

## ORIGINAL RESEARCH

# Body mass index and body fat percentage of male firefighters in Montenegro among different age groups

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## Abstract

**Background:** Firefighting imposes extreme physical and psychological demands. Elevated body mass index (BMI) and high body fat percentage (FAT%) may impair operational performance and increase cardiometabolic risk. This study provides the first comprehensive, age-stratified analysis of BMI and FAT% among professional firefighters in Montenegro. **Methods:** A cross-sectional sample of 148 male career firefighters (mean age  $35.4 \pm 11.3$  years; range 20–60 years) from nine municipalities (Budva, Danilovgrad, Kolasin, Kotor, Mojkovac, Niksic, Pluzine, Podgorica, Zabljak) was assessed between April 2024 and February 2025. Anthropometric measures included body height, weight, and pectoral, abdominal, and front-thigh skinfolds. BMI was calculated ( $\text{kg}/\text{m}^2$ ), and FAT% estimated via the Jackson & Pollock three-site equation. One-way Analysis of Variance (ANOVA) with Bonferroni *post-hoc* tests and Multivariate Analysis of Variance (MANOVA) examined age-group differences (seven categories: <25, 25–29, 30–34, 35–39, 40–44, 45–49,  $\geq 50$  years). **Results:** Mean BMI and FAT% were  $28.05 \pm 4.44 \text{ kg}/\text{m}^2$  and  $21.12 \pm 8.15\%$ , respectively—both in the overweight/above-average ranges. Both indicators increased significantly with age (BMI:  $F = 3.071$ ,  $p = 0.007$ ; FAT%:  $F = 4.735$ ,  $p < 0.001$ ), with marked differences between firefighters <30 years and those  $\geq 35$  years. While BMI plateaued after age 45, FAT% continued to rise, suggesting age-related lean-mass loss. **Conclusions:** A majority of Montenegrin firefighters exceed recommended BMI and FAT% thresholds, with a clear age-related deterioration in body composition. We recommend implementing routine, career-long monitoring of body composition, coupled with targeted fitness and nutrition interventions, to enhance operational readiness and long-term health.

## Keywords

Body composition; Occupational health; Firefighters; Aging; Montenegro

## 1. Introduction

Obesity and changes in body composition represent a growing public health challenge in modern society. According to the World Health Organization [1], obesity has reached the level of a global epidemic, with serious implications for morbidity, mortality, and the overall functioning of contemporary healthcare systems. Although initially considered a problem typical of developed countries and urban areas, recent studies indicate that obesity is increasingly present in rural areas and developing countries as well [2]. Montenegro is no exception to this trend [3].

Particular attention in the context of public health and professional capacity must be given to members of Public Safety Systems, including firefighters. Their work is characterized by high physical demands, operation in stressful and hazardous conditions, and the need for rapid and effective response [4]. Increased body mass and reduced functional fitness can significantly impair their ability to perform professional tasks, thus

affecting the safety of firefighters themselves, their colleagues, and the civilians they protect [5, 6]. In addition to these operational demands, the profession of firefighting involves meeting specific general and special requirements [7], including good health status, sufficient physical and psychophysical fitness, and the ability to perform under specific and often extreme conditions. In Montenegro, these criteria are verified through systematic medical check-ups, assessments of work capacity, and often through periodic physical training and evaluations [7]. These aspects further support the need for analyzing body mass and composition as key indicators of functional readiness.

Despite the physically demanding nature of the job, numerous international studies show that firefighters are not immune to modern lifestyles, marked by reduced physical activity during off-duty hours, poor nutrition, chronic stress, and sleep disturbances caused by shift work [8–10]. These factors increase the risk of excessive body mass, obesity, and related chronic diseases. Previous global research highlights

a high prevalence of firefighters classified as overweight or obese based on body mass index (BMI), along with elevated levels of body fat percentage (FAT%) [11–13]. These findings raise concern regarding the physical readiness of professionals whose roles are critical in emergency response and public protection.

