ORIGINAL ARTICLE

Received: 10/18/2017
Accepted: 02/15/2018
Funding: Brazilian Federal Agency of Support and Evaluation of Graduate Education (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES)

Anthropometric profile of military firefighters: comparison between operational and administrative work groups

Perfil antropométrico de bombeiros militares: comparação entre os grupos de trabalho operacional e administrativo

Débora Aparecida Knihs[1], Bruno Monteiro de Moura[1], Luiz Francisco Reis[2]

ABSTRACT | Background: Body composition is relevant for the health and work performance of firefighters. However, the behavior of these parameters has not been elucidated for groups of firefighters performing different tasks. **Objectives:** To compare the anthropometric profile of military firefighters who perform administrative (ADM) or operational work . **Methods:** The sample comprised 121 (ADM = 50 and operational = 71) male military firefighters. Body mass (BM), body fat percentage (BFP), fat body mass, lean body mass, body mass index (BMI), waist circumference and somatotype were analyzed. **Results:** Intergroup difference was found for body mass (ADM = 78.5 kg — operational = 84.6 kg), BMI (ADM = 25.8 — operational = 27.2) and lean body mass (ADM = 61.9 kg — operational = 66.2 kg). **Conclusion:** The groups exhibited differences in their anthropometric profile and BFP and BMI above the recommended range.

Keywords | body composition; anthropometry; health; firefighters.

RESUMO | Introdução: A composição corporal é importante para o bombeiro militar no que diz respeito a sua saúde e ao seu desempenho no trabalho. Porém, o comportamento desse parâmetro não é elucidado nos diferentes grupos de trabalho do bombeiro militar. **Objetivo:** Comparar o perfil antropométrico de bombeiros militares entre os grupos de trabalho administrativo (ADM) e operacional. **Métodos:** A amostra foi composta por 121 (ADM = 50 e operacional = 71) bombeiros militares do sexo masculino. Foram aferidos massa corporal (MC), percentual de gordura (%G), massa gorda, massa magra, índice de massa corporal (IMC), circunferência da cintura (CC) e somatotipia. **Resultados:** Houve diferenças entre os grupos para as variáveis massa corporal (ADM = 78,5 kg — operacional = 84,6 kg), IMC (ADM = 25,8 — operacional = 27,2) e massa magra (ADM = 61,9 kg — operacional = 66,2 kg). **Conclusão:** Conclui-se que os grupos apresentam diferenças entre os perfis antropométricos e apresentam %G e IMC acima do recomendável.

Palavras-chave | composição corporal; antropometria; saúde; bombeiros.

[1]Graduate Program in Physical Education, Federal University of Santa Catarina (Universidade Federal de Santa Catarina – UFSC) – Florianópolis (SC), Brazil.
[2]Department of Physical Education, Regional University of Blumenau (Universidade Regional de Blumenau – FURB) –Blumenau (SC), Brazil.
DOI: 10.5327/Z1679443520180122

INTRODUCTION

Military firefighters perform their work in highly diversified environments, which require highly qualified professional performance and precision[1], in addition to eventually posing considerable physical demands[2]. The activities of these professionals are basically divided between two groups: administrative (ADM), charged of office work, and operational, which main functions are combatting fires; search, saving and rescuing people and things; and delivery of prehospital care[3]. Independently from the group of allocation, military firefighters must be in a good state of health to perform their job safely and efficiently[1,4]. However, to the best of our knowledge no study has yet investigated differences in body composition between the two groups of military firefighters.

Body composition is a widely used health indicator, because, for instance, increased adipose tissue has strong association with risk of chronic degenerative diseases, such as obesity[5,6]. In addition, body composition is one of the five components of physical fitness; together with flexibility, muscular strength, muscular endurance and cardiorespiratory endurance it helps to determine the state of health of individuals and their condition to perform physical activities of daily life[7,8].

Body composition is not only relevant for health, but also for the performance at work of firefighters[9-12]. Strong association was found between poor performance on tests of skills required by the profession and elevated body mass index (BMI), body fat percentage (BFP) and waist circumference (WC)[13]. In addition, obesity seems to interfere with strength, agility, speed, cardiorespiratory endurance and power[2].

