# Longitudinal Assessment of Physical Fitness of Students from the University of Defence in the Czech Republic

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## *ABSTRACT*

**Objectives**: Cardiorespiratory fitness demands are placed on students of all military schools. The bachelor's study programmes usually include subjects which requires the high level of physical fitness. The study aims to give a comprehensive account of the level of physical fitness of a selected military school.

**Design**: Comparing of results of the physical activity tests were used in this study.

**Methods**: The sample consisted of bachelor´s students of University of Defence between the academic year 2008/2009 and 2015/2016. Testing took place in the second year of each proband´s study, i.e. different students were tested each year. The total number of participated students in our study depends on academic year and number of tested students (men from 102 to 111; women from 76 to 84 through years). A male group (the sum of all male probands during the testing years) (mean ± SD: 19.91 ± 0.29 years, 182.8 ± 7.2 cm, 82.9 ± 10.9 kg) performed all physical activity tests (12 min running, push-ups, sit-ups, pull-up on the crossbar, running the 100 m and throwing a hand grenade). A women group (the sum of all female probands during the testing years) (mean ± SD: 19.36 ± 1.23 years, 171.8 ± 7.2 cm, 66.9 ± 8.7 kg) performed physical activity tests (12 min running, sit-ups, running the 100 m and throwing a hand grenade).

**Results**: It has been found that study programme which includes physical activity subjects (> 7 hours per week) is highly effective because we did not observe statistical significance decrease of values in selected physical tests.

**Conclusions**: Summing up the results, it can be concluded good physical readiness and preparation for military duty in students of University of Defence in Czech Republic.

**Keywords:** Aerobic Exercise, Cardiorespiratory fitness, Exercise Testing, Physical Activity, Military Education

## INTRODUCTION

It is broadly accepted that soldiers require a high level of overall physical fitness, to be able to complete demanding tasks both near and on the battlefield. The tasks such as carrying heavy backpacks on a long distance place a great demand on endurance capacity, in contrast short and more intensive activities such as sprints on the battlefield and traversing obstacles require a high level of speed, strength and agility. The manner in which soldiers perform those tasks may affect their effectiveness and survivability on the battlefield. Thus, there should be considerable focus on developing the most effective training program to prepare soldiers for action (Harman et al., 2008). Endurance, strength, mobility and flexibility are considered as key measurable fitness components for soldiers (Heinrich, Spencer, Fehl, & Carlos Poston, 2012).

Low physical fitness level is associated with increased prevalence of musculoskeletal injury among military recruits (Molloy, Feltwell, Scott, & Niebuhr, 2012). Musculoskeletal injury can be a burden for a military healthcare system and may result in decreased productivity of military recruits. Training related musculoskeletal injuries are the major reason for disability, long-term rehabilitation, functional impairment and early release from military service (Hua, Chen, Wan, Lu, & Xiong, 2018).

Not only fitness level, but even low BMI can be a risk factor for musculoskeletal injury. Low BMI could be an indicator of a lesser amount of muscle mass or bone mass, and underweight recruits may struggle with tasks requiring a high amount of strength (e.g. load bearing) (Blacker, Wilkinson, Bilzon, & Rayson, 2008). On the other hand, a high BMI index can be a result of accumulation of excess body fat. According to World health Organization (WHO) data from 2016, 39 % (1,9 billion) of adults aged 18 years and over were overweight and 13 % (650 million) obese (World Health Organization, 2020).

Obesity is also a growing concern in the military, survey estimates from 2015 have shown that 65.7 % of US military personnel are currently classified as overweight or obese (Meadows et al., 2018). The authors Omar, Leong, & Moy (2020) provided us with a systematic review in which they discussed the trend and prevalence of obesity among the military population in different states. The general trend between the analyzed studies was the increased prevalence of people who were overweight (30 %–50 %) and obese (2 %–30 %). Among males, the Czech Army had the highest prevalence of overweight with 57.1 % (in 2009); alternatively, the Greek Army recorded the lowest prevalence of overweight 26.6 % (in 1998), in the case of female there tended to be a lower prevalence of overweight with a maximum of 41 % in US Army and a minimum of 11,1 % in UK and Germany Army. The prevalence of obesity was recorded to be highest (18,9 %) in active duty personnel in the US in 2009, while the lowest prevalence of obesity (4,9 %) was observed in the Royal Thai Army in 2004 (Omar et al., 2020).

Although it is important to notice that BMI as a screening measure has a low specificity to distinguish between fat free mass and fat mass, hence a muscular person can be classified as overweight in spite of carrying a low amount of fat mass. This limitation of BMI measurement could be partly reversed by a concurrent measurement of a waist and hip circumference, those could be more accurate measurements of adiposity (Shams-White, Chui, Deuster, McKeown, & Must, 2020).

There are many approaches in testing overall fitness of military recruits, for example Leyk, Rohde, Gorges, Rüther, & Witzki (2017) in their study conducted on German military soldiers used The basic fitness test which measures parameters from three dimensions – endurance (1000m run), speed/ agility (110m shuttle run) and upper body strength (flexed arm hang in chin-up position). Another research team (Santtila, Pihlainen, Koski, & Kyröläinen, 2017) collected data from Finnish male conscripts and female recruits during the first week of their military service during 1975–2015. Measured data included for example mean body mass, aerobic capacity, mean distance of 12-minute running test and the standing long jump test (Santtila et al., 2017).

