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Analysis of the Metabolic and Cardiorespiratory Profiles of Female Military Personnel Belonging to Operative and Non-operative Military Organizations of the Brazilian Army

Análisis del perfil metabólico y cardiorrespiratorio de mujeres militares pertenecientes a organizaciones militares operativas y no operativas del Ejército brasileño

Abstract: The metabolic and cardiorespiratory profiles of 301 female soldiers from Non-Operative Military Organizations (OMNOP) and Operative Organizations (OMOP) of the Brazilian Army were compared. This is an analytical cross-sectional study, which analyzed the following variables:cardiorespiratory fitness, biochemical markers and body composition. In the difference of VO_{2max} averages, the OMOP military had statistically higher scores (M = 36.2 ± 4.4 ml/kg/min) than the OMNOP (M = 34.2 ± 5.7 ml/kg/min). VO_{2max} correlated positively with HDL cholesterol and negatively with triglyceride and BMI. On the other hand, BMI correlated negatively with HDL cholesterol and positively with triglyceride and glucose. Glucose correlated with HDL cholesterol. The results of the study corroborated the evidence in the literature regarding productive, positive and negative associations between VO_{2max} and indicators of cardiovascular health.

Keywords: cardiorespiratory fitness; metabolic profile; body composition.

Resumen: Se compararon los perfiles metabólicos y cardiorrespiratorios de 301 mujeres militares, integrantes de Organizaciones Militares No Operativas (OMNOP) y Organizaciones Militares Operativas (OMOP) del Ejército Brasileño. Se trata de un estudio transversal analítico, en el que se analizaron las siguientes variables: aptitud cardiorrespiratoria, marcadores bioquímicos y composición corporal. En la diferencia de medias de $VO_{2máx}$, las militares de OMOP tuvieron puntuaciones estadísticamente más altas (M = 36,2 ± 4,4 ml/kg/min) que las de OMNOP (M = 34,2 ± 5,7 ml/kg/min). El $VO_{2máx}$, se correlacionó positivamente con el colesterol HDL (lipoproteína de alta densidad) y negativamente con los triglicéridos y el índice de masa corporal (IMC). El IMC se correlacionó negativamente con HDL y positivamente con triglicéridos y glucosa. La glucosa, a su vez, se correlacionó negativamente con HDL. Los resultados de este artículo corroboran las evidencias halladas en la bibliografía sobre las asociaciones significativas entre el $VO_{2máx}$, y los indicadores de salud cardiovascular.

Palabras clave: aptitud cardiorrespiratoria; perfil metabólico; composición corporal.

Paula Fernandez Ferreira
Exército Brasileiro. Instituto de Pesquisa da Capacitação Física do Exército. Rio de Janeiro, RJ, Brasil.
bioquimica.ipcfex@gmail.com

Marcio Antonio de Barros Sena
Exército Brasileiro. Instituto de Pesquisa da Capacitação Física do Exército. Rio de Janeiro, RJ, Brasil.
mabsmarcio@gmail.com

Aline Tito Barbosa Silva
Exército Brasileiro. Instituto de Pesquisa da Capacitação Física do Exército. Rio de Janeiro, RJ, Brasil.
aline.tito@yahoo.com

Runer Augusto Marson
Exército Brasileiro. Instituto de Pesquisa da Capacitação Física do Exército. Rio de Janeiro, RJ, Brasil.
runer.marson@gmail.com

Marcos de Sá Rego Fortes
Exército Brasileiro. Instituto de Pesquisa da Capacitação Física do Exército. Rio de Janeiro, RJ, Brasil.
msrfortes@gmail.com

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1 INTRODUCTION

The inclusion of women in the Brazilian Armed Forces dates back to the late 1980s and early 1990s. In the Brazilian Army (EB), the pioneering military women, who entered the career through public tender, recently completed the cycle of 30 years of service provision and, in 2017, the first group of women joined the Army Cadet Preparatory School, in the line of military education. Brazil is part of the agreements included in the United Nations' Women, Peace and Security program, which aims to increase women's participation in peacekeeping missions. According to the guideline on increasing EB participation in UN Peacekeeping Operations (BRAZIL, 2022), minimum percentages of female soldiers must be met for the deployment in peacekeeping operations, as recommended in the UN Uniformed Gender Parity Strategy 2018-2028. In this context, the importance of maintaining the health and physical fitness of military women is emphasized for the fulfillment of the various functions of the craft, at the national and international levels (FIELDHOUSE; O'LEARY, 2020; JONES *et al*., 2019; MACGREGOR *et al*., 2021).