As adequate body composition is relevant for this population, the aim of the present study was to compare the anthropometric profile of military firefighters from groups ADM and operational. It should be observed that the tasks performed by the latter seem to pose greater physical demands. Therefore, our hypothesis was that there would differences in body composition between both groups, the operational group exhibiting less adipose tissue and more lean body mass compared to ADM.

METHODS

The present cross-sectional descriptive study was conducted with a sample of 121 male military firefighters with average age 37.3±8.5 years old from the 3rd Military Firefighters Battalion of Santa Catarina (3º Batalhão de Bombeiros Militares de Santa Catarina — 3º BBM-SC) which covers the cities of Apiúna, Benedito Novo, Blumenau, Botuverá, Brusque, Gaspar, Guabiruba, Indaial, Pomerode, Rio dos Cedros and Timbó. Recruitment was performed by means of convenience sampling; the sample corresponded to ~52.6% (n=230) of the total population of 3º BBM-SC firefighters. Fifty participants were from ADM and performed office work, and 71 from the operational group, charged of searching, saving and rescuing people and things. Data collection was performed from April through June 2016. We should observe that the full 3º BBM-SC staff (n=230) was invited to participate, but only the male firefighters present at headquarters at the time of data collection and signed an informed consent form were assessed. The study was approved by the ethics committee for research involving human beings of Regional University of Blumenau (Comitê de Ética e Pesquisa em Seres Humanos da Universidade Regional de Blumenau — CEPH/FURB), ruling no. 1,607,563.

The body composition data were collected following the standards recommended by International Society for the Advancement of Kinanthropometry (ISAK) by two certified examiners (ISAK level 2). The participants were allocated to a secluded room, wearing clothes adequate for assessment and without having previously performed exhausting physical activity. Body mass (BM) was measured with 100-gram precision Tanita® scale (Illinois, USA) and height (HGT) with millimeter-precision tape measure fixated to a wall. Triceps, subscapular, suprailiac and calf skinfolds were measured with millimeter-precision scientific caliper with 10 g/cm^3 of pressure. The arm, waist and calf circumference was measured with millimeter-precision flexible tape measure. The femur and humerus biepicondylar diameter was measured with millimeter-precision caliper. Anthropometric measurements were performed with CESCORF® device (Porto Alegre, Brazil). The protocol used for measurements was the one formulated by ISAK.

For calculation of BFP, Petroski's (1995) equation for prediction of the body density was first applied; the results were converted into percentages with Siri's (1961) equation. Fractionation was performed based on the values found for the analyzed variables, resulting in partitioning

the total body mass into two components. Fat mass was calculated as BFP X BM/100. Lean mass was calculated by subtracting fat body mass from BM. BMI, to wit, the standard used by the World Health Organization (WHO) to assess obesity, was calculated (BM/HGT squared, kg/m^2) and the results were categorized as per the WHO classification[5]. WC is an indicator of risk of metabolic diseases related to the visceral fat; in the present study the results were categorized according to the classification developed by the Brazilian Society of Cardiology (Sociedade Brasileira de Cardiologia (SBC)[14]. Finally, somatotypes represent body types and are based on the relative proportion of the three components of the human body, bone, muscle and fat. Somatotyping was performed by means of the Heath-Carter equations (1990) which served as reference to categorize the subjects. It should be noticed that the 13 somatotype categories are based on the three main body types, to wit, endomorph (relative fatness), mesomorph (relative musculoskeletal robustness) and ectomorph (relative slenderness).

Statistical analysis was performed with software *Statistical Package for the Social Sciences* — SPSS (version 15.0). We first performed descriptive analysis, the results were expressed as mean, standard deviation, minimum and maximum. The normal distribution of the data was assessed by means of the Kolmogorov-Smirnov test. For data with normal distribution, comparison of means between groups ADM and operational was performed by means of Student's t-test for independent samples. The data without normal distribution were subjected to logarithmic transformation and normality was tested again; the data then exhibited normal distribution and were also analyzed by means of Student's t-test for independent samples in intergroup comparison of means. The significance level was set to $p<0.05$.