K. R. Kelly & J. T. Jameson conducted research with a goal to develop a physical performance and body composition profile of female active-duty marines (Kelly & Jameson, 2016). For this purpose, authors of the study used tasks including for example lifting a machine gun from the ground to overhead, pull ups, clean and press, crunches, 4,8 km (3 mile) run. Body composition was assessed by height and weight measurement, BMI, percent body fat and fat free mass was calculated for each individual (Kelly & Jameson, 2016).

Performance in the military fitness test or in the combat fitness test can be affected by many variables, for example cardiovascular warm-ups, dynamic stretching and dynamic warm-ups have positive outcomes for performance in chosen exercise tests, when static stretching was reported to have no beneficial or detrimental effect on performance (Zeno et al., 2013).

Armies of different states use various fitness tests as a part of recruiting new army members. For example, British Army new fitness test consists of the 2km run (after 800m warm-up), the 4kg medicine ball throw from seated position and the mid-thigh pull ('Home - British Army Jobs', n.d.). The new physical fitness standards for British army are now called "Physical Employment Standards", are role-related and no longer gender or age specific. Physical fitness assessment in British Army is now known as "Soldier conditioning review" and includes these tests – horizontal jump, med ball throw, deadlift, shuttle sprints, pull-ups and 2 km run (Coupe, 2019). IN 2020 US Army replaced Army physical fitness test with new standards of Army Combat Fitness. The test consists of six events that assess the ability to perform physical tasks army members may encounter during combat – strength deadlift, standing power throw, hand-release push ups, sprint/drag/carry, leg tuck, two-mile run. The minimum requirements for the above-mentioned tests vary by job or unit (Militaryonesource, 2020).

The New Zealand Defence Force is assessing fitness standards of their members once or twice per year, the Service fitness test differ between the Navy, Army and Air force and include Multi-Stage Fitness Test (beep test), simulated body drag, equipment carry and swim test (NAVY); 2,4 km run, press ups, curl ups (ARMY); 5 km weighted march, push-ups (AIR FORCE) (New Zealand Defence Force, 2020).

Spanish Army reviewed the Annual Fitness Test in 2009, and it resulted in a new evaluation system with four obligatory events. The event consists of two strength tests (sit-ups, push-ups), one endurance test (6 km run) and speed-agility test including zigzag circuit among cones ('Boletín Tierra' Newspaper Reports, 2012).

The German Army assesses the physical fitness of their soldiers through Basis Fitness Test. The test components are 11 × 10 m sprint, pull-up hang (chin over the bar in pull up position), 1 km run (Bundeswehr, 2020).

The main aim of the study was to assess physical fitness of students from University of Defence.

## METHODS

### *Participants*

The sample consisted bachelor´s students of University of Defence. The total number of participated students in our study depends of academic year and number of tested students (men from 102 to 111; women from 76 to 84). Different group of students was tested during each year. A male group (mean ± SD: 19.91 ± 0.29 years, 182.8 ± 7.2 cm, 82.9 ± 10.9 kg) performed all physical activity tests (12 min running, push-ups, sit-ups, pull-up on the crossbar, running the 100 m and throwing a hand grenade). Due to a physiological differences between the genders a women group (mean ± SD: 19.36 ± 1.23 years, 171.8 ± 7.2 cm, 66.9 ± 8.7 kg) performed physical activity tests (12 min running, sit-ups, running the 100 m and throwing a hand grenade).

### *Physical Activity Assessment*

The physical fitness test was explained to all participants, and they were asked to sign a written informed consent. The study was approved by ethics committee University of Defence. All participants were included to the study if they have preparticipation examination proved by the sports medicine physician (necessary condition for studying at University of Defence and Faculty of Sport Study). Field tests were used to assess the physical fitness. Tests were conducted during autumn semester, on the same athletic stadium.

#### *A. 12 min running*

Each participant was asked for run as far as possible within 12 minutes. Test was conducted on 400 m athletic track with clearly marked distance. The distance of the participants was covered to the nearest 10 meters.

#### *B. Push-Ups*

Assessing of the upper body fitness was recorded via push-up test. The researcher instructed each participant about the content of the test. The initial position was set up and controlled by researcher (push-up position with fully extended elbow and knees off the ground). Subsequently, the participant was asked to go to 90° elbows flexed position with maintaining a straight trunk position. The total number of correct push-ups in one minute was recorded.

#### *C. Sit-Ups*

Assessing of the muscle endurance of the abdominal muscle via one-minute sit-ups test body. The starting position was precisely controlled by the researcher. The test started from sitting position with bent knees, the feet must be on the floor and the upper extremity crossed the chest. Subsequently, the test started from up position and the participant went to the position when the shoulder blades touched the floor. The total number of sit- ups in one minute was recorded.

#### *D. Pull-up On The Crossbar*

Assessing of the upper body fitness was recorded via pull-up on the crossbar test. The initial position was precisely controlled by the researcher. The researcher decided to use the wide technique. Subsequently, the participant grabs the bar with palms anteriorly and hands were on the lateral side of the bar. The participant´s arms were fully extended at the beginning of the test. Then, then

the participants started pulling upward to bring his chin over the bar. After this, he/she was going to the initial position of the test while maintaining full-body tension. The participant was asked to go to 90° elbows flexed position with maintaining a straight trunk position. The total number of correct pull-ups on the crossbar was recorded.