Within the Public Safety Systems in Montenegro, previous studies have examined police and military personnel, also reporting a high proportion of individuals with unfavorable body composition indicators [14, 15]. However, when it comes to firefighters, there have been no official data or systematic research conducted on their physical condition to date (Author's review of available literature, 2025). Based on these insights, it is evident that examining the specific nutritional and body composition profiles of this population in a local context is necessary. In emergency response scenarios, appropriate body composition can be critical for the efficiency and safety of interventions. This study represents the first scientific attempt to analyze the body composition of firefighters in Montenegro, addressing a significant gap in the literature and opening avenues for further research and practical application.

Body mass index (BMI) and body fat percentage (FAT%) are considered key parameters for assessing nutritional status and body composition, and their use is particularly relevant among populations exposed to high physical and psychological demands. BMI is calculated as the ratio of body weight to height squared ( $\text{kg}/\text{m}^2$ ), while FAT% provides a more detailed insight into the ratio of fat and lean tissue. Ideally, both indicators should be interpreted complementarily [16].

To date, no systematic research in Montenegro has examined the nutritional status of firefighters by age group using both BMI and FAT%. Therefore, the main objective of this study is to provide the first comprehensive assessment of body mass index and fat percentage among firefighters in Montenegro, analyzing differences in BMI and FAT% across various age categories. The results may contribute to the development of specific recommendations for maintaining and improving the physical health and professional readiness of firefighters in Montenegro, and raise the question of the need for regional standards in evaluating body composition among Public Safety Systems personnel.

## 2. Materials and methods

The study was conducted on a sample of 148 male professional firefighters employed in fire and rescue services in nine Montenegrin municipalities: Budva, Danilovgrad, Kolasin, Kotor, Mojkovac, Niksic, Pluzine, Podgorica, and Zabljak. Considering that Montenegro has a relatively small number of professional firefighters, this sample represents 24.14% of the total firefighter population in the country [17], thus ensuring high representativeness of the obtained data.

This research followed a cross-sectional study design, aiming to analyze differences among age categories at a single point in time. All participants were clinically healthy and without diagnosed physical deformities, as verified through official medical documentation and records of systematic health examinations for the current year. The average age of participants was  $35.40 \pm 11.32$  years, with an age range of 20 to 60

years. Based on chronological age, firefighters were divided into seven age groups: Group I (under 25 years;  $n = 39$ ; Mean (M) =  $22.96 \pm 1.24$ ), Group II (25–29 years;  $n = 24$ ; M =  $26.65 \pm 1.35$ ), Group III (30–34 years;  $n = 15$ ; M =  $32.19 \pm 1.44$ ), Group IV (35–39 years;  $n = 14$ ; M =  $37.55 \pm 1.66$ ), Group V (40–44 years;  $n = 16$ ; M =  $42.16 \pm 1.64$ ), Group VI (45–49 years;  $n = 21$ ; M =  $47.42 \pm 1.34$ ), and Group VII (50 years and older;  $n = 19$ ; M =  $53.96 \pm 3.20$ ). All participants were informed about the purpose of the study, potential risks, and benefits of participation, and provided written, voluntary informed consent. Measurements were conducted from 24 April 2024, to 26 February 2025. All procedures followed the ethical principles of scientific research and were approved by the Ethics Committee Western Balkan Sport Innovation Lab.

The variable sample included five anthropometric measurements: body height, body weight, and skinfold thicknesses at the abdominal, pectoral, and anterior thigh sites. All measurements were carried out by trained and certified assessors, and the reliability of their work was verified in accordance with the standards of the International Society for the Advancement of Kinanthropometry (ISAK) [18]. Based on the collected data, two key body composition indicators were calculated: Body Mass Index (BMI) and Body Fat Percentage (FAT%). BMI was calculated using the standard formula: body weight in kilograms divided by the square of body height in meters ( $\text{kg}/\text{m}^2$ ). Body fat percentage was calculated based on body density using the following formula:  $\text{body density} = 1.10938 - 0.0008267 \times (\text{sum of three skinfolds}) + 0.0000016 \times (\text{sum of three skinfolds})^2 - 0.00002574 \times \text{age}$ . FAT% was then derived using the equation:  $\text{FAT\%} = (4.95/\text{body density} - 4.50) \times 100$ . This method corresponds to the Jackson & Pollock equation for estimating body fat in males [19].

