Original Article

RBAFS Revista Brasileira de Atividade Física & Saúde
SOCIEDADE BRASILEIRA DE ATIVIDADE FÍSICA & SAÚDE

rbafs.org.br

Health and lifestyle risk factors: a comparison between Brazilian athletes and non-athletes

Fatores de risco para saúde e estilo de vida: uma comparação entre atletas e não atletas brasileiros

AUTHORS

Christianne de Faria Coelho-Ravagnani[1]
Mario Sergio Vaz da Silva[1,2]
Jeeser Alves de Almeida[1]
Adriano Percival Calderaro Calvo[3]
Fabricio Cesar de Paula Ravagnani[4]
Sérgio Itacarambi Guasque Faria[5]
Alan Nevill[6]

1 Federal University of Mato Grosso do Sul, Faculty Education, Physical Education course, Research Group in Exercise and Nutrition in Health and Sports Performance – PENSARE. Graduate Program in Movement Sciences, Campo Grande, Mato Grosso do Sul, Brazil.

2 Federal University of Grande Dourados, Faculty Education, Faculty Education, Physical Education course, Research Group in Exercise and Nutrition in Health and Sports Performance – PENSARE. Graduate Program in Movement Sciences, Dourados, Mato Grosso do Sul, Brazil.

3 University of the Air Force. Institute of Aerospace Medicine Brig. Doctor Roberto Teixeira, postgraduate in Operational Human Performance. Rio de Janeiro, Rio de Janeiro, Brazil.

4 Federal Institute of Mato Grosso do Sul, Research Group in Exercise and Nutrition in Health and Sports Performance – PENSARE. Graduate Program in Movement Sciences, Campo Grande, Mato Grosso do Sul, Brazil.

5 Federal University of Mato Grosso, Doctoral student in Health Science, Cuiabá, Mato Grosso, Brazil.

6 University of Wolverhampton, Faculty of Education, Health and Wellbeing, Walsall Campus, Walsall, United Kingdom.

CORRESPONDING

Mário Sérgio Vaz da Silva
mariovaz@ufgd.edu.br
Travessa João Domingos, n. 231, casa 1, Jardim TV Morena. Campo Grande, Mato Grosso do Sul, Brasil.
Zip code: 79050-032.

DOI

10.12820/rbafs.29e0373

ABSTRACT

Introduction: Athletes are more exposed to mental and physical stress and injuries, affecting performance and health. However, evidence shows that endurance but not power athletes have greater longevity when compared to their non-athlete peers which could be explained by health factors. Objective: To compare the lifestyle characteristics and health profile between Brazilian athletes and non-athletes. Methods: This is a cross-sectional study comparing male athletes recruited between 2013 and 2016 (n = 147) representing 13 sports, which were divided into two categories: strength/velocity (SV) and endurance/mixed sports (EM). The non-athlete adult group was selected according to the National Health Survey. Athletes were assessed using health questionnaires, anthropometric, blood pressure and resting electrocardiograms measurements. Results: SV had higher body weight, body mass index, and blood pressure compared to the EM ($p < 0.05$). In addition, higher use of pharmacological substances, tobacco, and poor perception of health was observed in SV athletes. When compared to the non-athlete population, the EM showed a lower prevalence of overweight (56% vs. 26%), hypertension (18% vs. 3%), and self-reported depression (4% vs. 0%) while SV showed a higher prevalence of poor health perception (49% vs. 30%). Conclusions: Our findings reaffirm that athletes have higher health status than the general population but that more in-depth analysis must be carried out in sports with different natures.

Keywords: Athletes; Lifestyle; Health behaviors.

RESUMO

Introdução: Atletas estão mais expostos ao estresse físico e mental e a lesões, afetando o desempenho e a saúde. No entanto, evidências mostram que atletas de resistência, mas não de potência, têm maior longevidade quando comparados a seus pares não atletas, o que pode ser explicado por fatores de saúde. Objetivo: Comparar as características de estilo de vida e o perfil de saúde entre atletas brasileiros e não atletas. Métodos: Este é um estudo transversal comparando atletas do sexo masculino recrutados entre 2013 e 2016 (n = 147) representando 13 esportes, que foram divididos em duas categorias: força/velocidade (SV) e resistência/esportes mistos (EM). O grupo adulto não atleta foi selecionado de acordo com a Pesquisa Nacional de Saúde. Os atletas foram avaliados por meio de questionários de saúde, medidas antropométricas, de pressão arterial e eletrocardiogramas de repouso. Resultados: SV apresentaram maior peso corporal, índice de massa corporal e pressão arterial quando comparados aos EM ($p < 0,05$). Além disso, foi observado maior uso de substâncias farmacológicas, tabaco e percepção ruim de saúde em atletas de SV. Quando comparado à população não atleta, o EM apresentou menor prevalência de sobrepeso (56% vs. 26%), hipertensão (18% vs. 3%) e depressão autorrelatada (4% vs. 0%), enquanto o SV apresentou maior prevalência de percepção de saúde ruim (49% vs. 30%). Conclusões: Nossos achados reafirmam que os atletas têm maior estado de saúde do que a população em geral, mas que análises mais aprofundadas devem ser realizadas em esportes com naturezas diferentes.