***E. Running the 100m***

The automatic timing system, dual-beamed photocells and laser guns were used to measure the exact time of a 100m performance. The testing took place on the athletic stadium. Each participant sets up the starting blocks according his/her preference. Also, the angle of the block pedals was set up according by each preference of the participant. Participants were instructed to run as fast as possible. The run started on the ….mark (doplnit)

***F. Throwing a hand grenade***

The distance of the test was covered to the nearest 5 cm. Each participant was asked to throw a hand grenade as far as possible from the standing position. The weight of the hand grenade was 283.49 grams. The longest attempt was recorded (each participant had three attempts).

### *Statistical Analysis*

All analyses were conducted using version 12 of the STATISTICA software package (Statsoft Inc, Tulsa, Oklahoma, USA). Descriptive data are summarized as mean ± standard deviation (SD). A comparison between groups in the selected academic years were analyzed. Statistical significance was set at $p \leq 0.05$, and all data are expressed as mean ± SD. Analysis of variance were used to prove the statistical significance between the different student groups in individual years.

## RESULTS

The overall measurement results are summarized in Table I and II

**Table1.** The average values of physical fitness in years in group of men bachelor studies

| Academic year | 12 min Running (m) | Push-Ups (n) | Sit-Ups (n) | Pull-up On The Crossbar (n) | Running the 100m (seconds) | Throwing a hand grenade (m) |
|---|---|---|---|---|---|---|
| **2008–2009** (n = 102) | 2841.54 ± 176,88 | 33.41 ± 4.36 | 53.94 ± 6.19 | 10.93 ± 2.87 | 13.98 ± 1.17 | 45.34 ± 7.24 |
| **2009–2010** (n = 108) | 2822.83 ± 297.97 | 32.95 ± 4.34 | 54.17 ± 5.86 | 11.95 ± 4.18 | 14.17 ± 1.03 | 48.51 ± 5.45 |
| **2010–2011** ( n= 108) | 2839.50 ± 189.65 | 33.59 ± 4.51 | 55.25 ± 5.58 | 12.42 ± 4.28 | 14.10 ± 1.11 | 46.43 ± 4.45 |
| **2011–2012** ( n= 107) | 2836.56 ± 193.43 | 33.93 ± 3.67 | 55.87 ± 4.99 | 11.92 ± 3.42 | 13.87 ± 1.24 | 47.15 ± 4.01 |
| **2012–2013** ( n= 104) | 2810.37 ± 154.68 | 35.57 ± 5.28 | 55.77 ± 5.58 | 12.77 ± 3.64 | 13.73 ± 1.10 | 45.32 ± 5.09 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2013–2014** ( n= 111) | 2853.29 ± 187.19 | 33.39 ± 4.62 | 54.85 ± 4.92 | 11.25 ± 3.59 | 13.56 ± 1.02 | 46.41 ± 5.11 |
| **2014–2015** ( n= 109) | 2854.35 ± 183.05 | 33.08 ± 4.65 | 55.14 ± 4.95 | 13.14 ± 3.91 | 13.51 ± 1.09 | 47.12 ± 4.99 |
| **2015–2016** ( n= 108) | 2878.20 ± 166. 12 | 32.44 ± 3.90 | 55.25 ± 5.09 | 12.54 ± 2.11 | 13.59 ± 1.07 | 47.48 ± 5.03 |
| **p-value** | NS (0.1633) | **0.0004*** | **0.0404*** | **0.0010*** | **0.0116*** | NS (0.1255) |

*p < 0.05; NS: not statistically significant

**Table 2.** The average values of physical fitness in years in group of women´s bachelor studies

| Academic year | 12 min Running (m) | Sit-Ups (n) | Running the 100m (seconds) | Throwing a hand grenade (m) |
|---|---|---|---|---|
| **2008–2009** (n = 84) | 2426.90 ± 156.49 | 52.20 ± 5.36 | 16.01 ± 1.02 | 29.30 ± 6.55 |
| **2009–2010** (n = 83) | 2462.47 ± 180.69 | 52.19 ± 5.35 | 16.22 ± 1.13 | 29.03 ± 7.21 |
| **2010–2011** (n = 78) | 2448.14 ± 178.94 | 52.07 ± 3.95 | 16.04 ± 1.06 | 29.70 ± 4.45 |
| **2011–2012** (n = 75) | 2522.00 ± 190.66 | 53.77 ± 2.63 | 16.18 ± 1.24 | 29.71 ± 5.92 |
| **2012–2013** (n = 76) | 2533.19 ± 156.08 | 51.23 ± 3.87 | 16.13 ± 1.21 | 28.59 ± 6.17 |
| **2013–2014** (n = 76) | 2414.06 ± 118.76 | 53.72 ± 6.06 | 16.38 ± 0.54 | 27.43 ± 5.11 |
| **2014–2015** (n = 78) | 2502.63 ± 149.10 | 48.20 ± 4.31 | 16.12 ± 0.82 | 28.12 ± 5.69 |
| **2015–2016** (n = 81) | 2515.54 ± 190.44 | 54.66 ± 5.03 | 15.74 ± 0.72 | 27.56 ± 5.13 |
| **p-value** | **0.0466*** | NS (0.4123) | **0.0116*** | NS (0.8405) |