The age of each participant was determined directly from their date of birth. Collected data were statistically processed using IBM SPSS Statistics, version 20.0 (IBM Corp., Armonk, NY, USA). Basic measures of central tendency and variability were calculated for descriptive statistics, both for the entire sample and for each age group individually. To assess differences in body mass index and body fat percentage among age categories, both univariate (one-way ANOVA) and multivariate analysis of variance (MANOVA) were applied, followed by Bonferroni *Post Hoc* testing. Statistical significance was set at  $p < 0.05$ .

## 3. Results

The average values of body mass index (BMI) and body fat percentage (FAT%) for the entire sample and across age groups are presented in Table 1. Descriptive statistics show a clear trend of increasing BMI and FAT% with age among firefighters. The average BMI for the entire sample was  $28.05 \pm 4.44 \text{ kg}/\text{m}^2$ , indicating the overweight category. The lowest values were recorded in groups I ( $26.74 \pm 3.89$ ) and II ( $26.32 \pm 5.01$ ), while the highest were found in groups IV, V, and VI (approximately or above  $30 \text{ kg}/\text{m}^2$ ). Similarly, the average FAT% in the sample was  $21.12 \pm 8.15\%$ , with the lowest values in group I ( $16.92 \pm 7.86$ ) and the highest in group V ( $25.99 \pm 7.56$ ). These values indicate an overall increase in body mass and fat tissue with age.

**TABLE 1. Anthropometric measures and body composition indicators of study sample and subsamples.**

Variables	All (n = 148)	I (n = 39)	II (n = 24)	III (n = 15)	IV (n = 14)	V (n = 16)	VI (n = 21)	VII (n = 19)
	Mean ± SD							
Age (yr)	35.40 ± 11.32	22.96 ± 1.24	26.65 ± 1.35	32.19 ± 1.44	37.55 ± 1.66	42.16 ± 1.64	47.42 ± 1.34	53.96 ± 3.20
Body Height (cm)	183.04 ± 6.46	181.38 ± 7.00	182.37 ± 4.93	184.92 ± 8.05	184.34 ± 6.24	183.51 ± 6.52	183.00 ± 5.31	184.67 ± 7.30
Body Weight (kg)	94.16 ± 16.87	88.05 ± 14.15	87.51 ± 17.06	93.88 ± 14.80	103.05 ± 26.76	101.63 ± 14.48	99.54 ± 13.93	96.50 ± 12.70
Pectoral Skinfold (mm)	16.94 ± 8.95	13.36 ± 8.69	14.50 ± 9.91	15.75 ± 7.87	19.50 ± 8.43	21.76 ± 9.07	20.94 ± 8.86	17.91 ± 5.65
Abdominal Skinfold (mm)	33.67 ± 15.47	27.37 ± 14.30	31.34 ± 19.9	34.56 ± 12.74	40.76 ± 12.16	43.66 ± 16.11	34.36 ± 15.18	34.46 ± 9.42
Front thigh Skinfold (mm)	20.58 ± 9.89	20.29 ± 9.58	21.03 ± 11.30	20.73 ± 7.05	24.26 ± 12.97	21.59 ± 10.38	20.42 ± 9.64	17.05 ± 7.92
Body Mass Index (kg/m <sup>2</sup> )	28.05 ± 4.44	26.74 ± 3.89	26.32 ± 5.01	27.42 ± 3.96	30.11 ± 6.42	30.20 ± 4.30	29.67 ± 3.50	28.30 ± 2.74
Body Fat Percentage (%)	21.12 ± 8.15	16.92 ± 7.86	18.68 ± 9.60	20.92 ± 6.55	24.89 ± 7.32	25.99 ± 7.56	23.79 ± 7.45	23.17 ± 4.71

Mean: Arithmetic mean; SD: Standard deviation.

Trends in the distribution of BMI and FAT% are further illustrated in Fig. 1, clearly showing the increase of both variables with age, with a leveling off in the oldest group.

To simultaneously assess the effect of age on BMI and FAT%, a multivariate analysis of variance (MANOVA) was conducted. The Wilks' Lambda statistic showed that age groups had a significant joint effect on these two variables ( $F = 0.809$ ,  $p = 0.002$ ). This finding confirms that age has a measurable impact on the overall pattern of changes in body composition.