Palavras-chave: *Atletas; Estilo de vida; Comportamentos de saúde.*

Introduction

The effects of elite sports on health can be considered two sides of the same coin. High-performance athletes are generally exposed to several stressors[1] that could enhance their vulnerability to physical[2] and mental disorders[3], affecting performance and general health. Moreover, vigorous intensity exercises can also provoke cardiac alterations and sudden cardiac death[4]. In fact, some U-shape pattern related to cardiac risk is shown in the literature[5] which, in some way, strengthens the prevailing belief that competitive exercise is harmful.

Paradoxically, the data derived from athletic populations have strongly shown an increased longevity for this group compared to age-matched population counterparts. Potential explanations for the longer life expectancy in athletes include genetic endowment, healthy lifestyle after sport retirement (e.g. higher physical activity levels), wealth acquired with sporting fame and increased cardiorespiratory fitness[6-8].

With regards to the genetic role on the development of diseases and longevity, Ruiz et al.[7] compared a health-related polygenic profile that combined 33 disease risk-related mutations and polymorphisms among non-athletic male controls and endurance elite athletes to see whether this group was genetically predisposed to lower disease risk. The results indicated similar disease-trait-related genotype scores between athletes and non-athletes, suggesting no evidences of "genetic advantages" for the former but a potential contribution of several lifestyle factors (e.g. physical activity, tobacco, alcohol and drug use, diet) to their higher life expectancy[6-8].

The athletes´ lifestyle during or after retirement from competition could be also the reason that might explain differences between types of sports in athletes' mortality and longevity. The findings from the studies included in the review by Teramoto and Bungum[10] indicate that endurance athletes live 2.8 to 5.7 years longer, while athletes from mixed sports (aerobic and anaerobic) live 4 years longer than the general population. In contrast, the death rates for power athletes reported across the included studies were less consistent. In the cohort study with a Finnish male population who were Olympic athletes during 1920 to 1965, the authors also observed lower mortality ratios for endurance athletes compared to both power athletes and non-athletes, but no differences between power athletes (e.g track and field throwers and weightlifters) and non-athletes. In a recent study, lower mortality ratios were also observed for endurance but not for power athletes compared to the control group of non-athletes[9].

Given the high level of sports participation and physical demand, it would be hypothesized that adults' athletes would have healthier lifestyles than adults, but no-athletes peers. However, studies addressing health behaviors during their career are scarce, pointing to the need for further investigations in this area. Two main questions were formulated for this study: (1) Do male Brazilian athletes have a better health profile than the sex-matched general population? and (2) Are there differences in lifestyle and health profile between endurance/mixed and power/velocity athletes? The purpose of this cross-sectional study was to compare lifestyle characteristics and the health profile between Brazilian athletes and the non-athletes (NA) population and between sports categories (i.e. endurance/mixed and power/velocity).

Methods

Participants

This is a cross-sectional study comparing male athletes and male non-athletes. The participants were recruited from the MEDAL Project (Multiprofessional Evaluation: Determinants of Athletes Longevity and performance), Mato Grosso, Brazil, between 2013 and 2016. The study was conducted according to the Declaration of Helsinki and approved by the local University Ethics Committee (25620713300005541). Two hundred and twenty-one athletes were invited to participate in the project directly by either telephone or e-mail and through sport federations/clubs or coaches recommendation (resulting in what is commonly referred to as a convenience sample).

Eligible athletes (n = 147) included male adults (18 to 57 years) who were: (1) currently registered in a sport federation; (2) training, preparing for competition; (3) actively participating in regional and/or international events; (4) devoting at least 6 hours of training weekly[10]. Athletes were informed of the study goals and procedures and provided written informed consent before participating.

The athletes represented 13 sports modalities: track and field (n = 8), judo (n = 7), karate (n = 4), Brazilian jiu-jitsu (n = 8), kung-fu (n = 3), mixed martial arts (n = 6), taekwondo (n = 1), swimming (n = 6), cycling (n = 1), soccer/futsal (n = 93), football (n = 1), triathlon (n = 1), bodybuilding (n = 8), and were grouped into 2 categories: 1) strength/velocity (SV) including judo, karate, Brazilian jiujitsu, kung fu, mixed martial arts,

bodybuilding, 100, 200, 400 m and long jump in track and field, 50 and 100m in swimming; and 2) endurance/mixed sports (EM) including half marathon and marathon, triathlon, 80km on cycling, 200 and 400m on swimming, football and soccer. The criteria for categorizing sports groups have been followed by other authors[6,7,10]. This classification is useful because it is impractical to analyze all 13 sports separately due to the low numbers of cases in some sports.

The NA male population prevalence data was obtained through the National Health Survey (Pesquisa Nacional de Saúde – PNS)[11]. This is a household-based nationwide survey carried out by the Ministry of Health in partnership with the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE) with the aim of establishing the health profile and lifestyles of the adult population using a sample size of approximately 62,000 participants[12,13]. The prevalence of health and lifestyle factors were compared between adult men (>18 years old) from our study with adult men from PNS (>18 years old).

Health profile and lifestyle measures

The athletes were instructed to avoid strenuous physical exercise for at least 24 h, and refrain from consuming alcoholic and caffeinated beverages for at least 48 h before physical evaluations. All measurements were performed during the morning in quiet air-conditioned (22-24ºC) rooms.