*p < 0.05; NS: not statistically significant

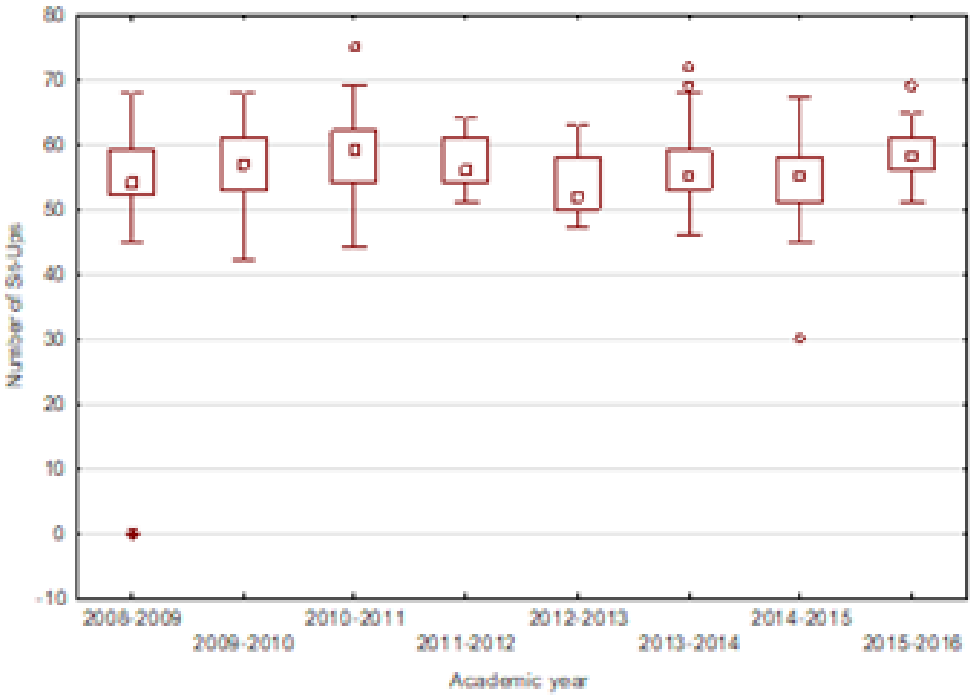


**Figure 1** The values of Sit-Ups in years in group of men bachelor studies

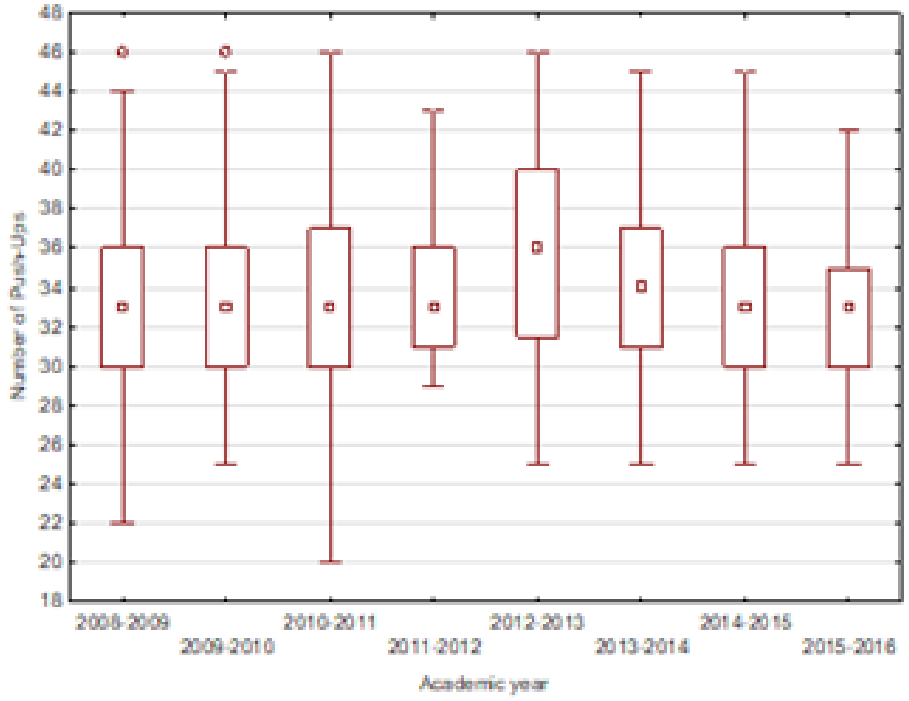


**Figure 2** The values of Push-Ups in years in group of men bachelor studies

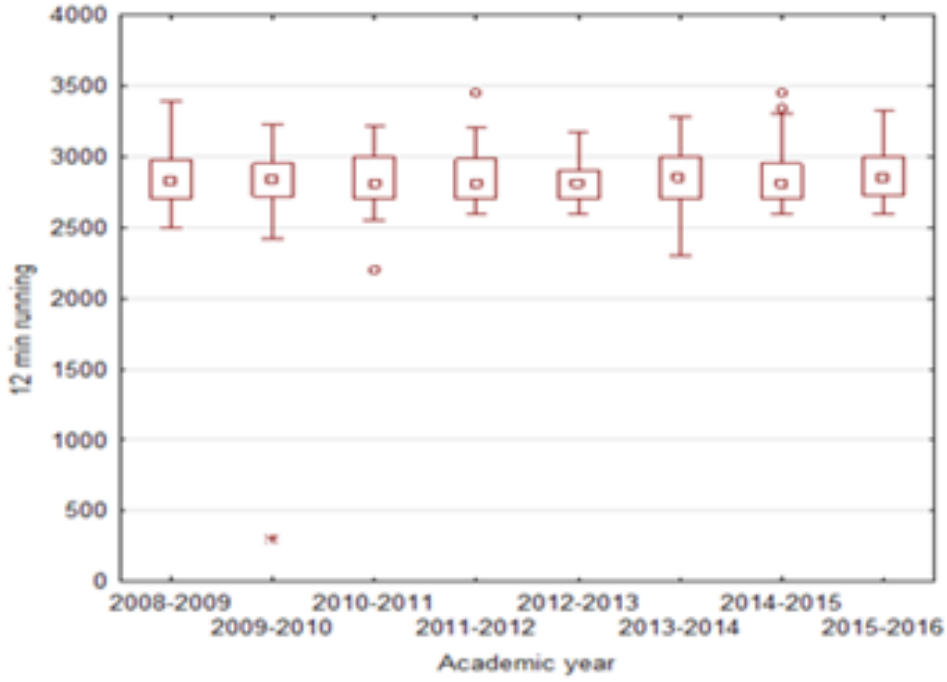


**Figure 3** The values of 12 min running in years in group of men bachelor studies

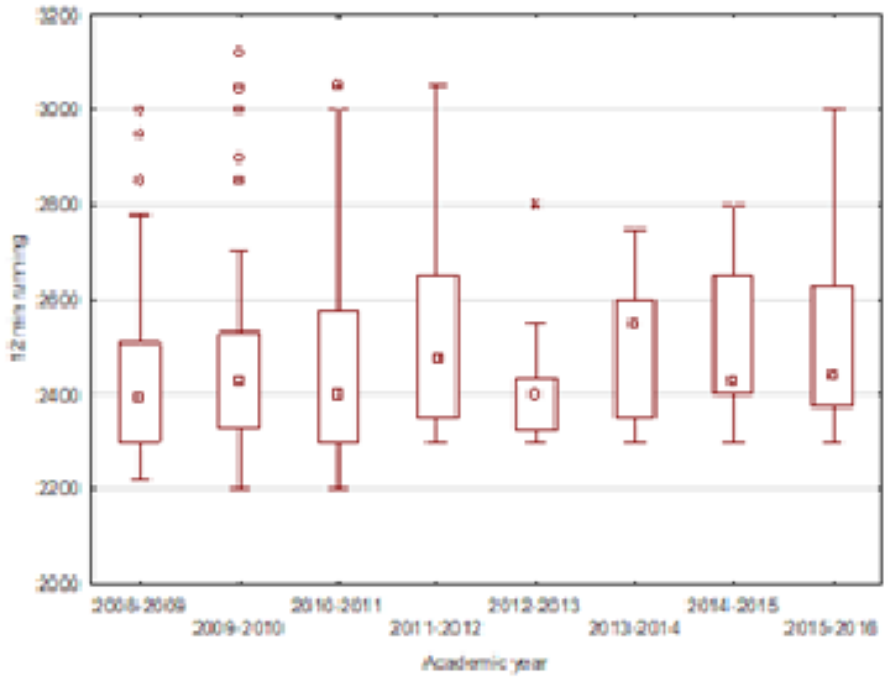


**Figure 4** The values of 12 min running in years in group of women bachelor studies

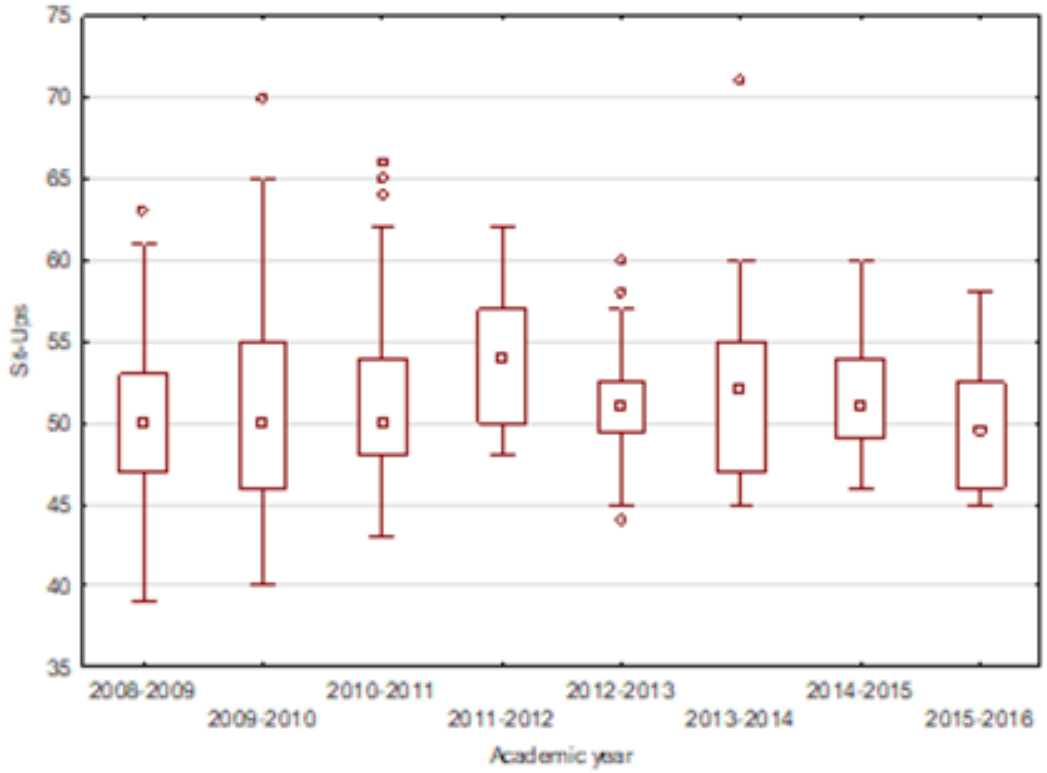


**Figure 5** The values of sit-ups in group of women bachelor studies

## DISCUSSION

The purpose of this study was to assess the physical fitness of a student from the University of Defence. Table 1. and Table 2. present mean results from chosen fitness test every student at University of Defence must undergo during the study. Low physical fitness often accompanied by obesity is a growing problem worldwide (WHO, 2020a). Furthermore, the WHO reported that 1 in 3 women and 1 in 4 men exercise not do enough physical activity to stay healthy (WHO, 2020b). Ultimately, these changes pose challenges for the army force to recruit physically capable soldiers (Kyröläinen, Pihlainen, Vaara, Ojanen & Santtila, 2018). In the literature there exists a general trend of lack of physical fitness as seen in other (eg, long jump from spot, 100m run, 12-minute running test) (Fotynyuk, 2017; Santtila et al., 2017). Although some studies do not fully support this (for example, trend in increasing muscle strength among US recruits between 1975–2013) (Knapik, Sharp, & Steelman, 2017).