The results of the one-way analysis of variance (ANOVA) indicate that age has a significant impact on both body composition indicators (Table 2). For body mass index (BMI), the  $F$ -value was 3.071;  $p = 0.007$ , while for body fat percentage (FAT%), the difference was even more pronounced— $F = 4.735$ ;  $p < 0.001$ . These findings confirm the existence of statistically significant differences between age groups for both parameters. However, these differences were not uniformly distributed—more substantial changes were observed between the younger groups (I and II) and the older groups (III, IV, and V), while the oldest groups (VI and VII) exhibited more similarity, suggesting a possible stabilization pattern in later life.

The Bonferroni *post hoc* test revealed that the youngest groups (I and II) differed significantly from older groups IV, V, and VI in terms of BMI (Table 3). For instance, the difference between groups I and V was  $p = 0.007$ , and between II and V was  $p = 0.005$ . These results suggest a sharp increase in BMI with age, followed by a plateau, as the older groups (V, VI, VII) showed no statistically significant differences among

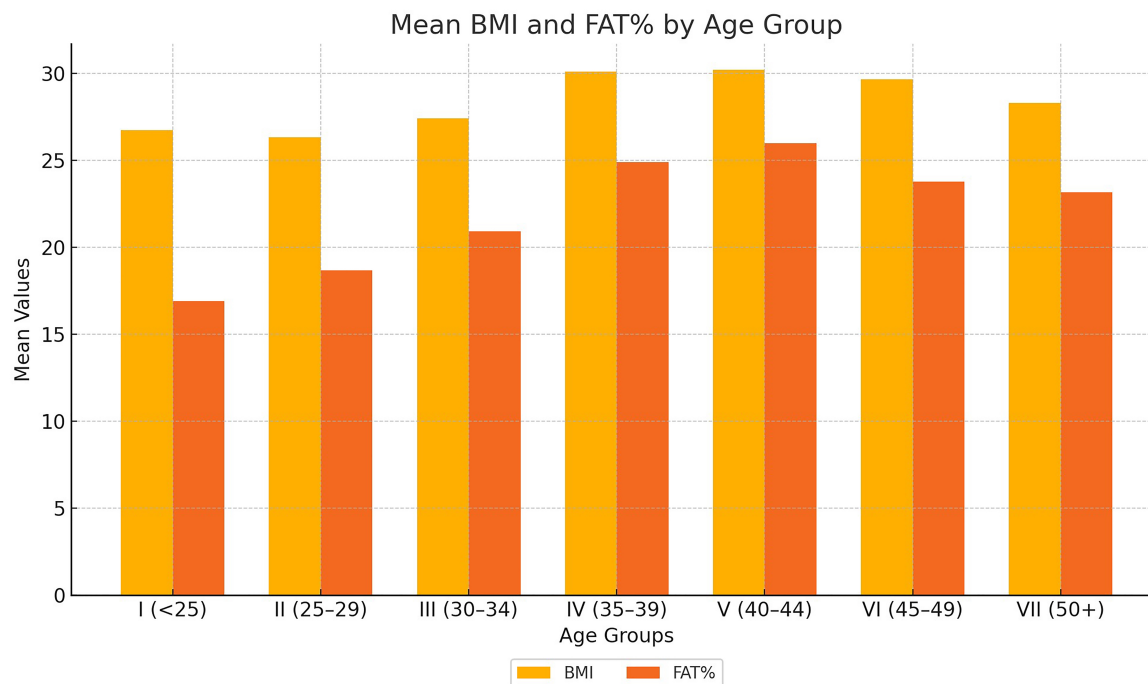
themselves.

The Bonferroni *post hoc* test for FAT% showed even more pronounced differences between age groups (Table 4). Group I differed significantly from nearly all older groups: IV ( $p = 0.001$ ), V ( $p < 0.001$ ), VI ( $p = 0.001$ ), and VII ( $p = 0.004$ ). Group II showed a similar pattern, differing from groups IV ( $p = 0.016$ ), V ( $p = 0.003$ ), and VI ( $p = 0.026$ ). Unlike BMI, FAT% did not show a stabilization trend, remaining elevated in older groups. This may suggest a redistribution of body mass toward fat tissue at the expense of muscle mass, a known consequence of aging and reduced physical activity.

