 1.6 | - 2.1 | 1.0 | 0.9 | 1.7 | | - 1.6 | - 0.6 | 0.9 | - 0.1 | - 0.2 | |
| 2022 | N | 23 | 27 | 83 | 28 | 16 | 177 | 2 | 6 | 45 | 51 | 64 | 168 |
| | % | 13.0 | 15.3 | 46.9 | 15.8 | 9.0 | 100 | 1.2 | 3.6 | 26.8 | 30.4 | 38.1 | 100 |
| | Res | - 0.4 | 0.2 | - 0.4 | 0.9 | - 0.1 | | 0.4 | - 0.2 | - 0.7 | 0.5 | 0.2 | |
| 2023 | N | 20 | 21 | 42 | 7 | 4 | 94 | 2 | 5 | 26 | 25 | 35 | 93 |
| | % | 21.3 | 22.3 | 44.7 | 7.4 | 4.3 | 100 | 2.2 | 5.4 | 28.0 | 26.9 | 37.6 | 100 |
| | Res | 2.4 | 2.3 | - 0.7 | - 2.1 | - 1.9 | | 1.4 | 0.9 | - 0.2 | - 0.5 | 0.0 | |
| Total | N | 60 | 65 | 209 | 61 | 40 | 435 | 4 | 16 | 121 | 122 | 158 | 421 |
| | % | 13.8 | 14.9 | 48.0 | 14.0 | 9.2 | 100 | 1.0 | 3.8 | 28.7 | 29.0 | 37.5 | 100 |
| | | Shuttle run | | | | | | W170/kg $\chi^2$=8.762, df=8, p=0.363, Eta=0.09 | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| 2021 | N | 6 | 12 | 91 | 33 | 18 | 160 | 24 | 17 | 32 | 30 | 59 | 162 |
| | % | 3.8 | 7.5 | 56.9 | 20.6 | 11.3 | 100 | 14.8 | 10.5 | 19.8 | 18.5 | 36.4 | 100 |
| | Res | - 0.8 | 0.7 | 4.2 | - 1.1 | - 4.0 | | 1.6 | - 0.4 | 1.0 | 0.2 | - 1.7 | |
| 2022 | N | 11 | 11 | 55 | 49 | 42 | 168 | 13 | 23 | 31 | 32 | 77 | 176 |
| | % | 6.5 | 6.5 | 32.7 | 29.2 | 25.0 | 100 | 7.4 | 13.1 | 17.6 | 18.2 | 43.8 | 100 |
| | Res | 1.4 | 0.1 | - 3.7 | 2.3 | 1.4 | | - 2.3 | 0.9 | 0.1 | 0.0 | 0.8 | |
| 2023 | N | 3 | 4 | 37 | 16 | 30 | 90 | 13 | 9 | 12 | 16 | 43 | 93 |
| | % | 3.3 | 4.4 | 41.1 | 17.8 | 33.3 | 100 | 14.0 | 9.7 | 12.9 | 17.2 | 46.2 | 100 |
| | Res | - 0.7 | - 0.9 | - 0.6 | - 1.4 | 3.1 | | 0.8 | - 0.6 | - 1.3 | - 0.3 | 1.0 | |
| Total | N | 20 | 27 | 183 | 98 | 90 | 418 | 50 | 49 | 75 | 78 | 179 | 431 |
| | % | 4.8 | 6.5 | 43.8 | 23.4 | 21.5 | 100 | 11.6 | 11.4 | 17.4 | 18.1 | 41.5 | 100 |

Legend: % – percentage representation; N – absolute (empirical) frequencies; Res – values of adjusted residuals; Performance categories: 1 – poor; 2 – medium; 3 – good; 4 – very good; 5 – excellent