The Armed Forces around the world strive to maintain their personnel in conditions of physical health for combat (NINDL *et al*., 2012; OJANEN *et al*., 2018; OJANEN; JALANKO; KYRÖLÄINEN, 2018).

Nevertheless, there is a growth in cardiometabolic diseases, for example, obesity and type 2 diabetes mellitus. Within the scope of the military career, some factors can contribute to this risk, such as stress, reduced physical activity, decreased sleep time and poor food choices.

In view of the necessary adjustments for the full integration of the military during their training, the Department of Education and Culture of the Army (DECEx) structured the Project for the Insertion of the Female Sex in the War Teaching Line (PISFLEMB), and the Army Physical Training Research Institute (IPCFEx) is responsible for actions regarding the physical training and monitoring of the health status of the combatant military. With regard to the female military, there are few scientific studies dedicated to this segment, considering its physiological particularities and life stages and, allied to these, the relationship with military activity, a gap that this article proposes to fill (O'LEARY; WARDLY; GREEVES, 2020; SCHRAM *et al*., 2022). Thus, this article intends to make a comparative analysis of the biochemical and cardiorespiratory profiles of female military personnel, in Non-Operative Military Organizations (OMNOP) and Operative Organizations (OMOP) of the EB, as well as to verify the association between the biochemical variables BMI and VO_{2max}. Therefore, this research is based on data collected in field surveys carried out by IPCFEx in 2018, with a sample of military personnel, representative of EB. The answers provided in this study will allow for the adoption of strategies to contribute to the improvement of the health and quality of life of the female military personnel of both types of OM, in addition to assuming that the military physical training (TFM) carried out in preparation for the physical assessment test (TAF) is consistent with the purpose of achieving better health indicators.

2 THEORETICAL REVIEW

In a survey carried out between 2014 and 2016 among EB military personnel and members of the UN peacekeeping mission contingents, the prevalence of metabolic syndrome (MS)

was 15% (ROSA *et al*., 2018). Another study, with 2,719 EB military personnel, found a prevalence of 12.2% (FORTES *et al*., 2019). It is noteworthy that both surveys included only male soldiers in the samples, although epidemiological data demonstrate that military training and operational environments induce greater damage in females when compared to males (NINDL *et al*., 2016).

Biochemical variables considered as MS risk factors, namely blood glucose (GLU), HDL-cholesterol (high-density lipoprotein) and triglycerides (TRIG), are related to an increased risk of developing cardiovascular diseases (LEE *et al*., 2021; TOTH *et al*., 2013). In relation to blood glucose, the decrease in the sensitivity of insulin receptors in the target tissues causes a condition of insulin resistance (IR) and elevation of blood glucose (YARIBEYGI *et al*., 2019), being related to the development of type 2 *diabetes mellitus*. In this sense, several studies have already been carried out to understand the effects of IR on metabolism in different tissues, for example, liver, muscle and fat, in addition to inflammation and other important biological processes (BÓDIS; RODEN, 2018; PETERSEN; SHULMAN, 2018; YANG; VIJAYAKUMAR; KAHN, 2018). As for HDL-cholesterol, studies show an inverse relationship between its systemic levels and cardiovascular risk (CVR) (NICHOLLS; NELSON, 2019). In addition to its key role in the reverse transport of cholesterol, HDL-c has a range of functional properties, which may exert a protective influence on inflammation, oxidative stress, angiogenesis and glucose homeostasis. Regarding TRIG levels, epidemiological analyzes have shown that high levels, even within the reference range, are related to higher CVR (BUDOFF, 2016; VALLEJO-VAZ *et al*, 2020). The desirable value of TRIG measured in the fasted state for adult subjects is less than 150 milligrams per deciliter (mg/dL).

Physical training is an important, effective and recommended non-pharmacological intervention for improving health and treating metabolic diseases such as obesity (KHALAFI *et al*., 2021). Recent data suggest that cardiorespiratory fitness (ACR) plays an important role in reducing not only cardiovascular mortality, but also myocardial infarction, hypertension, diabetes, atrial fibrillation, heart failure, and stroke (AL-MALLAH; SAKR; AL-QUNAIBET, 2018; SEALS; NAGY; MOREAU, 2019). Regarding the differences in physical performance between the sexes, it can be explained, according to literature review, due to the physiological and morphofunctional differences of men and women (FORTES *et al*., 2015). In military personnel, when the treadmill walk with progressive load (0%, 20% and 40% of body mass) was analyzed, the physiological demands increased with heavier loads, however, there was no difference between the sexes when compared to the relative VO_{2max}. In addition, in all load conditions, women worked with a higher relative intensity than men. (VICKERY-HOWE*et al*., 2020).