The population of students at the University of Defence consists of both men and women. Tables 1 and Table 2 represent the average values of physical fitness of male and female students in bachelor´s studies throughout the years 2008-2016. In men, as well as in women, there is not present trend in declining level of physical fitness.

Therefore, the results of our study are not in agreement with general findings on reducing physical fitness. In contrast, there could be a trend in an increasing physical fitness in students from the

University of Defence between 2008-2016. However, there is a fluctuation in results in individual disciplines, which makes it difficult to clearly interpret the conclusion (Figure 1 -to Figure 5). The percentage changes in the distance covered in 12-minute run test between years 2008-2009 vs 2012–2013 and 2012–2013 vs 2015–2016 are –1,10 %, + 2,36 % and +4,2 %, -0,72 % for men and women, respectively. In case of number of sit-ups, the % changes between above mentioned years are +3,39%, -0,90% and –1,89%, +6,70% for men and women respectively. Performance changes in 100m run between the previously mentioned years were +1,82 %, +1,12 % and –0,74 %, +2,48% for men and women respectively.

When comparing 8-year average results from men and women, men generally performed better in disciplines common to both sexes. These results are not surprising as sex has been identified as a major determinant of athletic performance through the impact of many aspects (e.g. height, muscle mass, hormonal milieu, genetic difference) (Thibault et al., 2010). Although, as seen in the case of sit ups, the gap between performance of different genders can be minimal (8-year average number of sit up 55,03 and 52,26 for men and women, respectively.