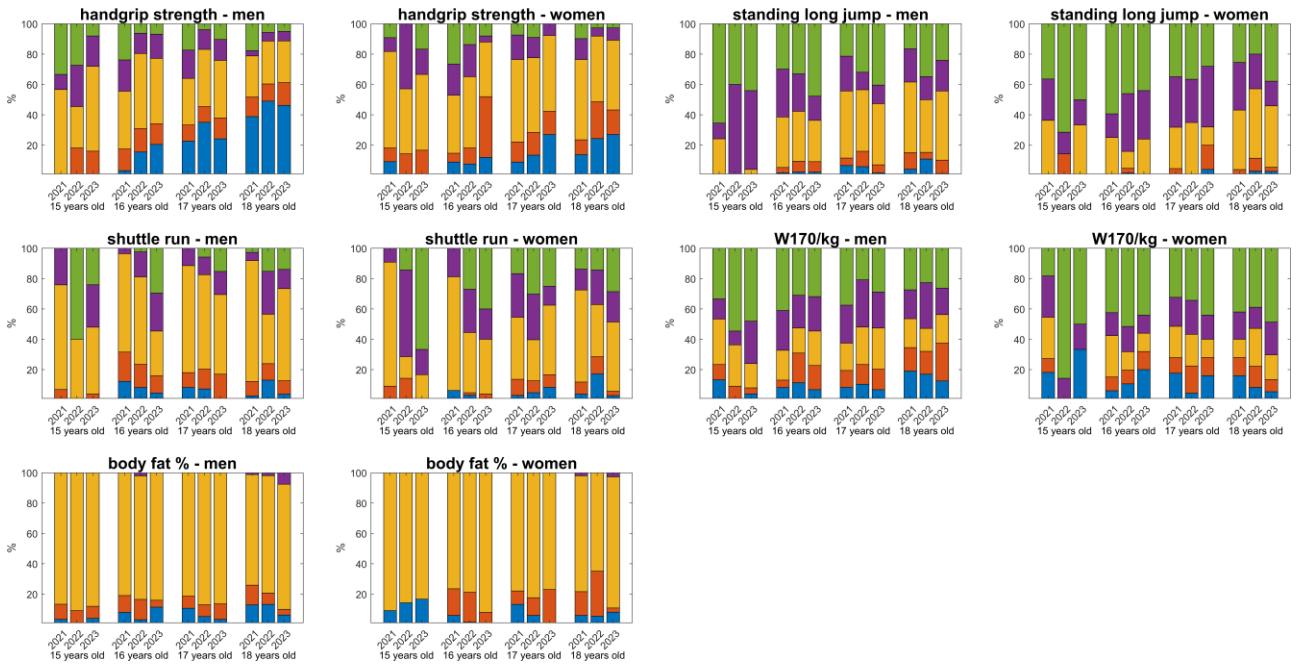


Fig. 1. Performance evaluation of the handgrip strength, standing long jump, shuttle run, W170/kg test and body fat % for men and women according to age categories. Performance categories: poor – blue, medium – red, good – yellow, very good – purple, excellent – green; Evaluation of body fat %: blue – obese; red – overweight; yellow – normal; purple – undernourished

Over the three-year period, there were no statistically significant differences in the percentage of subcutaneous fat in either men or women. Nevertheless, it can be concluded that there was an improvement in the results over the follow-up period. In 2021, 9.9% of men and 9.1% of women were obese, while in 2023, only 6.3% of men and 4.3% of women were obese. A Pearson chi-square test at the 0.05 significance level showed a statistically significant difference in body fat percentage scores between the gender (p-value=0.03). The largest difference was found in the category of overweight students. Body fat measurements showed that 6.2% of females and 7.4% of males of all tested over the three years were obese and a total of 14% of females and 9.2% of males were overweight. The frequencies for categories I-IV together with the result of the Pearson chi-square test are shown in Table 6.

Table 6.
Evaluation of the amount of body fat in relation to weight

| | | Body fat % $\chi^2$=8.925, df=3, p<0.03, Eta=0.089 | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | Total |
| Men | N | 52 | 64 | 573 | 10 | 699 |
| | % | 7.4 | 9.2 | 82.0 | 1.4 | 100 |
| | Res | 0.8 | - 2.5 | 1.1 | 1.6 | |
| Women | N | 27 | 61 | 346 | 2 | 436 |
| | % | 6.2 | 14.0 | 79.4 | 0.5 | 100 |
| | Res | - 0.8 | 2.5 | - 1.1 | - 1.6 | |
| Total | N | 79 | 125 | 919 | 12 | 1135 |
| | % | 7.0 | 11.0 | 81.0 | 1.1 | 100 |

Legend: % – percentage representation; N – absolute (empirical) frequencies; Res – values of adjusted residuals; Evaluation of body fat %: I – obese; II – overweight; III – normal; IV – undernourished

**Conclusions**

Motivated, competent, well-trained and therefore qualified military personnel are essential to the success of any army. Therefore, for planning and management of training it is necessary to have information about the physical condition of selected target groups from among the citizens of the Czech Republic. In accordance with European standards, the Physical Training and Sport Centre of the University of Defence designed an assessment of the physical fitness of youth (handgrip strength test, standing long jump from a standing position with a push-off, W170/kg stress test and 4x10 m shuttle run) and body composition (amount of body fat in the body). Subsequently, an assessment of physical performance and body fat mass, respectively, was performed.