3 METHODOLOGY

This is an analytical cross-sectional study carried out in a convenience sample with 301 female military personnel, with a mean age of 34.6 ± 6.9 years and a mean BMI of 24.6 ± 4.1 kg/m^2. The sample was selected from a group of volunteer military personnel from all military regions of Brazil, participating in the Physical Assessment Test Project,

which was carried out by IPCFEx in 2018. The sample was divided into two groups: 62 military operative OM (OMOP) and 239 military non-operative OM (OMNOP). The OMOP are those organized and trained for use in military operations, while the OMNOP refer to the units that perform activities, mainly administrative, teaching, health and research. Female active-duty EB military personnel who were under health conditions considered fit to perform the physical evaluation test (TAF) and who delivered the results of laboratory tests (GLUC, TRIG, HDL-c) were included. This research was approved by the Ethics Council of the Marcílio Dias Naval Hospital, No. 1,551,242, CAAE No. 47835615.5.0000.5256, on July 11, 2019.

Cooper's test (COOPER, 1968) was performed in a straight plane with distance markings every 50 meters, between seven and half and nine o'clock in the morning, being applied by physical education professionals. From the result, VO_{2max} was calculated using the formula: (D - 504.9) / 44.73, in which D is the distance reached in meters (COOPER, 1968). In the assessment of body composition, mass and height were measured to estimate BMI, according to international standards (NORTON, 1996).

As for statistical analysis, according to the Central Limit Theorem, if a sample is large enough (greater than 30), whatever the distribution of the sample mean, it will be approximately normal. In this sense, in descriptive statistics, the measures of central tendency used were dispersion (mean and standard deviation) for continuous variables. In the statistical inference, to evaluate the differences in means between the two groups (OMOP and OMNOP), a parametric analysis was used with the helpof Student's t-test (GLU, HDL-c and TRIG) or Welch's test (VO_{2max}), depending on the violation of the assumption of homogeneity of variances, verified with the help of Levene's test. In addition, Pearson's Correlation test was used to evaluate the level of association between continuous variables, with Pearson's correlation coefficient values categorized as follows: from 0 to 0.3 (weak correlation); from 0.3 to 0.6 (moderate correlation); and from 0.6 to 0.9 (strong correlation) (CALLEGARI-JACQUES, 2009). The significance level adopted was $p < 0.05$, and the JAMOVI program (version 2.3.9) was used for the statistical analysis.

4 RESULTS

The results of this research will be presented with the help of tables.

Table 1 – Mean (M) and Standard Deviation (SD) values of the variables: Age, Body Mass, Height and BMI of the military women of the sample

	OMOP	OMNOP
Age (years)	32.9 ± 6.5	35.1 ± 7.0
Body mass (kg)	64.2 ± 9.3	66.3 ± 10.9
Height (cm)	164.3 ± 7.1	163.8 ± 7.1
BMI (kg/m^2)	23.9 ± 3.7	24.8 ± 4.2

OMOP = Military Operative Organization; OMNOP = Military Non-Operative Organization; BMI = Body Mass Index. Data were expressed as means and standard deviations

Source: Prepared by the author, 2023.

Table 2 – *T-test* for independent samples in military women of OMNOP and OMOP

	GROUP	M	DP	p-value
VO_{2max} (mL/Kg/min)	**OMNOP**	34.2	5.7	0.002*
	OMOP	36.2	4.4	
GLU (mg/dL)	**OMNOP**	87.7	8.6	0.375
	OMOP	86.6	7.8	
HDL-c (mg/dL)	**OMNOP**	62.3	14.5	0.821
	OMOP	62.8	15.1	
TRIG (mg/dL)	**OMNOP**	89.8	39.3	0.730
	OMOP	91.7	33.6	

VO_{2max} = Maximum Oxygen Consumption; GLU = glucose; HDL-c = high-density lipoprotein;
TRIG = triglycerides; OMOP = Military Operative Organization; OMNOP = Military Non-Operative Organization.
* = significant difference. Data were expressed as means and standard deviations.
Source: Prepared by the author, 2023.