All the tests were administered on two separate days in groups of 5 to 25 athletes per session. The questionnaire and the clinical battery were tested previously using a group of recreational athletes. They were revised based on their comments to optimize time and understanding.

On the first visit, the athletes answered the questionnaires on health, lifestyle, psychological (including self-related depression) and sociodemographic data. The athletes underwent a physical evaluation on the following day, which included anthropometric measurements (weight, height, body mass index-BMI), and body composition), resting electrocardiogram (ECG), and blood pressure (systolic/diastolic) measurements. The athletes wore light clothing, and the equipment used was correctly calibrated. An experienced evaluator carried out the assessments.

A bioelectrical impedance device (Inbody® S10) was used to estimate percentage of body fat (%BF) and fat free mass (FFM) at a single frequency (50 kHz).

The ECG was recorded continuously with a twelve-channel recording system (Cardio care 2000; Bionet). The interpretation of ECG findings was assessed by a physician expert in cardiology. According to the lack or the presence of any change, the ECG was classified as "normal" or "no normal". Resting systolic (SBP) and diastolic blood pressures (DBP) were measured sphygmomanometrically (stethoscope Welchallyn) and hypertension was characterized by SBP levels ≥ 140mmHg and/or DBP levels ≥ 90 mmHg.

For psychological questionnaires, the athletes answered the Beck Depression Inventory (BDI)[13] and Beck Anxiety Inventory (BAI)[14] translated for the Portuguese language[15].

Alcohol use was defined as consuming one or more drinks/week and tobacco consumption was defined as smoke one or more cigarettes per day. The use of dietary supplement and pharmacological substance was assessed using closed-ended options with additional open-ended questions. The present study adopted the definition of dietary supplements according to the Administration Dietary Supplement[16]. A broad definition of pharmacological substances was used, which included analgesics, anabolic steroids, diuretics, stimulants, fat burners, anti-inflammatory drugs, using some common substances used by athletes as examples.

Information on sleep quality was obtained by asking "How do you classify your sleep quality? with answer categories "bad", "regular", "good", "very good" or "excellent". Good sleep quality was defined as excellent, very good or good. The health perception was assessed by asking "How do you think your health is?" with answer categories "very bad", "bad", "good" or "excellent". Good health quality was defined as good or excellent. The time spent watching tv was obtained by the question "On average, how many hours every day do you spend sitting watching tv or in the internet?" and divided into 2 categories ≥ 3 hours/day and < 3 hours/day.

The Figure 1 summarizes the methods for assessing athletes and NA's health profile and lifestyle characteristics with their respective reference values.

Statistical Analysis

Differences between SV vs EM in the age, training volume, body composition, SBP and DBP were analyzed using Student t-test and/or Mann-Whitney tests. Chi-square test of independence (frequencies

Health Profile	Criteria (Reference data)	Methods for evaluation (in athletes population)	**Criteria (Reference data)** (PNS)[13,14]	Methods for evaluation (in non-athletes)
Body mass index (BMI)	Eutrophic <25kg/m²	Direct measurement of weight and height BMI = Weight(kg)/Height (m)²	Eutrophic <25kg/m²	Direct measurement of weight and height BMI = Weight(kg)/Height (m)²
	Overweight >25kg/m²		Overweight >25kg/m²	
Hypertension	Normotension (SBP<140mmHg and DBP <90mmHg)	Direct measurement of systolic blood pressure (SBP) and diastolic blood pressure (SBP)	Yes	Interview "Has a doctor ever diagnosed you with high blood pressure?"
	Hypertension (SBP≥140mmHg and/or DBP≥90mmHg		No	
Watching TV	≥ 3 hours/day	Questionnaire 'On average, how many hours every day do you spend sitting watching tv or in the internet?'	≥ 3 hours/day	Interview (On average, how many hours a day do you usually spend watching television?)
	< 3 hours/day		< 3 hours/day	
Health perception	Excellent, good	Questionnaire 'In general, how do you think your health is - excellent, good, bad, or very bad?'	Good or very good	Interview "In general, how would you rate your overall health-very good, good, fair, poor, or very poor?"
	Bad or Very bad		Fair, poor, very poor	
Depression	Yes	Questionnaire 'Do you suffer from any of the diseases mentioned (e.g. depression)?'	Yes	Interview "Has a doctor or mental health professional (such as a psychiatrist or psychologist) ever diagnosed you with depression?" Self-report
	No		No	
Diabetes	Yes	Questionnaire 'Do you suffer from any of the diseases mentioned (e.g. diabetes)?'	Yes	Interview "Has a doctor ever diagnosed you with diabetes?
	No		No	
Smoking	Yes (smoke one or more cigarettes per day)	Questionnaire 'How many cigarettes do you usually smoke per day? – I do not smoke or x cigarettes'	Yes = smoke one or more cigarettes per day	Interview "Do you currently smoke any tobacco products?" Self-report
	No		No	
Alcohol	Yes (consuming one or more drinks/week)	Questionnaire 'In the last month, how often did you drink alcohol? I didn't drink or x times/month'	Yes = consuming one or more drinks/week	Interview 'How often do you drink alcohol? I never drink, less than once/month, once or more/month'
	No	'On the day you consumed alcohol, how many drinks did you drink? I didn't drink or doses/day'	No	
Resting electrocardiogram	Altered	Diagnosed by a medical report (cardiologist)	Not measured	Not measured
	Normal			
Sleep quality	Very good or good	Questionnaire 'How do you rate the quality of your sleep? poor, fair, good, very good and excellent'	Not measured	Not measured
	Fair or bad or very bad			
Anxiety	Positive (score ≥ 16 on BAI)	Beck Anxiety Inventory (BAI)[17]	Not measured	Not measured
	Negative			
Depression	Positive (score ≥ 19 on BDI)	Beck Depression Inventory (BDI)[16]	Not measured	Not measured
	Negative			
Pharmacological substances use	Yes (used in the last 6 months)	Questionnaire with closed and opened options 'Check the substances you used in the last 6 months (e.g. anabolic steroids, diuretics, stimulants, fat reducers and others'	Not measured	Not measured
	No			
Supplements use	Yes	Questionnaire with closed and opened options. ´Do you use dietary supplements (yes/no) 'Check the supplements you regularly use'	Not measured	Not measured
	No			