RESULTS

Table 1 describes the results for the analyzed variables stratified per group, as well as the comparison of means between groups. Significant difference was not found between the groups for variables HGT, BFP, WC or fat body mass ($p>0.05$). The groups differed in regard,

Table 1. Descriptive statistics of the analyzed variables and comparison of means between groups administrative work (n=50) and operational (n=71), Santa Catarina, 2016.

Variable	Group	Mean	Standard deviation	Significance
Height (cm)	ADM	174.2	5.4	0.115
	Operational	176.0	6.5	
Body mass (kg)	ADM	78.5	9.5	0.006*
	Operational	84.6	14.3	
Percent fat **	ADM	20.7	6.0	0.892
	Operational	20.9	6.2	
Fat body mass (kg)**	ADM	16.6	6.6	0.324
	Operational	18.4	8.3	
Lean body mass (kg)	ADM	61.9	5.6	0.001*
	Operational	66.2	7.6	
BMI (kg/m^2)	ADM	25.8	3.2	0.048*
	Operational	27.2	4.0	
Waist circumference (cm)	ADM Operational	87.9 90.2	8.6 10.0	0.198

ADM: administrative; BMI: body mass index; *p<0.05; **data subjected to logarithmic transformation.

to lean body mass (p=0.001), BM (p=0.006) and BMI (p=0.048).

Table 2 describes the absolute and relative frequencies of the somatotype categories per group. Although the number of participants in each group was different, the largest proportion of participants corresponded to the endo-mesomorph, followed by the mesomorph endomorph category. The ecto-mesomorph category comprised the lowest number of participants. We should observe that the sample exhibited only 7 out of Heath-Carter's 13 somatotype categories.

Figure 1 depicts the distribution of somatotype categories for the total sample (n=12) and per group (ADM, n=50, operational – n=71). The graphic was plotted based on the mean value of each component. As is shown, the somatotype categories did not vary much, but all corresponded to the endo-mesomorph.

DISCUSSION

The aims of the present study were to investigate the anthropometric profile of military firefighters and compare it between groups ADM and operational. Both groups exhibited BFP and BMI above the recommended levels[5,15]. Only mean BM, lean body mass and BMI exhibited statistically significance (p<0.05) between the groups, the values being higher for the operational group. On somatotype analysis, fatness and musculoskeletal robustness stood out. Thus being, our initial hypothesis was partially confirmed.

BFP was above the recommended values in both groups. While the reference range that ensures an adequate state of health for men is 10% to 15%, the range recommended for optimal fitness — desirable for firefighters considering their routine work — is 12 to 18%[15]. On these grounds, the percentages found in the present study (Table 1) are above the recommended ones. This finding suggests that the

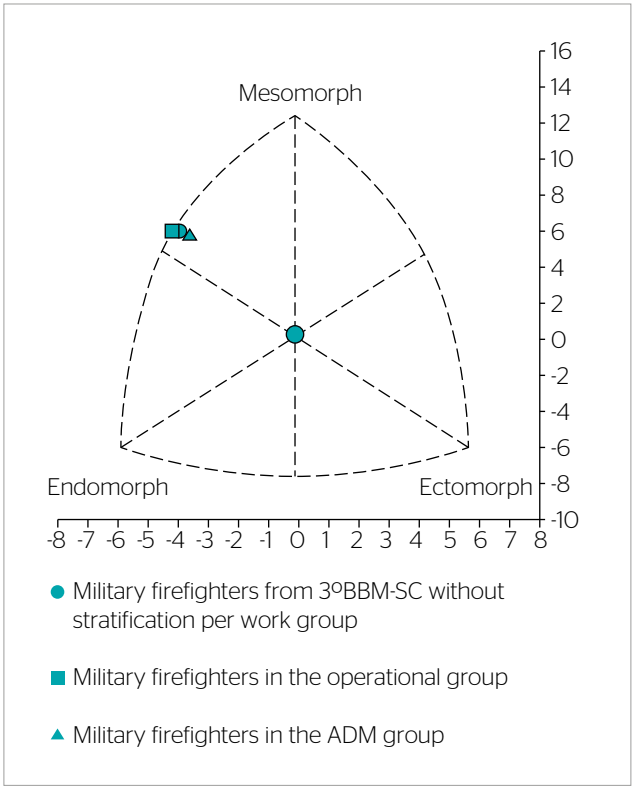

Figure 1. Distribution of somatotypes among military firefighters, Santa Catarina, 2016.