So, to investigate the extent to which VO_{2max} levels were different between OMNOP and OMOP, Welch's t-test for independent samples was performed, since the assumption of homogeneity of variance, evaluated by Levene's test, was violated ($p < 0.05$). For biochemical markers, Student's t-test was performed. The result obtained shows there were significant differences only in the variable VO_{2max}, in which the OMOP military obtained a statistically higher result (M = 36.2 ± 4.4 ml/Kg/min) than the military of OMNOP (M = 34.2 ± 5.71 ml/Kg/min). In the other variables, however, no significant results were found. One should note the percentage of military personnel of OMOP with blood glucose, HDL-c, and triglycerides levels within the reference values, according to the Brazilian Society of Dyslipidemias and the Brazilian Society of Diabetes, was 99%, 95.4% and 98.7%, respectively. In relation to the military of OMNOP, the percentages were: 96.4%, 81.1% and 95%, respectively.

Table 3 – Correlation Matrix between all variables of the study of female military of the EB

		TRIG	GLU	HDL-c	BMI	VO_{2max}
TRIG	Pearson r	—				
	p-value	—				
GLU	Pearson r	0.089$^{n.s}$	—			
	p-value	0.123$^{n.s}$	—			
HDL-c	Pearson r	-0.030$^{n.s}$	**-0.194*****	—		
	p-value	0.604	<0.001	—		
BMI	Pearson r	**0.129***	**0.154****	**-0.224*****	—	
	p-value	0.026	0.007	< 0.001	—	
VO_{2max}	Pearson r	**-0.168****	-0.051$^{n.s}$	**0.123***	**-0.288*****	—
	p-value	0.004	0.380	0.033	<0.001	—

BMI = Body Mass Index; GLU = glucose; HDL-c = high-densitylipoprotein;
TRIG = triglycerides; VO_{2max} = Maximum Oxygen Consumption.
Note. * p <05, ** p <.01, *** p <.001,
n.s. = non-significant relationship
Source: Prepared by the author, 2023.

In the matrix above, one can observe that VO_{2max} correlated significantly and positively with HDL-c (r =0.123; p=0.03) and negatively with both TRIG (r=-0.168; p=0.004) and BMI (r = -0.288; p < 0.001). BMI, in addition to VO_{2max}, correlated with all variables of the analysis, namely: negatively with HDL-c (r = -0.224; p < 0.001); and positively with TRIG (r = 0.129; p=0.026) and GLU (r = 0.154; p = 0.007). GLU, in addition to BMI, was statistically negatively correlated with HDL-c (r = -0.194; p < 0.001).

5 DISCUSSION

Since military physical training is compulsorily inserted into the routines of corporations, the results of this article point to the positive effects of its practice on the metabolic profile and body composition, regardless of the end activity of the OM in which the military woman performs its job. This inference is consistent with studies that examined long training programs, for example, a six-month study that examined a mixed sample of both healthy and sedentary men and women, and demonstrated significantly positive changes in total cholesterol and HDL-c (DUNN, 1997). In relation to cardiopulmonary capacity, female military personnel from OMOP presented higher values compared to military personnel from OMNOP. This result can be explained by the higher physical demand required in OMOP to perform imediate missions, which leads to improved aerobic conditioning.

The mean BMI in both types of OM considered as normal (BMI ≤ 25) and the favorable metabolic profile were evidenced, with all averages of biomarkers concentrations within the reference values (RV) (GLU RV < 100 mg/dL, HDL-c RV > 50 mg/dL and TRIG RV < 150 mg/dL). In these lipid and glycemic profile variables, no significant difference was found between the OMOP and OMNOP groups. These results are consistent with those presented in the literature, according to research by Lemura (2000), which exclusively examined women under the effects of 16 weeks of resistance exercises, with a significant increase in HDL-c and a decrease in TRIG concentration. Another study should be highlighted, in which women underwent 24 weeks of functional training, showing an increase in the strength variable, which directly contributed to improved metabolism and, therefore, better expression of biomarkers (NINDL *et al*., 2017).

Regardless of the training programs (aerobic and neuromuscular) used by both types of military organizations, favorable metabolic profiles are observed (AHMETI *et al*., 2020; MOGHARNASI *et al*., 2017). In the study by Schroeder *et al*. (2019), it was observed that the changes induced by three distinct training programs for 8 weeks in fasting lipids and glycemia were small and did not vary between the training groups and the control without training. Another study with women from two different countries, despite cultural and socioeconomic differences that led to a different involvement in physical training programs, reported differences in cardiometabolic parameters, HDL-c and total cholesterol; however, no difference in TRIG levels was observed between the groups. In the case of this study, women with a higher age group and BMI (Age: 50 years; BMI: 29.5 Kg/m^2) were evaluated than in that study.