Figure 1 – Methods for assessing lifestyle and health profile and their respective reference values of athletes and non-atlhetes populations

reported as contingency tables) were used to compare the number of athletes (SV vs EM) and other categorical variables such as BMI (above vs below 25kg/m^2); ECG (non-normal vs normal); dietary supplement and pharmacological consumption (no vs yes for the last 6 months); time watching TV (≤3 hours vs>3 hours); sleep quality (good vs bad); and Depression, Anxiety (negative vs positive). Comparisons between the prevalence of athletes categorized according to lifestyle characteristics and health profile (e.g. relative frequency of BMI above vs below 25kg/m^2) with those reported in the Brazilian population, were analyzed using chi-squared goodness-of-fit tests. Inferential analyses were performed using JASP for Windows (Version 0.19.0, Amsterdam, Netherlands). The significance level used was $p < 0.05$.

Table 2 – Health and lifestyle characteristics and comparisons between athletes groups.

Variables	Endurance/mixed (n = 100)	Strength and velocity athletes (n = 47)	p
	n (%)	n (%)	
Electrocardiogram [altered]	3 (5)	4 (11)	0.171
Supplement [yes]	48 (52)	21 (46)	0.248
Pharmacological Substances Use [yes]	12 (12)	11 (23)	0.007
Sleep Quality [≤ Regular]	29 (29)	16 (35)	0.225
Depression - BDI [Positive]	0 (0)	44 (4)	0.136
Anxiety - BAI [Positive]	8 (8)	3 (7)	0.491

Values expressed as absolute and relative frequencies (proportions); BDI = Beck Depression Inventory; BAI = Beck Anxiety Inventory.

Results

Table 1 shows the characteristics of the athletes´ groups. The SV athletes had a higher weight, BMI, and SBP and DBP than EM. There were no differences between athletes´ groups in training volume, body fat and lean body mass.

Table 2 shows the health and lifestyle characteristics for SV and EM athletes. Compared to EM athletes, SV athletes reported more frequently pharmacological substances.

Comparisons between athletes and non-athletic

Table 3 also shows the comparison between athletes' groups with the NA population. Compared to NA, the EM athletes showed a lower prevalence of overweight (56 vs 26%) and hypertension (18 vs 3%). No differences were observed between SV and NA for these two health risk factors. Both, EM and SV athletes reported less frequently alcohol use, tobacco use and watching television than NA. Additionally, the EM athletes presented significantly lower percentage of self-reported depression than NA (0% vs 4%). Also, SV athletes presented significantly higher prevalence of bad health perception than NA (49 vs 30%). Figure 2 summarizes the differences in health risk factors and lifestyle characteristics between NA, EM and SV athletes in our study.

Discussion

This cross-sectional study of local Brazilian male athletes revealed significant differences in some health risk factors compared to NA age-matched population.

Table 1 – Anthropometric and training characteristics of the athlete's groups

Athletes Groups	n	Endurance/mixed		Strength and velocity athletes			
		Mean	SD	n	Mean	SD	p
Age (y)§	100	23.83	7.14	47	25.12	6.46	0.074
Weight (kg)§	100	74.98	9.73	47	82.02	17.33	0.021
Height (m)#	100	1.77	0.07	47	1.76	0.07	0.161
Body mass index (kg/m^2)§	100	23.76	2.29	47	26.41	4.28	< 0.001
Training Volume (h/week)§	100	29.21	18.40	47	30.05	33.80	0.099
Fat body mass (kg)§	67	9.87	3.97	43	11.20	6.14	0.481
Lean body mass (kg)§	67	65.97	7.35	43	69.21	10.86	0.232
Fat (%)#	67	12.78	4.26	43	13.45	5.80	0.513
SBP (mmHg)§	92	114.24	9.72	37	119.19	10.96	0.010
DBP (mmHg)§	92	71.96	7.84	37	77.03	9.61	0.004

Data are presented as means and standard deviation (SD). Y = years; SBP = systolic blood pressure; DBP = diastolic blood pressure. #t-Student test. § Mann-Whitney test

Table 3 – Health and lifestyle characteristics and comparisons between athletes and non-athletes' (non-athletic) groups.