The best results were achieved in the W170 test and in the standing long jump. Performance in these two disciplines did not change significantly over the time period. Statistically significant differences in performance were found over the three years in the handgrip strength and shuttle run disciplines. Improvements in performance over the time period were observed in both the men's and women's shuttle run disciplines. In the hand grip, on the other hand, there was a deterioration of results for both women and men, but the deterioration was not as pronounced for women as for men.

Significant differences in scores between genders were found in all tested sports disciplines. In all sports disciplines, females performed better than males. A total of 53.5% of females and 41.9% of males met the required standards in all sports disciplines tested. In addition, if the percentage of body fat is considered as an indicator of the morphological component of physical fitness, 43.9% of women and 37.3% of men meet the requirements. The measurements showed that most of the respondents have fat percentages within the norm. A total of 6.2% of the women and 7.4% of the men tested over the three years were obese and a total of 14% of the women and 9.2% of the men were overweight. The proportion of adolescents who are overweight or obese decreased during the period.

The analysis of the current state of physical fitness of secondary school students will allow to direct the process of recruitment and training of personnel in the resort of the Ministry of Defence. The findings can be used in the preparation of future military professionals prepared in all educational institutions of the Czech Armed Forces, but also in the educational process of the population.

**Limitations**

It is important to note that these data have methodological limitations. Respondents completed other measurements as part of the BODY project, including questionnaire surveys, so fatigue from these parts of the project may have played a role in the physical testing results. It should also be noted that some events, particularly the long jump from a standing position or shuttle run, require professional supervision and training. If students have not encountered this discipline before, they may perform significantly worse and vice versa.

**Acknowledgements**

This study was supported by the Ministry of Defence of the Czech Republic, the programme: Development of the Armed Forces of the Czech Republic, main objective: Personnel Preparation (project OYUOB20200001, 2021).

**References**

1. **Geets Kesic M., Gilic B., Cerkez Zovko I., Drid P., Korovljev D., Sekulic D.** Differential impact of COVID-19 lockdown on physical activity in younger and older adolescents – prospective study, Med Pr 72 (2021) 633–643. https://doi.org/10.13075/mp.5893.01180.
2. **Chambonniere C., Lambert C., Fearnbach N., Tardieu M., Fillon A., Genin P., Larras B., Melsens P., Bois J., Pereira B., Tremblay A., Thivel D., Duclos M.** Effect of the COVID-19 lockdown on physical activity and sedentary behaviors in French children and adolescents: New results from the ONAPS national survey, European Journal of Integrative Medicine 43 (2021) 101308. https://doi.org/10.1016/j.eujim.2021.101308.
3. **Sunda M., Gilic B., Peric I., Jurcev Savicevic A., Sekulic D.** Evidencing the Influence of the COVID-19 Pandemic and Imposed Lockdown Measures on Fitness Status in Adolescents: A Preliminary Report, Healthcare 9 (2021) 681. https://doi.org/10.3390/healthcare9060681.
4. **Pysna J.** Physical Activity and BMI before and after the Situation Caused by COVID-19 in Upper Primary School Pupils in Czech Republic, (2021).
5. **Kellner P., Neubauer J., Kellnerová Z., Zahradníček P., Novotný V., Wawrzacz L., Punčochář M.** The reasoning behind assessing push-up tests – an in depth analysis, Journal of Physical Education and Sport 23 (2023) 1706–1713. ISSN 2247-8051. doi:10.7752/jpes.2023.07209.
6. **Kolimechkov S., Petrov L., Alexandrova A.** Alpha-Fit Test Battery Norms for Children and Adolescents from 5 to 18 years of Age Obtained by a Linear Interpolation of Existing European Physical Fitness References, (2019). https://doi.org/10.5281/ZENODO.2546360.
7. **McCarthy H.D., Cole T.J., Fry T., Jebb S.A., Prentice A.M.** Body fat reference curves for children, Int J Obes 30 (2006) 598–602. https://doi.org/10.1038/sj.ijo.0803232.
8. **Agresti A.** Categorical data analysis. (Vol. 792). John Wiley & Sons.

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of CNDCGS 2024 and/or the editor(s). CNDCGS 2024 and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.