Cardiorespiratory fitness (ACR) refers to the ability of the circulatory and respiratory systems to deliver oxygen to the mitochondria of skeletal muscle for the production of energy required during a physical activity (ROSS *et al*., 2016). Namely, OMOPs are those that, due to their functional characteristic, of operational activities, are employed in combat situations; therefore, it becomes interesting that this group presents an optimal ACR. In this context, the OMOP group had a significantly higher mean compared to OMNOP. According to the American Society of Sports Medicine, the VO_{2max} results of OMOP and OMNOP are classified as excellent and good, respectively (RIEBE *et al*., 2018). In addition, the positive association between HDL levels and VO_{2max} in this research corroborates the results that point to the fact that women with better cardiorespiratory fitness had higher levels of HDL-c (APARICIO, 2012). In this scenario, we list this result as satisfactory, as individuals with a better VO_{2max} have positive associations with health indicators and are associated with a lower prevalence of metabolic syndrome (KELLEY *et al*., 2018). This article therefore found an association between ACR and the biochemical markers TRIG and HDL-c, which corroborates studies that demonstrate that aerobic training and higher levels of ACR are related to lower cardiometabolic risks (AHMETI *et al*., 2020; HAAPALA *et al*., 2022).

Despite the limitations found, particularly regarding the control of temperature, humidity and the phase of the menstrual cycle, which can interfere with physical performance, we highlight, with the help of the results found, the positive effects of the practice of TFM on the glycemic lipid panel and on the cardiopulmonary capacity of female soldiers from the various OM of the EB. However, no differences were evidenced between the biochemical and body composition parameters of the military from OMOP and OMNOP, probably because these markers present positive results in the physically active sample of this research. Another limitation refers to laboratory tests having been performed in different laboratories, which may lead to possible differences in the analysis methodologies.

It is worth mentioning the importance of monitoring the health status of military personnel who perform different missions within the EB, as the increase in the prevalence of cardiovascular risk factors in the civilian and military population is alarming (FORTES *et al*., 2019). In this context, this article, which involved physically active female participants, apparently healthy and with BMI within the normal range, contributes with knowledge to outline the profile of the EB military and association between the physical parameter and biochemical and morphological markers.

6 CONCLUSION

This article involved healthy female participants with BMI within the normal range, however, due to the alarming trends of increasing cardiovascular risk factors in the civilian and military population, it is of paramount importance to monitor the health status of officers of military units in different missions.

A good metabolic profile was observed, with no difference between the groups studied; however, there was a difference in the cardiopulmonary fitness of the groups. Although a weak association was found between BMI and biochemical variables and VO_{2max} with TRIG and

HDL-c, these data are in agreement with the established literature, since body composition and cardiopulmonary fitness are related to better indicators of cardiovascular health.

Finally, this research provides a profile of the female population of the EB, thus contributing to advances in management strategies to control chronic non-communicable diseases and improve the physical and operative capacity of the ground troops.

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AUTHORS' CONTRIBUTIONS

1 – Paula Fernandez Ferreira: study planning, data collection and analysis, writing and review of the article.

2 – Marcio Antonio de Barros Sena: data collection, writing and review of the article.

3 – Aline Tito Barbosa: writing and reviewing the article.

4 – Runer Augusto Marson: study planning and data analysis.

5 – Marcos de Sá Rego Fortes: study planning, writing, data analysis and article review.

All authors read and approved the final article.

REFERENCES

AHMETI G. B.; IDRIZOVIC, K.; ELEZI, A.; ZENIC, N.; OSTOJIC, L. Endurance Training vs. Circuit Resistance Training: Effects on Lipid Profile and Anthropometric/Body Composition Status in Healthy Young Adult Women. **International Journal of Environmental Research and Public Health**, Basel, v. 17, n. 4, p. 1-15, 2020. Available from: https://www.mdpi.com/1660-4601/17/4/1222. Access: April 27, 2023.

AL-MALLAH, M. H.; SAKR, S.; AL-QUNAIBET, A. Cardiorespiratory Fitness and Cardiovascular Disease Prevention: an Update. **Current Atherosclerosis Reports**, New York, v. 20, n. 1, 2018. Available from: https://link.springer.com/article/10.1007/s11883-018-0711-4. Access: April 27, 2023.

APARICIO, V. A.; ORTEGA, F. B.; CARBONELL-BAEZA, A.; FERNÁNDEZ, M.; SENHAJI, M.; RUIZ, J. R.; ERRAMI, M.; DELGADO-FERNÁNDEZ, M.; ARANDA, P. Fitness, fatness and cardiovascular profile in South Spanish and North Moroccan women. **Nutricion Hospitalaria**, Madrid, v. 27, n. 1, p. 227-231, 2012. Available from: https://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-16112012000100029&lng=es&nrm=iso&tlng=en. Access: April 27, 2023.