## 4. Discussion

This study provides the first systematic, age-stratified analysis of body-composition indicators among Montenegrin career firefighters, based on the only nationally representative dataset collected to date. With a sample covering more than 24% of the national firefighter population and a parallel analysis of both body-mass index (BMI) and body-fat percentage (FAT%), the research delivers a detailed and nuanced insight into the physical status of this critical professional group. Furthermore, the age-specific findings contribute to understanding physiological changes across career stages, which may inform recruitment, training and health-monitoring practices. Given the lack of local standards, these results may also serve as a foundation for the future development of regional norms tailored to the specific characteristics of public safety professionals in the Western Balkans.

Results from this investigation reveal a pronounced



**FIGURE 1. Body composition indicators of study sample and subsamples.** BMI: body mass index; FAT%: body fat percentage.

**TABLE 2. One-way analysis of variance in BMI and FAT% of the study sample.**

Variables	<i>F</i>	<i>p</i>
BMI	3.071	0.007
FAT%	4.735	<0.001

*F*: *f* test; *p*: probability level; BMI: body mass index; FAT%: body fat percentage.

**TABLE 3. Post hoc analysis of variance on BMI with study subsamples.**

Group	I	II	III	IV	V	VI
II	<i>(p</i> = 0.702)					
III	<i>(p</i> = 0.603)		<i>(p</i> = 0.435)			
IV	<i>(p</i> = 0.012)*		<i>(p</i> = 0.009)**		<i>(p</i> = 0.091)	
V	<i>(p</i> = 0.007)**		<i>(p</i> = 0.005)**		<i>(p</i> = 0.071)	
VI	<i>(p</i> = 0.012)*		<i>(p</i> = 0.009)**		<i>(p</i> = 0.120)	
VII	<i>(p</i> = 0.012)*		<i>(p</i> = 0.009)**		<i>(p</i> = 0.120)	
	<i>(p</i> = 0.192)	<i>(p</i> = 0.131)	<i>(p</i> = 0.547)	<i>(p</i> = 0.230)	<i>(p</i> = 0.710)	<i>(p</i> = 0.710)
	<i>(p</i> = 0.192)	<i>(p</i> = 0.131)	<i>(p</i> = 0.547)	<i>(p</i> = 0.230)	<i>(p</i> = 0.192)	<i>(p</i> = 0.313)

\*\**: significance* ≤ 0.01; \**: significance* ≤ 0.05.

**TABLE 4. Post hoc analysis of variance on FAT% with study subsamples.**

Group	I	II	III	IV	V	VI
II	<i>(p</i> = 0.373)					
III	<i>(p</i> = 0.086)		<i>(p</i> = 0.373)			
IV	<i>(p</i> = 0.001)**		<i>(p</i> = 0.016)*		<i>(p</i> = 0.162)	
V	<i>(p</i> < 0.001)**		<i>(p</i> = 0.003)**		<i>(p</i> = 0.065)	
VI	<i>(p</i> = 0.001)**		<i>(p</i> = 0.026)*		<i>(p</i> = 0.264)	
VII	<i>(p</i> = 0.001)**		<i>(p</i> = 0.026)*		<i>(p</i> = 0.264)	
	<i>(p</i> = 0.004)**	<i>(p</i> = 0.056)	<i>(p</i> = 0.392)	<i>(p</i> = 0.522)	<i>(p</i> = 0.276)	<i>(p</i> = 0.796)

\*\**: significance* ≤ 0.01; \**: significance* ≤ 0.05.