Table 2. Distribution of participants in groups administrative work (n=50) and operational (n=71) per somatotype category, Santa Catarina, 2016.

Category	ADM (n)	ADM (%)	Operational (n)	Operational (%)
Endo-mesomorph	26	52.0	40	56.3
Meso-endomorph	05	10.0	06	8.5
Mesomorph-endomorph	12	24.0	15	21.1
Balanced mesomorph	03	6.0	03	4.2
Ecto-mesomorph	01	2.0	04	5.6
Mesomorph-ectomorph	00	0.0	01	1.4
Central	03	6.0	02	2.8

ADM: administrative.

investigated population probably needs to be encouraged to regularly perform physical activity and have a balanced diet to reduce BFP.

The results of previous studies conducted with Brazilian military firefighters agree with ours, as the BFP found was 22.08[6] and 20.70%[16]. However, BFP was lower in other studies: 15.10[9], 11.10[17], 11.00[18] and 16.30%[19]. Adequate BFP is relevant for firefighters, because high BFP is a risk factor related to metabolic syndrome and impairs their physical performance[6,9,20]. Also reduction of BFP below the recommended minimum might be harmful, as the body fat is crucial for metabolic reactions and as energy source[7].

BMI was calculated from BM and HGT. According to the WHO classification[5], the BMI found in the analyzed sample (Table 1) corresponded to the overweight range (25.0–29.9) in both groups. It should be noticed that BMI alone is not recommended as indicator for individuals who exercise regularly, as a high lean body mass interferes with the interpretation of findings[6,19]. Nevertheless, it is still frequently used in studies performed in other countries on the prevalence of overweight and obesity among firefighters [4,10,12,21,22].

A study conducted with newly hired firefighters[18] found that low BMI was appropriate to ensure high-quality professional activity. Some studies[18,19] reported values lower than the ones found in the present study, which only agree with the ones reported in a study conducted with firefighters from the state of Rio Grande do Sul, Brazil[11]. This discrepancy might be accounted for by the fact that the BM found in the two aforementioned studies was lower than in ours, and as BMI is calculated based on BM, the latter might be the key factor in the explanation of the difference between studies.

WC was another health indicator we analyzed. The cutoff points established by SBC for "increased risk" and "substantially increased risk" among men are 94 cm and 102 cm, respectively. In the present study, the WC values were below the cutoff points (Table 1) in both groups, and similar to the ones reported in a previous study conducted with a similar population[11]. In addition, as the BFP (subcutaneous fat) values were "above the recommended ones", but the ones of WC (visceral fat) were not, one might infer that in the present sample fat was more concentrated at the subcutaneous level.

The two-compartment division of the human body comprises the fat and lean body mass. In the present study, the lean body mass corresponded to 78.8% of BM in ADM and to 78.2% in the operational group. In other studies conducted with military firefighters the lean body mass was 60.0±5.2 kg[17] and 64.1±7.1 kg[18], corresponding to 88.4% and 89.0% of BM, respectively. Therefore, the percent lean body mass seems to be lower in the present sample compared to the populations of other studies. Lean body mass has positive correlation with physical aspects such as strength, power and speed, which are relevant for the tasks performed military firefighters[13].

Assessment of somatotypes contributes to the estimation of the relative proportion of body components that might influence the health and performance of military firefighters. The results of the present study (Table 2) show that most of the participants from both groups corresponded to the endo-mesomorph category, in which musculoskeletal robustness is the dominant component followed by fatness. In second place came the meso-morph-endomorph category, in which the participation of fatness and musculoskeletal robustness is equivalent. In turn, slenderness (ectomorphy) was the least frequent in both groups. Although no biotype is considered to be ideal for military firefighters, predominance of fatness is not desirable, as it affects the health and work of this population[6,13]. The similarity in somatotypes between the groups (mean) and also by comparison to the total sample is depicted in Figure 1.