BÓDIS, K.; RODEN, M. Energy metabolism of white adipose tissue and insulin resistance in humans. **European Journal of Clinical Investigation**, Hoboken, v. 48, n. 11, 2018. Available from: https://onlinelibrary.wiley.com/doi/10.1111/eci.13017. Access: April 27, 2023.

BRASIL. Ministério da Defesa. Exército Brasileiro. Estado-Maior do Exército. **Portaria nº 1.771-EME, de 14 de junho de 2022**. Aprova a Diretriz para o incremento da participação do Exército Brasileiro em Operações de Paz da Organização das Nações Unidas (ONU) e na sede da ONU, em Nova Iorque – (EB10-D-01.039). Brasília, DF: Ministério da Defesa, 2022. Available from: http://www.sgex.eb.mil.br/sg8/006_outras_publicacoes/01_diretrizes/01_comando_do_exercito/port_n_1771_cmdo_eb_14jun2022.html. Acesso em April 27, 2023.

BUDOFF, M. Triglycerides and Triglyceride-Rich Lipoproteins in the Causal Pathway of Cardiovascular Disease. **The American Journal of Cardiology**, Amsterdam, v. 118, n. 1, p 138-145, 2016. Available from: https://www.ajconline.org/article/S0002-9149(16)30484-2/fulltext. Access: April 27, 2023.

CALLEGARI-JACQUES, S. M. **Bioestatística**: princípios e aplicações. Porto Alegre: Artmed, 2009.

DUNN, A. L.; MARCUS, B. H.; KAMPERT, J. B.; GARCIA, M. E.; KOHL, H. W.; BLAIR, S. N. Reduction in cardiovascular disease risk factors: 6-month results from Project Active. **Preventive Medicine**, Amsterdam, v. 26, n. 6, p. 883–892, 2017. Available from: https://www.sciencedirect.com/science/article/pii/S0091743597902188?via%3Dihub. Access: April 27, 2023.

FIELDHOUSE, A.; O'LEARY, T. J. Integrating women into combat roles: Comparing the UK Armed Forces and Israeli Defense Forces to understand where lessons can be learnt. **BMJ Military Health**, London, v. 169, n. 1, p. 78-80, 2020. Available from: https://militaryhealth.bmj.com/content/169/1/78.long. Access: April 27, 2023.

FORTES, M. S. R.; MARSON, R. A.; MARTINEZ, E. C. Comparação de Desempenho entre Homens e Mulheres: Revisão de Literatura. **Revista Mineira de Educação Física**, Viçosa, v. 23, p. 54, 2015. Available from: https://periodicos.ufv.br/revminef/article/view/9964. Access: April 27, 2023.

FORTES, M. S. R.; DA ROSA, S. E.; COUTINHO, W.; NEVES, E. B. Epidemiological study of metabolic syndrome in Brazilian soldiers. **Archives of Endocrinology and Metabolism**, São Paulo, v. 63, n. 4, p. 345-350, 2019. Available from: https://www.scielo.br/j/aem/a/R5TxygTTb96CsMtwRWYwtHQ/?lang=en. Access: April 27, 2023.

HAAPALA, E. A.; TOMPURI, T.; LINTU, N.; VIITASALO, A.; SAVONEN, K.; LAKKA, T. A.; LAUKKANEN, J. A. Is low cardiorespiratory fitness a feature of metabolic syndrome in children and adults? **Journal of Science and Medicine in Sport**, London, v. 25, n. 1, p. 923-929, 2022. Available from: https://www.jsams.org/article/S1440-2440(22)00213-4/fulltext. Access: April 27, 2023.

JONES, N.; GREENBERG, N.; PHILLIPS, A.; SIMMS, A.; WESSELY, S. British military women: Combat exposure, deployment and mental health. **Occupational Medicine**, Oxford, v. 69, n. 8-9, p. 549-558, 2019. Available from: https://academic.oup.com/occmed/article/69/8-9/549/5548904?login=false. Access: April 27, 2023.

KELLEY, E.; IMBODEN, M. T.; HARBER, M. P.; FINCH, H.; KAMINSKY, L. A.; WHALEY, M. H. Cardiorespiratory Fitness Is Inversely Associated with Clustering of Metabolic Syndrome Risk Factors: The Ball State Adult Fitness Program Longitudinal Lifestyle Study. **Mayo Clinic Proceedings**: Innovations, Quality & Outcomes, Scottsdale, v. 2, n. 2, p. 155-164, 2018. Available from: https://www.mcpiqojournal.org/article/S2542-4548(18)30023-7/fulltext. Access: April 27, 2023.