age-related escalation in both body-mass index and body-fat percentage. Every age group, without exception, fell into the overweight or obese range: according to World Health Organization cut-offs 45.95% of participants were overweight and 29.05% obese, leaving just 23% within the normal-weight band. FAT% offered an even starker picture—35.81% of fire-fighters were classified as “poor”, 12.16% as “below average” and 18.24% as “average”, so only 33.78% achieved “good” or “excellent” status according to American College of Sports Medicine (ACSM) cut-offs [1, 16]. The youngest cohort (<25 years) was the only group whose mean FAT% reached even the “average” standard. Multivariate analysis of variance (MANOVA) confirmed a joint effect of age group on both BMI and FAT%, while follow-up ANOVAs with *post-hoc* tests detected significant differences between younger (<30 years) and older cohorts (>35 years). These findings echo the negative trajectory reported worldwide among fire-fighters [20–22] and point to an emerging sarcopenic shift in older personnel—a change that can under-mine the strength, reaction speed and endurance required for effective fire-ground operations [23–25]. For context, the overall Montenegrin mean (BMI  $28.05 \pm 4.44$  kg/m<sup>2</sup>; FAT%  $21.12 \pm 8.15\%$ ) aligns closely with values reported for the United States (BMI 29.1; FAT% 25.6) and the United Kingdom (BMI  $27.7 \pm 4.2$ ; FAT%  $22.1 \pm 5.4$ ) but lags behind Germany (BMI  $25.9 \pm 3.2$ ; FAT%  $17.7 \pm 6.2$ ), Brazil (BMI  $26.16 \pm 3.32$ ; FAT%  $20.77 \pm 6.82$ ) and Serbia (BMI  $27.83 \pm 3.6$ ; FAT%  $21.07 \pm 6.62$ ) [12, 13, 21, 26, 27]. Comparisons with other public-safety services in Montenegro suggest that firefighters exhibit higher mean BMI and FAT% than police officers and military personnel [14, 15]. However, owing to differing selection criteria and occupational demands, such intra-service contrasts should be interpreted with caution and are mentioned here solely to highlight the need for firefighter-specific monitoring and intervention strategies.

Interpretation of BMI in isolation is problematic for personnel within Public Safety Systems—firefighters, police officers and military service members alike. Self-selection into these occupations and sustained on-the-job physical training foster considerable muscular development [28], so BMI alone can-not distinguish muscle from adipose tissue [29]. Regional studies across the Dinaric Alps further demonstrate body-size variability linked to geography and lifestyle [30, 31], and several authors from the Western Balkans have therefore questioned the suitability of universal BMI cut-offs for this region (personal communication, Stevo Popovic, 2024). The present findings lend cautious support to that view: in the youngest cohorts—Groups I–II (<30 years)—the mismatch between BMI and FAT% is pronounced, implying that high BMI values often reflect greater muscle mass rather than excess fat. From Group III (30–35 years) onward, concordance between the two indicators becomes progressively clearer, and in Groups IV–VII (>35 years) BMI aligns closely with elevated FAT%, indicating that age-related loss of lean mass makes BMI a more reliable marker of adiposity.

This study has certain limitations, including its cross-sectional design, potential volunteer bias, and a possible healthy-worker effect that may mask early attrition of less-fit individuals and the absence of detailed injury-history

or rehabilitation data—factors that could alter muscle–fat balance. Nevertheless, its principal strength lies in the robust, nationally representative sample (148 firefighters, >24% of the work-force) and the standardised measurement protocol. Future longitudinal work incorporating physical-activity logs and medical-intervention records would refine these insights.

Building on these findings, we recommend systematic, career-long surveillance of firefighters’ body composition, rather than a one-off check during recruitment. The emphasis should be on regular evaluations that monitor changes in body weight and composition over time. We therefore recommend a comprehensive framework that couples periodic anthropometric assessments with targeted physical-training programmers, nutrition support and individually tailored conditioning plans. Such a coordinated, multidisciplinary approach is likely to preserve functional capacity, reduce health risks and enhance the operational effectiveness of Montenegro’s fire-service personnel.

In addition, given the safety-critical nature of frontline fire-fighting, it may be appropriate to consider differentiated operational responses in cases where markedly unfavorable body-composition profiles persist despite structured support and intervention. Temporary restrictions from the most physically demanding and high-risk duties could be considered, alongside a defined period focused on restoring adequate physical fitness and body composition. If, following this period, minimum functional and health-related standards remain unmet, longer-term reassignment away from frontline duties—or, in exceptional circumstances and in accordance with legal and organizational frameworks, separation from operational roles—may warrant careful consideration. Such measures would be grounded not in punitive intent, but in the fundamental responsibility of fire services to protect public safety, co-worker wellbeing, and property.