In case of general weakening of physical performance, for example, Santilla et al. (2017) reported a decrease in aerobic capacity in male conscripts by 12.2 % from 1980 to 2015, our assessment of aerobic fitness, which was a 12-minute run, did not point to the same trend of decreasing aerobic capacity (Figure 3 and Figure 4 for men and women, respectively). It is necessary to mention that our analysis depicts the situation through 8 years, it is possible that because of analysing shorter time period there was no direct decrease in performance as mentioned in the work of the authors Santtila et al. (2017). Pihlainen et al. (2020) conducted the research with a goal to find out how 6–12 months (average time of the military service was 36 weeks) of military service influences the baseline fitness characteristics. For example, baseline 12- min run mean distance covered was 2461 m, after the end of the service this mean covered distance increased by 107 m. When compared to mean distance covered by students in our analyses (8 years average 2848,38 m), these numbers are still lower, indicating that aerobic capacity of students from University of Defence is slightly better, it must be mentioned that Pihlainen et al. (2020) analysed much bigger sample of participants (218 810 vs. 631 in our study). In terms of average population results in 12-min run test (also known as Cooper test) there exist many tables to help interpret the results. The original table pairing performance with fitness level in Cooper´s paper describes that covering distance of 1,75 miles (2,82 Km) or more is characterised as excellent fitness level (Cooper, 1968). It could be concluded from our results that through 8 years every year mean distance covered points to excellent average fitness level of participants from our study.