KHALAFI, M.; MALANDISH, A.; ROSENKRANZ, S. K.; RAVASI, A. A. Effect of resistance training with and without caloric restriction on visceral fat: A systemic review and meta-analysis. **Obesity Reviews**, Hoboken, v. 22, n. 9, 2021. Available from: https://onlinelibrary.wiley.com/doi/10.1111/obr.13275. Access: April 27, 2023.

LEE, H. R.; KIM, J. K.; KIM, J. H.; CHUNG, T. H. Compared to serum triglyceride alone, the association between serum triglyceride to high-density lipoprotein cholesterol ratio and 10-year cardiovascular disease risk as determined by Framingham risk scores in a large Korean cohort. **ClinicaChimica Acta**, Amsterdam, v. 520, p. 29-33, 2021. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0009898121001856?via%3Dihub. Access: April 27, 2023.

MACGREGOR, A.; ZOURIS, J.; DOUGHERTY, A.; DYE, J. Health Profiles of Military Women and the Impact of Combat-Related Injury. **Women's Health Issues**, Oxford, v. 31, n. 4, p. 392-398, 2021. Available from: https://www.whijournal.com/article/S1049-3867(21)00032-3/fulltext. Access: April 27, 2023.

MOGHARNASI, M.; CHERAGH-BIRJANDI, K.; CHERAGH-BIRJANDI, S.; TAHERICHADORNESHIN, H. The effects of resistance and endurance training on risk factors of vascular inflammation and atherogenesis in non-athlete men. **Interventional Medicine and Applied Science**, Budapest, v. 9, n. 4, p. 185-190, 2017. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6016202/. Access: April 27, 2023.

NICHOLLS, S. J.; NELSON, A. J. HDL and cardiovascular disease. **Pathology**, Amsterdam, v. 51, n. 2, p. 142-147, 2019. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0031302518305129. Access: April 27, 2023.

NINDL, B. C.; EAGLE, S. R.; FRYKMAN, P. N.; PALMER, C.; LAMMI, E.; REYNOLDS, K.; ALLISON, K.; HARMAN, E. Functional physical training improves women's military occupational performance. **Journal of Science and Medicine in Sport**, London v. 20, n. 4, p. 91-97, 2017. Available from: https://www.jsams.org/article/S1440-2440(17)30953-2/fulltext. Access: April 27, 2023.

NINDL, B. C.; JONES, B. H.; VAN ARSDALE, S. J.; KELLY, K.; KRAEMER, W. J. Operational physical performance and fitness in military women: Physiological, musculoskeletal injury, and optimized physical training considerations for successfully integrating women into combat-centric military occupations. **Military Medicine**, Oxford, v. 181, n. 1, p. 50-62, 2016. Available from: https://academic.oup.com/milmed/article/181/suppl_1/50/4209407?login=false. Access: April 27, 2023.

NINDL, B.; SCOFIELD, D.; STROHBACH, C.; CENTI, A.; EVANS, R.; YANOVICH, R.; MORAN, D. IGF-I, IGFBPs, and inflammatory cytokine responses during gender-integrated Israeli Army basic combat training. **The Journal of Strength and Conditioning Research**, Philadelphia, v. 26, n. 2, p. 73-81, 2012. Available from: https://journals.lww.com/nsca-jscr/Abstract/2012/07002/IGF_I,_IGFBPs,_and_Inflammatory_Cytokine_Responses.10.aspx. Access: April 27, 2023.

OJANEN, T.; JALANKO, P.; KYRÖLÄINEN, H. Physical fitness, hormonal, and immunological responses during prolonged military field training. **Physiological Reports**, London, v. 6, n. 17, p. 1-10, 2018. Available from: https://physoc.onlinelibrary.wiley.com/doi/10.14814/phy2.13850. Access: April 27, 2023.

OJANEN, T.; KYRÖLÄINEN, H.; IGENDIA, M.; HÄKKINEN, K. Effect of Prolonged Military Field Training on Neuromuscular and Hormonal Responses and Shooting Performance in Warfighters. **Military Medicine**, Oxford, v. 183, n. 11-12, p. 705-712, 2018. Available from: https://academic.oup.com/milmed/article/183/11-12/e705/5025890?login=false. Access: April 27, 2023.

O'LEARY, T. J.; WARDLE, S. L.; GREEVES, J. P. Energy Deficiency in Soldiers: The Risk of the Athlete Triad and Relative Energy Deficiency in Sport Syndromes in the Military. **Frontiers in Nutrition**, London, v. 7, p. 1-18, 2020. Available from: https://www.frontiersin.org/articles/10.3389/fnut.2020.00142/full. Access: April 27, 2023.