Variables	Groups					
	Endurance/mixed athletes (n = 100) n (%)	Strength, and velocity athletes (n = 47) n (%)	Non- athletes[1] %	Endurance/mixed athletes x Strength, and velocity athletes	Endurance/mixed athletes x Non-athletes	Strength, and velocity athletes x Non- athletes
				p	p	p
Body mass index [>25kg/m^2]	26 (26)	24 (51)	(56)	<0.001	<0.001	0.495
Hypertension [Yes]	3 (3)	7 (19)	(18)	<0.001	<0.001	0.884
Diabetes mellitus [Yes]	1 (1)	0 (0)	(5)	NA	0.066	0.116
Alcohol use [Yes]	7 (7)	7 (15)	(36)	0.030	<0.001	0.003
Tobacco [Yes]	1 (1)	0 (0)	(19)	NA	<0.001	<0.001
Watch TV, h/d [>3]	30 (58)	11 (50)	(26)	0.267	0.007	0.010
Health perception [Bad]	24 (24)	23 (49)	(30)	<0.001	0.190	<0.001
Self-related depression [Yes]	0 (0)	0 (0)	(4)	NA	0.040	0.162

Values expressed as absolute and relative frequencies (proportions). 1 = Data are available from the National Health Survey (PNS).

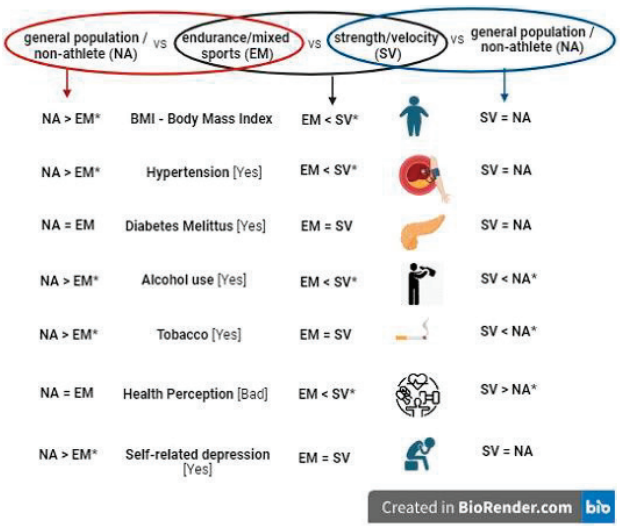

Figure 2 – Health and lifestyle characteristics and comparisons between athletes and non-athletes. * p<0,05.

Overall, athletes exhibited a better health profile and lifestyle characteristics than NA. In addition, our finding indicates that there are differences between athletes based on sports types. The EM athletes had better health profile and lifestyle characteristics when compared to the SV athletes.

As expected, in this study the prevalence of overweight/obesity was higher in NA compared to EM athletes, with no differences between SV athletes and the general population. Additionally, the EM group is lighter weight and had lower BMI compared to SV group. Significantly lower BMI was also found in other studies including master (≥30y)[17] or younger athletes from different sports[18] compared to the matched controls. Similar to our findings, another study[19] showed that when dividing according to the sports, SV athletes presented similar BMI than the NA but higher BMI than EM athletes

Our finding comparing EM's BMI to that of SV's athletes could be accounted for the sports natural selection since endurance athletes with lower body weight usually show better results for aerobic sports[20]. Moreover, the morphological adaptations related to SV training such muscle mass[21] leads to a greater body weight and consequently a higher BMI in these athletes. It is worth noting that despite being a poor performance predictor in SV sports, the BMI have been used as an independent predictor of mortality and morbidity (e.g. hypertension, diabetes, dyslipidemia, coronary heart disease, sleep apnea, osteoarthritis, cancers) even among athletes[22]. In a recent systematic review and meta-analysis, McHugh et al.[24] showed that athletes with larger body mass display higher prevalence of cardiovascular risk factors, possibly reflecting a relationship with increased BMI.

In our study, the higher BMI in SV athletes (51%) and NA population (56%) compared to EM athletes (26%), could explain the higher prevalence of hypertension and/or SBP and DBP values. Another potential mechanism might be linked to genetic characteristics. Some variant-type alleles of few genes, such as ACE, ACTN3, NOS3, UCP2, and UCP3 which tend to predispose the development of speed-strength qualities and predominance of fast muscle fibers[23], at the same time can predispose arterial hypertension and myocardial hypertrophy, and could increase vascular tone. The ACE gene, responsible for the production

of angiotensin II, activation of aldosterone synthesis, bradykinin decomposition is linked to blood pressure diseases and blood pressure response to exercise including power and short events[24]. On the other hand, endurance athletes are less likely to have risk alleles for obesity and obesity co-morbidities compared to sprint/power athletes and to NA controls[25].