Since the work demands are different for ADM and the operational group, and the latter's work poses more physical demands, we expected statistically significant difference in body composition, somatotypes and obesity indicators between the groups. As a fact, we expected that BFP, WC and BMI would be lower and lean body mass higher in the operational group. However, analysis of the results (Table 1) showed that only BM, lean body mass and BMI exhibited statistically significant difference, being the values higher for the operational group compared to ADM. Significant difference was not found for the remainder of the analyzed variables.

The difference found in lean body mass between the groups might explain the differences in BM and BMI. The fact that lean body mass was higher in the operational group compared to ADM and the groups did not differ in

fat body mass might account for the higher BM (heavier, due to more lean body mass) and BMI (calculated based on BM) in the former. One factor that might help explain the difference in lean body mass between the groups is the work demands to which they are exposed, which are considerable heavier for firefighters in the operational group[3], resulting in increased lean body mass. Nevertheless, it is difficult to explain why variables lean body mass, BMI and BMI exhibited statistically significant difference but BFP did not. More thorough assessment of the level of physical activity and diet of the target population is thus needed. We might speculate that the physical demands imposed on the operational group promotes increase of the lean body mass, which is however not attended by reduction of the body fat, or alternatively, that the workers' diet interferes somehow in this process.

Differences were expected in the distribution of the participants as a function of the somatotype categories. As the groups differed in lean body mass, we expected that the operational group would exhibit a larger proportion of the somatotype categories defined by musculoskeletal robustness. However, the results suggest that although this group had indeed high lean body mass, it also exhibited considerable fat body mass. In turn, slenderness was the least frequent aspect.

Some limitations of the present study are deserving of mention. First, we did not investigate practice of physical activity at and outside the institution. Information on this parameter might have helped explain the results obtained. We neither inquired the participants as to their dietary habits, which would have also helped explain the results obtained. Finally, we did not use more robust instruments for determination of the body composition. The reason is that use of such instruments would have increased the cost of the study and required a longer period of data collection at the firefighter headquarters. Therefore, we recommend for future studies to investigate the dietary habits and practice of physical activity of the target population to account more soundly for the findings relative to body composition and somatotypes.

CONCLUSION

The present study found that BFP and BMI were above the recommended levels among the analyzed military firefighters, but WC was below the cutoff points indicative of risk. Difference was found in BM, BMI and lean body mass between the groups, the values being higher for the operational group. The results of the present study might help the targeted professionals and institution detect probable risks to health derived from inadequate body composition. As such we believe that research should continue to monitor possible changes in the anthropometric profile of the participants.

ACKNOWLEDGMENTS

The authors thank 3º BBM-SC for collaborating in the present study. We also thank the Brazilian Federal Agency of Support and Evaluation of Graduate Education (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior — CAPES) for its financial support.

REFERENCES

1. Tsismenakis AJ, Christophi CA, Burress JW, Kinney AM, Kim M, Kales SN. The obesity epidemic and future emergency responders. Obesity (Silver Spring). 2009;17(8):1648-50. https://doi.org/10.1038/oby.2009.63
2. Nogueira EC, Porto LG, Nogueira RM, Martins WR, Fonseca RM, Lunardi CC, et al. Body composition is strongly associated with cardiorespiratory fitness in a large Brazilian military firefighter cohort: The Brazilian Firefighters Study. J Strength Cond Res. 2016;30(1):33-8. https://doi.org/10.1519/JSC.0000000000001039
3. 3º Batalhão de Bombeiros Militar. Relatório de atividades 2015. Blumenau: 3º Batalhão de Bombeiros Militar; 2016. 55p.
4. Donovan R, Nelson T, Peel J, Lipsey T, Voyles W, Israel RG. Cardiorespiratory fitness and the metabolic syndrome in firefighters. Occup Med. 2009;59(7):487-92. https://doi.org/10.1093/occmed/kqp095
5. World Health Organization. Global report on diabetes. Geneva: World Health Organization; 2016. 88p.
6. Confortin FG, Soeiro M. Estado nutricional dos alunos soldados bombeiros militares *versus* soldados bombeiros do oeste do estado de Santa Catarina. Rev Bras Nut Esport. 2014;8(44):103-9.
7. Heyward VH. Avaliação física e prescrição de exercício: técnicas avançadas. 6ª ed. Porto Alegre: Artmed; 2013.