## 5. Conclusions

Most Montenegrin firefighters exceed recommended thresholds for body mass and body-fat percentage. This imbalance becomes more pronounced with age and is accompanied by a gradual decline in lean tissue—a combination that jeopardises both operational readiness and long-term cardiometabolic health. These findings underscore the need for age-adjusted, career-long monitoring of body composition and for tailored fitness-and-nutrition programmers to preserve a fit, resilient and deployable workforce.

## AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## AUTHOR CONTRIBUTIONS

MR, ZS and BM—conceptualization; investigation; resources. MR and BM—methodology; writing—original

draft preparation. BM—software. ZS and MM—validation; formal analysis. MR, ZS, BK and BM—data curation; project administration. ZS, MM and BM—writing—review and editing. MR and ZS—supervision; funding acquisition. All authors have read and agreed to the published version of the manuscript.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All procedures conducted in the study were in accordance with the Helsinki Declaration and approved by the Ethics Committee of the Western Balkan Sport Innovation Lab (decision number: 01-20243; date: 29 March 2024). Written informed consent was obtained from all participants.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest. The authors declare no conflict of interest. Bojan Masanovic is serving as one of the Editorial Board members of this journal. We declare that Bojan Masanovic had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to WYS.

## REFERENCES

- [1] World Health Organization. Obesity: preventing and managing the global epidemic: report of a WHO consultation. 2000. Available at: <https://iris.who.int/handle/10665/42330> (Accessed: 20 October 2025).
- [2] Ivanovitch K, Keolangsy S, Homkham N. Overweight and obesity coexist with thinness among Lao's Urban Area Adolescents. *Journal of Obesity*. 2020; 2020: 5610834.
- [3] NCD Risk Factor Collaboration (NCD-RisC). Rising rural body-mass index is the main driver of the global obesity epidemic in adults. *Nature*. 2019; 569: 260–264.
- [4] Tamminen JI, Hoppu SE, Kämäräinen AJ. Professional firefighter and trained volunteer first-responding units in emergency medical service. *Acta Anaesthesiologica Scandinavica*. 2019; 63: 111–116.
- [5] Smith DL. Firefighter fitness: improving performance and preventing injuries and fatalities. *Current Sports Medicine Reports*. 2011; 10: 167–172.
- [6] Poston WS, Haddock CK, Jahnke SA, Jitnarin N, Day RS. An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health*. 2013; 13: 805.
- [7] Ministry of the Interior. Protection and rescue act. 2019. Available at: <https://www.gov.me/dokumenta/b9fec705-09a8-46dd-91e0-27763081a804> (Accessed: 20 October 2025).
- [8] Gonzalez DE, Lanham SN, Martin SE, Cleveland RE, Wilson TE, Langford EL, *et al.* Firefighter health: a narrative review of occupational threats and countermeasures. *Healthcare*. 2024; 12: 40.
- [9] Vancampfort D, De Soir E, van Winkel R, Louw QA, McKeon G, Rosenbaum S, *et al.* Physical activity, sedentary behaviour and mental health outcomes in firefighters: a cross-sectional study. *Journal of Workplace Behavioral Health*. 2024; 39: 88–105.
- [10] Khoshakhlagh AH, Al Sulaie S, Yazdanirad S, Orr RM, Dehdarirad H, Milajerdi A. Global prevalence and associated factors of sleep disorders and poor sleep quality among firefighters: a systematic review and meta-analysis. *Heliyon*. 2023; 9: e13250.
- [11] Soares EMKVK, Smith D, Porto LGG. Worldwide prevalence of obesity among firefighters: a systematic review protocol. *BMJ Open*. 2020; 10: e031282.
- [12] Bode ED, Mathias KC, Stewart DF, Moffatt SM, Jack K, Smith DL. Cardiovascular disease risk factors by BMI and age in United States firefighters. *Obesity*. 2021; 29: 1186–1194.
- [13] Lessons GR, Bhakta D, McCarthy D. Development of muscle mass and body fat reference curves for white male UK firefighters. *International Archives of Occupational and Environmental Health*. 2022; 95: 779–790.