In case of sit-ups and push-ups both with time limit of 1 minute, conscripts after their military service improved mean number of repetitions to 40,8 (± 8,4) and 37 (± 10) for sit-ups and push-ups respectively (Pihlainen et al., 2020). If we compare these number of repetitions with numbers from our participants (mean 8 years average 33,54 push-ups, 55,03 sit-ups), the mean number of repetitions in push-ups is slightly higher and mean number of repetitions in sit-ups is perceptibly lower. Sit-ups and push-ups were used concomitantly with other measurements in study conducted by Dawes et al. (2017) on state troopers. Authors collected data as part of the agency's normal yearly fitness assessment. The mean numbers of repetition obtained by male officers in push-ups

and sit-ups test were 39.09 (± 15.61) and 34.46 (± 10.29) respectively, which implies that male officers performed better in push-ups and worse in sit-ups test when compared with students from University of Defence.

Pull-up test provide information about upper body-pulling strength. Lockie et al. (2018) used pull-ups test as a part of their physical fitness assessing battery of test on law enforcements recruits, their mean repetition number 13.86 (± 6.70) was slightly higher than mean number of repetitions achieved by participants in our study (8-year average 12,12 repetition). On the other side our participants achieved higher number of repetitions in pull-ups than members of Slovenian Armed Forces included in study from authors Šimenko et al. (2020). In this study mean repetition number achieved by participants in pull-ups was 5, authors reported that these data confirm their assumption about weakness in muscle groups involved in this movement and recommend that physical condition programs should focus on strengthening these lagging muscle groups (Šimenko et al., 2020).

Capacity to generate power, and a high ratio between body mass and power are the main variables influencing sprint performance (Perez-Gomez et al., 2008). In paper from (Smirniotou et al., 2008) male young sprinters (18,73 ± 1,79 years) participated in study when power parameters were associated with sprint performance, participants ran 100 m sprint with average time 12,00 ± 0,40 s. Their performance was better than performance of participants from our study (8-year average time 13,81 s), however, the participants were athletes that participated for at least 3 years in a sprint-specific training program (Smirniotou et al., 2008).

## CONCLUSION

The main goal of the study was to assess physical fitness of students from University of Defence through years 2008–2016. Data indicates that during the observed period of time there was no decrease in physical fitness from the students of University of Defence. Physical performance in the chosen tests is quite stable throughout the monitored period and comparison with other papers indicated good physical readiness and preparation for military duty in students from the University of Defence in the Czech Republic.

## ACKNOWLEDGMENTS

*There has been no financial assistance with the project, this must be clearly stated.*

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## REFERENCE

Blacker, S. D., Wilkinson, D. M., Bilzon, J. L. J., & Rayson, M. P. (2008). Risk factors for training injuries among British Army recruits. *Military Medicine*, *173*(3), 278–286. https://doi.org/10.7205/milmed.173.3.278

'Boletín Tierra' Newspaper Reports. (2012). NEW ARMY PHYSICAL FITNESS TEST FROM THE MONTH OF MARCH. Retrieved 18 October 2020, from https://ejercito.defensa.gob.es/en/noticias/2010/02/Noticia669.html?__locale=en

Bundeswehr. (2020). Der Basis-Fitness-Test. Retrieved 18 October 2020, from https://www.bundeswehrkarriere.de/dierekruten/infos/basis-fitness-test

Cooper, K. H. (1968). A Means of Assessing Maximal Oxygen Intake: Correlation Between Field and Treadmill Testing. *JAMA*, *203*(3), 201–204. https://doi.org/10.1001/jama.1968.03140030033008

Coupe, G. (2019). All You Need To Know About The British Army's Fitness Standards. Retrieved 17 October 2020, from Forces Network website: https://www.forces.net/services/army/all-you-need-know-about-british-armys-fitness-standards

Dawes, J. J., Orr, R. M., Flores, R. R., Lockie, R. G., Kornhauser, C., & Holmes, R. (2017). A physical fitness profile of state highway patrol officers by gender and age. *Annals of Occupational and Environmental Medicine*, *29*(1), 16. https://doi.org/10.1186/s40557-017-0173-0

Fotynyuk, V. G. (2017). Determination of first year students' physical condition and physical fitness level. *Physical Education of Students*, *21*(3), 116–120. https://doi.org/10.15561/20755279.2017.0303

Harman, E. A., Gutekunst, D. J., Frykman, P. N., Nindl, B. C., Alemany, J. A., Mello, R. P., & Sharp, M. A. (2008). Effects of Two Different Eight-Week Training Programs on Military Physical Performance. *The Journal of Strength & Conditioning Research*, *22*(2), 524–534. https://doi.org/10.1519/JSC.0b013e31816347b6

Heinrich, K. M., Spencer, V., Fehl, N., & Carlos Poston, W. S. (2012). Mission Essential Fitness: Comparison of Functional Circuit Training to Traditional Army Physical Training for Active Duty Military. *Military Medicine*, *177*(10), 1125–1130. https://doi.org/10.7205/MILMED-D-12-00143

Home—British Army Jobs. (n.d.). Retrieved 17 October 2020, from https://apply.army.mod.uk/

Hua, W., Chen, Q., Wan, M., Lu, J., & Xiong, L. (2018). The incidence of military training-related injuries in Chinese new recruits: A systematic review and meta-analysis. *BMJ Military Health*, *164*(4), 309–313. https://doi.org/10.1136/jramc-2016-000710

Kelly, K. R., & Jameson, J. T. (2016). Preparing for Combat Readiness for the Fight: Physical Performance Profile of Female U.S. Marines. *Journal of Strength and Conditioning Research*, *30*(3), 595–604. https://doi.org/10.1519/JSC.0000000000001269