PETERSEN, M. C.; SHULMAN, G. I. Mechanisms of Insulin Action and Insulin Resistance. **Physiological Reviews**, Bethesda, v. 98, n. 4, p. 2133-2223, 2018. Available from: https://pubmed.ncbi.nlm.nih.gov/30067154/. Access: April 27, 2023.

RIEBE, D.; EHRMAN, J.; LIGUORI, G.; MAGAL, M. **ACSM's guidelines for exercise testing and prescription**. Philadelphia: Lippincott Williams & Wilkins, 2018.

ROSA, S. E.; LIPPERT, M. A.; MARSON, R. A.; FORTES, M. S. R.; RODRIGUES, L. C.; FERNANDES FILHO, J. Desempenho físico, composição corporal e síndrome metabólica em militares brasileiros. **Revista Brasileira de Medicina do Esporte**, São Paulo, v. 24, n. 6, p. 422-425, 2018. Available from: https://www.scielo.br/j/rbme/a/8R9f7gbKbFy7vgPts47MCDn/?lang=en. Access: April 27, 2023.

ROSS, R. *et al*. Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: a Case for Fitness as a Clinical Vital Sign: A Scientific Statement From the American Heart Association. **Circulation**, Dallas, v. 134, n. 24, p. 653-699, 2016. Available from: https://www.ahajournals.org/doi/10.1161/CIR.0000000000000461?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed. Access: April 27, 2023.

SCHRAM, B.; CANETTI, E.; ORR, R.; POPE, R. Injury rates in female and male military personnel: a systematic review and meta-analysis. **BMC Women's Health**, New York, v. 22, n. 1, p. 1-14, 2022. Available from: https://bmcwomenshealth.biomedcentral.com/articles/10.1186/s12905-022-01899-4. Access: April 27, 2023.

SCHROEDER, E. C.; FRANKE, W. D.; SHARP, R. L.; LEE, D. C. Comparative effectiveness of aerobic, resistance, and combined training on cardiovascular disease risk factors: A randomized controlled trial. **PLoSOne**, San Francisco, v. 147, n. 1, p. 1-14, 2019. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0210292. Access: April 27, 2023.

SEALS, D. R.; NAGY, E. E.; MOREAU, K. L. Aerobic exercise training and vascular function with ageing in healthy men and women. **The Journal of Physiology**, London, v. 597, n. 19, p. 4901–4914, 2019. Available from: https://physoc.onlinelibrary.wiley.com/doi/10.1113/JP277764. Access: April 27, 2023.

TOTH, P. P. *et al*. High-density lipoproteins: A consensus statement from the National Lipid Association. **Journal of Clinical Lipidology**, Philadelphia, v. 7, n. 5, p. 484-225, 2013. Available from: https://www.lipidjournal.com/article/S1933-2874(13)00249-3/fulltext. Access: April 27, 2023.

VALLEJO-VAZ, A. J.; CORRAL, P.; SCHREIER, L.; RAY, K. K. Triglycerides and residual risk. **Current Opinion in Endocrinology, Diabetes and Obesity**, London, v. 27, n. 2, p. 95-103, 2020. Available from: https://europepmc.org/article/med/32073428. Access: April 27, 2023.

VICKERY-HOWE, D. M.; DRAIN, J. R.; CLARKE, A. C.; DASCOMBE, B. J.; MCWILLIAM, J. T.; MIDDLETON, K. J. Treadmill load carriage overestimates energy expenditure of overground load carriage. **Ergonomics**, Abingdon, v. 64, n. 4, p. 521-531, 2020. Available from: https://www.tandfonline.com/doi/abs/10.1080/00140139.2020.1839675. Access: April 27, 2023.

YANG, Q.; VIJAYAKUMAR, A.; KAHN, B. B. Metabolites as regulators of insulin sensitivity and metabolism. **Nature Reviews Molecular Cell Biology**, New York, v. 19, n. 10, p. 654-672, 2018. Available from: https://www.nature.com/articles/s41580-018-0044-8. Access: April 27, 2023.

YARIBEYGI, H.; FARROKHI, F. R.; BUTLER, A. E.; SAHEBKAR, A. Insulin resistance: Review of the underlying molecular mechanisms. **Journal of Cellular Physiology**, Hoboken, v. 234, n. 6, p. 8152-8161, 2019. Available from: https://onlinelibrary.wiley.com/doi/10.1002/jcp.27603. Access: April 27, 2023.