- [14] Banjevic B, Popovic S, Masanovic B. Body mass index and body fat percentage of armed forces personnel in Montenegro among different age groups. *Iranian Journal of Public Health*. 2020; 49: 1010–1011.
- [15] Veljovic V, Spalevic Z, Bubanja M, Masanovic B. Body mass index and body fat percentage of police force in Montenegro in different age groups. *Nutrición Hospitalaria*. 2021; 38: 679–680.
- [16] American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 12th edn. Wolters Kluwer Health: Philadelphia, PA. 2018.
- [17] Government of Montenegro. Report on the state of the protection and rescue system in Montenegro in 2024. 2024. Available at: <https://www.gov.me/dokumenta/e1865870-4eae-47e8-8f16-54d69cef0e7a> (Accessed: 20 October 2025).
- [18] Marfell-Jones MJ, Stewart AD, de Ridder JH. International standards for anthropometric assessment. 3rd edn. International Society for the Advancement of Kinanthropometry: Wellington, New Zealand. 2012.
- [19] Jackson AS, Pollock ML. Practical assessment of body composition. *The Physician and Sportsmedicine*. 1985; 13: 76–90.
- [20] Lockie RG, Dulla JM, Higuera D, Ross K, Orr RM, Dawes JJ, *et al.* Age-related differences in body fat and fitness of firefighters participating in a health and wellness program. *Journal of Strength & Conditioning Research*. 2024; 38: 1127–1135.
- [21] Samardzic N, Koropanovski N, Kucic F, Dopsaj M. Age-dependent model for dynamics of change in body composition indicators in professional firefighters: Serbian cross-sectional study. *International Journal of Morphology*. 2024; 42: 1125–1131.
- [22] Bond CW, Waletzko SP, Reed V, Glasner E, Noonan B. Retrospective longitudinal evaluation of male firefighter's body composition and cardiovascular health. *Journal of Occupational and Environmental Medicine*. 2022; 64: 123–130.
- [23] Parpa K, Michaelides M. Age-related differences in physical fitness and performance of an "ability test" among firefighters. *Muscles*. 2024; 3: 88–99.
- [24] Baur DM, Christophi CA, Cook EF, Kales SN. Age-related decline in cardiorespiratory fitness among career firefighters: modification by physical activity and adiposity. *Journal of Obesity*. 2012; 2012: 710903.
- [25] Redshaw AS, Carrick-Ranson G, Bennett H, Norton KI, Walker A. Effect of aging on movement quality in Australian Urban firefighters. *Journal of Strength & Conditioning Research*. 2023; 37: e601–e608.
- [26] Damacena FC, Batista TJ, Ayres LR, Zandonade E, Sampaio KN. Obesity prevalence in Brazilian firefighters and the association of central obesity with personal, occupational and cardiovascular risk factors: a cross-sectional study. *BMJ Open*. 2020; 10: e032933.
- [27] Strauss M, Foshag P, Jehn U, Brzęk A, Littwitz H, Leischik R. Higher cardiorespiratory fitness is strongly associated with lower cardiovascular risk factors in firefighters: a cross-sectional study in a German fire brigade. *Scientific Reports*. 2021; 11: 2445.
- [28] Choi B, Steiss D, Garcia-Rivas J, Kojaku S, Schnall P, Dobson M, *et al.* Comparison of body mass index with waist circumference and

- skinfold-based percent body fat in firefighters: adiposity classification and associations with cardiovascular disease risk factors. *International Archives of Occupational and Environmental Health*. 2016; 89: 435–448.
- [29] Lockie RG, Dulla JM, Higuera D, Ross KA, Orr RM, Dawes JJ, *et al*. Body composition and fitness characteristics of firefighters participating in a health and wellness program: relationships and descriptive data. *International Journal of Environmental Research and Public Health*. 2022; 19: 15758.
- [30] Popovic S. Local geographical differences in adult body height in Montenegro. *Montenegrin Journal of Sports Science and Medicine*. 2017; 6: 81–87.
- [31] Masanovic B, Bavcevic T, Prskalo I. Regional differences in adult body height in Kosovo. *Montenegrin Journal of Sports Science and Medicine*. 2019; 8: 69–76.

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