Knapik, J. J., Sharp, M. A., & Steelman, R. A. (2017). Secular Trends in the Physical Fitness of United States Army Recruits on Entry to Service, 1975–2013. *The Journal of Strength & Conditioning Research*, *31*(7), 2030–2052. https://doi.org/10.1519/JSC.0000000000001928

Kyröläinen, H., Pihlainen, K., Vaara, J. P., Ojanen, T., & Santtila, M. (2018). Optimising training adaptations and performance in military environment. *Journal of Science and Medicine in Sport*, *21*(11), 1131–1138. https://doi.org/10.1016/j.jsams.2017.11.019

Leyk, D., Rohde, U., Gorges, W., Rüther, T., & Witzki, A. (2017). Physical fitness of German Soldiers 2010–2015. *Journal of Science and Medicine in Sport*, *20*, S11. https://doi.org/10.1016/j.jsams.2017.09.030

Lockie, R. G., Dawes, J. J., Balfany, K., Gonzales, C. E., Beitzel, M. M., Dulla, J. M., & Orr, R. M. (2018). Physical Fitness Characteristics That Relate to Work Sample Test Battery Performance in Law Enforcement Recruits. *International Journal of Environmental Research and Public Health*, *15*(11), 2477. https://doi.org/10.3390/ijerph15112477

Meadows, S. O., Engel, C. C., Collins, R. L., Beckman, R. L., Cefalu, M., Hawes-Dawson, J., … Williams, K. M. (2018). 2015 Department of Defense Health Related Behaviors Survey (HRBS). *Rand Health Quarterly*, *8*(2). Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6183770/

Militaryonesource. (2020). ACFT: The New Army Combat Fitness Test, formerly APFT | Military OneSource. Retrieved 17 October 2020, from https://www.militaryonesource.mil/military-life-cycle/new-to-the-military/getting-settled/the-army-combat-fitness-test

Molloy, J. M., Feltwell, D. N., Scott, S. J., & Niebuhr, D. W. (2012). Physical Training Injuries and Interventions for Military Recruits. *Military Medicine*, *177*(5), 553–558. https://doi.org/10.7205/MILMED-D-11-00329

Omar, A., Leong, H. L., & Moy, F. M. (2020). *Trend and Prevalence of Overweight and Obesity among The Military Population – A Systematic Review*. https://doi.org/10.20944/preprints202008.0311.v1

Perez-Gomez, J., Rodriguez, G. V., Ara, I., Olmedillas, H., Chavarren, J., González-Henriquez, J. J., … Calbet, J. A. L. (2008). Role of muscle mass on sprint performance: Gender differences? *European Journal of Applied Physiology*, *102*(6), 685–694. https://doi.org/10.1007/s00421-007-0648-8

Pihlainen, K., Vaara, J., Ojanen, T., Santtila, M., Vasankari, T., Tokola, K., & Kyröläinen, H. (2020). Effects of baseline fitness and BMI levels on changes in physical fitness during military service. *Journal of Science and Medicine in Sport*, *23*(9), 841–845. https://doi.org/10.1016/j.jsams.2020.02.006

Santtila, M., Pihlainen, K., Koski, H., & Kyröläinen, H. (2017). Physical fitness trends in Finnish male conscripts between 1975 and 2015 and female recruits during 2005–2015. *Journal of Science and Medicine in Sport*, *20*, S12. https://doi.org/10.1016/j.jsams.2017.09.032

Shams-White, M. M., Chui, K., Deuster, P. A., McKeown, N. M., & Must, A. (2020). Comparison of Anthropometric Measures in US Military Personnel in the Classification of Overweight and Obesity. *Obesity*, *28*(2), 362–370. https://doi.org/10.1002/oby.22675

Šimenko, J., Kovcan, B., Pori, P., Vodicar, J., Vodicar, M., & Hadžic, V. (2020). The Relationship Between Army Physical Fitness and Functional Capacities in Infantry Members of the Slovenian Armed Forces. *The Journal of Strength & Conditioning Research*, *Publish Ahead of Print*. https://doi.org/10.1519/JSC.0000000000003344

Smirniotou, A., Katsikas, C., Paradisis, G., Argeitaki, P., Zacharogiannis, E., & Tziortzis, S. (2008). Strength-power parameters as predictors of sprinting performance. *The Journal of Sports Medicine and Physical Fitness*, *48*(4), 447–454.

Thibault, V., Guillaume, M., Berthelot, G., Helou, N. E., Schaal, K., Quinquis, L., … Toussaint, J.-François. (2010). Women and Men in Sport Performance: The Gender Gap has not Evolved since 1983. *Journal of Sports Science & Medicine*, *9*(2), 214–223. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3761733/

WHO. (2020a). Obesity and overweight. Retrieved 12 January 2021, from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

WHO. (2020b). Physical activity. Retrieved 12 January 2021, from https://www.who.int/news-room/fact-sheets/detail/physical-activity

Zeno, S. A., Purvis, D., Crawford, C., Lee, C., Lisman, P., & Deuster, P. A. (2013). Warm-ups for Military Fitness Testing: Rapid Evidence Assessment of the Literature. *Medicine & Science in Sports & Exercise*, *45*(7), 1369–1376. https://doi.org/10.1249/MSS.0b013e318285c1b9