The higher prevalence of hypertension in SV athletes in our study may also be due to the higher prevalence of pharmacological substances use in this group (12% EM vs 23% SV). Some studies found associations between performance enhanced drugs or pain killers use such as analgesics[26] and anabolic steroids[27] and the risk of hypertension. The association between analgesic use and hypertension may be mediated through inhibition of vasodilator prostaglandins, increases in cellular oxidative stress, endothelial dysfunction and increased renal sodium and water reabsorption[28] while the anabolic steroids can cause disorders in lipid metabolism, increase the procoagulant state and renal retention of sodium[28] Currently, some health effects of different drugs like stimulants on cardiovascular health is still unknown in athletes[29]. As such, further studies are needed to confirm these associations among this particular population.

Interestingly, in this present study, the SV group had a worse self-perception of health, even when compared to NA. These findings are inconsistent with the results of Zhou et al.[30] and could be explained by two main factors: 1) the athlete social environment; and 2) the health and lifestyle conditions. Regarding the social environment, athletes are always being pressured by coaches to lose weight to improve performance. The aim of having the ideal body is likely to worsen psychological issues related to weight and self-reported health. Hunger & Major[31] showed that weight stigma is an important mediator of the association between BMI and self-reported health, which could partially explain these results. Our finding corroborates the review by Rice et al[32], which shows that elite athletes are susceptible to numerous stressors, such as injuries, overtraining, burnout, and other factors that impair mental health. However, little evidence is available on this topic.

Concerning the health profile and lifestyle factors, according to McHugh et al.[24] in sports where body size is integral to successful participation such as SV sports, athletes often pursue extreme solutions to gain competitive advantages that can jeopardize their health. Possibly, the use of performance-enhancing drugs and supplements as part of these solutions, associated with a higher occurrence of self-image disorder (e.g. dysmorphia)[33] could also affect their health perception[34]. Additionally, the higher consumption of alcohol possibly could make SV athletes more likely to have a worse perception of their health status.

Factors like pharmacological substance, legal or illegal use has been linked to sports for several decades, which can play a role for sports performance influencing better outcomes both in endurance and power-velocity influenced sports. However, in some strength related sports such as bodybuilding, the use of these substances may be even more common[35]. Our findings show greater pharmacological use prevalence for the SV group, warrant continued attention from health teams as they can compromise athletes' careers and long-term health.

Nevertheless, both SV and EM athletes reported less alcohol, tobacco use and watching TV than the NA population. These results are consistent with those of Burtscher et al.[36], which observed that long-term skiers reported lower use of tobacco and alcohol than the matched-population. The use of alcohol and tobacco are presented in several studies as exponential factors for death from any cause and may respond in part to the greater longevity in athletes compared to the general population[37]. Furthermore, watching television for more than 3 hours is associated with unhealthy dietary intake, which is related to risk factors for the onset of chronic non-degenerative diseases[38].

Our results also align with those from Rice et al.[32], by showing a low prevalence of self related depression in athletes (specifically EM) compared to the NA control group. As a matter of interest, the depression prevalence of EM and SV athletes in our study (i.e. 0 and 4%, respectively) was lower than that observed among elite athletes from different sports and countries (34%)[3]. If on the one hand, evidences demonstrate that physical activity is a protection factor against depression and may also relieve the symptoms in those who are diagnosed, on the other hand, the sports career might be a great stressor likely to compromise the athletes mental health[3]. Precise comparisons are difficult to make because of the differences in countries, cultures, sports types, level of sport, and measures for depression across studies.

Overall, this study shows a variety of health and lifestyle factors from Brazilian athletes' groups and how they differ to the age matched population. To the best of our knowledge, this is the first study on this issue, in-

cluding Brazilian athletes from different sports. However, numerous limitations must be taken into account. Like many other studies in the sports field, our data did not include female athletes and the generalization of our findings to women is precluded. Also, due to Brazil's continental proportions, the athletes were selected in a specific region of the country, which may not accurately reflect the different regions and their particularities. Although some results reinforce that athletes have better overall health profile and lifestyle (less alcohol and tobacco use), others may need a more in-depth analysis of how they could be influenced by the sport played. More cohort studies including women and specific sports should establish relations between athletes' BMI and propensity to increased health risks and mortality and how sports practice could mitigate the risk of being overweight. Additionally, some diseases such as diabetes mellitus are uncommon in athletes, thus implying that larger samples would be necessary to provide sufficient power to identify differences in health profile due to sports participation. It is worth noting that PNS data has broad geographic coverage, which allows us to compare data from the Brazilian population with specific subpopulations, in addition to presenting statistical representativeness, even for a regional sample composed only of males. However, it is essential to consider the limitations when using PNS data to compare the general population with the subpopulation of athletes in our study, such as: a) the instruments and methods of measurement of some variables, although similar, were not the same, compromising comparisons; b) health characteristics may vary between regions of the country, which may difficult direct comparisons between subpopulations in specific areas, in this case the state of Mato Grosso.

Conclusion

Our findings reaffirm that athletes have a higher health profile and lifestyle than the general population, and that endurance/mixed-sport athletes have fewer health risk factors than strength/speed athletes and the NA population. However, further analyses should be conducted in different sports and in female athletes.

Conflict of interest

The authors declare no conflict of interest.

Funding

This study was financed in part by the e National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq), Foundation for Research Support of the State of Mato Grosso (Fundação de Amparo a Pesquisa do Estado de Mato Grosso - FAPEMAT), and supported by Federal University of Mato Grosso do Sul (Universidade Federal do Mato Grosso do Sul - UFMS).