8. Glaner MF. Importância da aptidão física relacionada à saúde. Rev Bras Cineantropom Desempenho Hum. 2003;5(2):75-85. https://doi.org/10.5007/%25x
9. Boldori R. Aptidão física e sua relação com a capacidade de trabalho dos bombeiros militares do Estado de Santa Catarina [mastering dissertation]. Florianópolis: Universidade Federal de Santa Catarina; 2002.
10. Soteriades ES, Hauser R, Kawachi I, Christiani DC, Kales SN. Obesity and risk of job disability in male firefighters. Occup Med. 2008;58(4):245-50. https://doi.org/10.1093/occmed/kqm153
11. Canabarro LK, Rombaldi AJ. Risco de sobrepeso e obesidade em soldados do corpo de bombeiros. Pensar a Prática. 2010;13(3):1-13. https://doi.org/10.5216/rpp.v13i3.10169
12. Storer TW, Dolezal BA, Abrazado ML, Smith DL, Batalin MA, Tseng CH, et al. Firefighter health and fitness assessment: a call to action. J Strength Cond Res. 2014;28(3):661-71. https://doi.org/10.1519/JSC.0b013e31829b54da
13. Michaelides MA, Parpa KM, Henry LJ, Thompson GB, Brown BS. Assessment of physical fitness aspects and their relationship to firefighters' job abilities. J Strength Cond Res. 2011;25(4):956-65. https://doi.org/10.1519/JSC.0b013e3181cc23ea
14. Sociedade Brasileira de Cardiologia. I Diretriz Brasileira de Diagnóstico e Tratamento da Síndrome Metabólica. Rev Bras Hipertens. 2004;7(4).
15. Foss ML, Keteuyan SJ. Bases fisiológicas do exercício e do esporte. 6ª ed. Rio de Janeiro: Guanabara Koogan; 2000.
16. Sousa TF, Ferreira WM, Santos SFS, Fonseca SA. Capacidade para o trabalho e aptidão física em bombeiros militares. Rev Saúde Pesq. 2012;5(2):310-8.
17. Arques FAB. Alterações da composição corporal no decurso do processo de recruta em candidatos a bombeiro profissional [mastering dissertation] Porto: Universidade do Porto; 2010.
18. Mezzaroba PV, Peserico CS, Machado FA. Efeito de 27 semanas de treinamento físico obrigatório na aptidão física e antropometria de bombeiros recém-admitidos. Rev Bras Cien Mov. 2013;21(4):103-11. http://dx.doi.org/10.18511/0103-1716/rbcm.v21n4p103-111
19. Perez AJ. Efeitos de diferentes modelos de periodização do treinamento aeróbio sobre parâmetros cardiovasculares, metabólicos e composição corporal de bombeiros militares. Rev Bras Educ Fís Esp. 2013;27(3):363-76.
20. Ciolac EG, Guimarães GV. Exercício físico e síndrome metabólica. Rev Bras Med Esp. 2004;10(4):319-24. http://dx.doi.org/10.1590/S1517-86922004000400009
21. Munir F, Clemes S, Houdmont J, Randall R. Overweight and obesity in UK firefighters. Occup Med. 2012;62(5):362-5. https://doi.org/10.1093/occmed/kqs077
22. 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. Int Arch Occup Environ Health. 2016;89(3):435-48. https://doi.org/10.1007/s00420-015-1082-6

Correspondence address: Débora Aparecida Knihs – Laboratório de Biomecânica, Centro de Desportos, Universidade Federal de Santa Catarina – Rua Vereador Frederico Veras – CEP: 88040-000 – Carvoeira – Florianópolis (SC), Brazil – E-mail: deboraknihs@gmail.com