Author's contributions

Coelho-Ravagnani CF: Conceptualization; Methodology; Investigation; Supervision; Writing – original draft; Writing – review & editing; Approval of the final version. Silva MSV: Conceptualization; Writing – original draft; Writing – review & editing; Approval of the final version. Almeida: JA: Formal analysis; Writing – original draft; Writing – review & editing; Approval of the final version. Calvo APC: Formal analysis; Writing – original draft; Writing – review & editing; Approval of the final version. Ravagnani FCP: Methodology; Formal analysis; Writing – original draft; Approval of the final version. Faria SIG: Formal analysis; Investigation; Writing – original draft; Approval of the final version. Nevill A: Conceptualization; Writing – review & editing; Approval of the final version.

Declaration regarding the use of artificial intelligence tools in the article writing process

The authors did not use artificial intelligence tools for preparation of the manuscript.

Availability of research data and other materials

The data of this study is available on demand from referees.

Acknowledgments

The source of these data is the MEDAL Project and PNS study. We thank the athletes and the MEDAL Project health team (students, technicians and physicians, dietitians, physical education teachers and physiotherapists) for collecting the data.

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Recebido:22/07/2024
Revisado: 01/10/2024
Aprovado: 20/12/2024

Cite this article as:

Coelho-Ravagnani CF, Silva MSV, Almeida JA, Calvo APC, Ravagnani FCP, Faria SIG, Nevill A. Health and lifestyle risk factors: a comparison between Brazilian athletes and non-athletes. Rev. Bras. Ativ. Fis. Saúde. 2024;29:e0373. doi: 10.12820/rbafs.29e0373

Reviewers' assessment

The reviews of this article were originally conducted in Portuguese. This version has been translated using ChatGPT and subsequently reviewed by the Chief Editors.

Reviewer A

Anonymous

- Was any evidence of plagiarism observed in the manuscript?
  No
- Did the authors provide clarifications regarding the ethical procedures adopted for conducting the research?
  Yes

Comments to the author

- Thank you for the opportunity to review the article titled "HEALTH AND LIFESTYLE RISK FACTORS: A COMPARISON BETWEEN BRAZILIAN ATHLETES AND NON-ATHLETES." It is a pleasure to contribute to the work by sharing my perspective and interpretation of the document. I hope to provide insights that will be useful for the final presentation and publication.
- The article presents an interesting analysis of health risk factors and lifestyle behaviors among Brazilian athletes and non-athletes. However, in my opinion, the authors need to more clearly demonstrate how this knowledge adds to what has already been described in the literature. It is important for the authors to pay attention to the description of the methods, especially regarding the matching process and characteristics of the non-athlete participants (e.g., were they physically active or not?). Below, I highlight a few summarized points (detailed comments are included in the attached file) aimed at improving the clarity and accuracy of the presented study. Here are my considerations:
- Clarity in the introduction: In the last paragraph of the introduction, terms like "lifestyles," "health behaviors," "health profiles," and "risk factors" are used confusingly. This hinders the understanding of what will be analyzed in the study. I recommend that the authors revise this paragraph to clearly define the terms and the focus of the study.
- Objectives and methods: The objectives need to be adjusted to reflect the actual analysis conducted, which grouped sports into "strength/speed" and "endurance/mixed." Additionally, it is important to include the athletes' age range in the text.
- Selection of non-athletes: The selection criteria for non-athletes must be clearly described, including how the sampling was conducted and how the matching process was performed.
- References and variables: The references and description of the analyzed variables should be reviewed and corrected, particularly regarding the use of data from the Brazilian National Health Survey (PNS) and how the health-related variables were collected.
- Data presentation: I suggest splitting Table 2 to improve the data presentation and enhance the understanding of the results.
- Discussion of results: The mean age of the non-athlete group should be included and the results adequately discussed, especially concerning the body mass index (BMI) and body fat percentage of the athletes.
- Limitations: The limitation of including only male athletes should be explained and justified.
- These revisions are essential to ensure the quality and clarity of the presented study.
- I am available for any further clarification and, once again, thank you for the opportunity to contribute to the publication.

Comments in the manuscript

- In the last paragraph of the introduction, the following terms are used: "lifestyles," "health behaviors," "health profile," and "risk factors." This does not make it clear what the authors will analyze in the study. For example, when the authors refer to health behaviors, I understand these to be specific actions that are performed and impact one's health (positively or negatively), such as engaging in physical exercise, wearing a seatbelt, undergoing regular check-ups, among others. On the other hand, when the authors refer to the "health profile," I understand this to be a general description of individuals' health based on health indicators, such as hypertension (yes/no), obesity (yes/no), exam results. Although these terms are interrelated and used in similar contexts, they are not synonyms and

have different meanings. The lack of clarity in the use of these terms in the text creates confusion regarding the study's objective. I recommend revising the paragraph to ensure the clear and consistent use of terms to better and more accurately reflect the study's focus. In particular, it is important for the authors to define whether the study investigates health indicators (health profile), lifestyle habits (lifestyles), specific actions affecting health (health behaviors), or factors that increase health risks (risk factors), or a combination of these outcomes.

- The authors appropriately justify in the methods that the sports modalities were grouped based on the sample size for each modality. Although I agree with the authors regarding this grouping, an analysis considering the type of sport, as mentioned in the objectives, was not conducted. Instead, the analysis considered the common characteristics of the sports grouped into "strength/velocity" and "endurance/mixed sports." The authors should adjust the objectives according to the grouping performed.
- What is the age range of these athletes? This data is important and should be included in the text.
- Studies referring to the PNS indicate that the number of adults was approximately 60,000 individuals (available, for example, at: http://scielo.iec.gov.br/pdf/ess/v31nesp1/2237-9622-ess-31-esp1-e2021364.pdf). What criteria did the authors use to select the individuals who were matched with the athletes participating in the study? Were individuals randomly selected by drawing lots among those of the same age, for example, or was another criterion used for the inclusion of non-athletes? Considering the number of people assessed in the PNS and that the sample of non-athletes is 147 people, this information is important and should be clear in the text.
- The reference given for the sample size of 80,000 households in the PNS is incorrect (reference 17). Please review the citation.
- Only data on alcohol consumption and tobacco use were used for the non-athlete group. As described in Table 2, the authors analyzed the following variables: BMI (self-reported or measured?); hypertension, diabetes, health perception, and depression. None of these variables were mentioned in the methods, nor was the way they were collected specified or referenced. Please add this information to the text.
- The authors can be more objective in describing these instruments since they are referenced and available for consultation. The authors should better detail other aspects of the study (see next comment).
- Unlike the previous description of the instruments that assess depression and anxiety, here the authors are too brief. Were these questions used in other studies or formulated specifically for this work? If the authors have a reference, they should include it in the text. If the questions were formulated for this study, a more detailed description of these questions should be included in the text. For example, the authors refer to "additional open questions." What are these questions? What was addressed in these questions? This should be referenced if the authors used a previously described questionnaire, or described in detail for a better understanding of what was evaluated
- Previously, I referred to the lack of information for this variable concerning the PNS data. Was the same question and response options as the PNS questionnaire used for the athletes? This information is important and should be included in the text.
- The variable "time watching TV" appears for the first time in the "statistical analysis" section. The authors need to specify in the methods how this variable was collected. Additionally, this variable was used in the 2013 PNS (https://www.pns.icict.fiocruz.br/wp-content/uploads/2021/02/Questionario-PNS-2013.pdf and https://www.scielo.br/j/csc/a/Y6VdtJnCtPNwNtBFwJ8Y3dv/?format=pdf&lang=pt). Why didn't the authors include the analysis of this variable among athletes and non-athletes?
- The study included 147 athletes, but the number of non-athletes included is not described in the text. It is important to include this information and clarify why there are 147 athletes and only 100 non-athletes, as the authors state that matching was done but do not describe how this matching was conducted (one-to-one matching, two-to-one matching?).
- In Table 1, there is a footnote indicating that the difference between the means of the variables with the # symbol was analyzed using the Student's t-test (#Student's t-test), which suggests that the comparison between the remaining variables was conducted using the Mann-Whitney test, as described in the statistical analysis. However, the authors should include in the table an indication and footnote for which variables the analyses were con-

ducted using the Mann-Whitney test, as tables and figures should be self-explanatory.

- According to the journal's publication guidelines, up to 5 illustrations are allowed for original articles (https://rbafs.org.br/RBAFS/diretrizes). Considering this, I suggest that the authors split Table 2. The first should contain the variables and analyses conducted only among athletes. The second should show the analyses conducted with non-athletes. This will improve the understanding and presentation quality of the data.
- This information regarding strength/velocity athletes compared to endurance/mixed athletes concerning tobacco use is different from what is reported in the table (in the table, the variable does not have the symbol indicating a statistical difference). The authors should correct the text or appropriately represent it in the table.
- The authors stated in the "statistical analysis" section that they categorized this variable using the cutoff point of 25 kg/m^2. The literature clearly states that one of the limitations of using BMI is in athletes, especially when classifying overweight. Athletes with a large muscle mass, characteristic of strength/speed modalities, may have an elevated BMI. This categorization does not seem appropriate, considering they are athletes. I suggest using the cutoff point of 30 kg/m^2 for this analysis, as values above 30 indicate excess body fat, regardless of the population. The authors describe using bioimpedance to "estimate body fat percentage," but this data is not shown in Table 2. Categorizing body fat percentage using a specific cutoff point could be a good strategy for comparing these athletes.
- When the authors write "...between athlete groups with the corresponding sex and age population," it suggests a stratified analysis by sex, which was not conducted in the study since only males were analyzed. Please rewrite the text more clearly.
- In Table 2, the p-value should be reported instead of the chi-square test statistic, maintaining the same table structure.
- Data collection was conducted over two days, with athletes responding to health, lifestyle, psychological data (including self-reported depression), and sociodemographic questionnaires on the first day. If the questionnaires were administered on the same day, why does the number of individuals described in Table 2 differ for some variables (TV = 22; anxiety = 46; depression = 45, for example)? This attrition should be presented and explained in the text (perhaps a flowchart), as it is not common for volunteers to leave certain instruments and/or questions unanswered on the same day of data collection using a single questionnaire.
- The authors state in the methods that matching was done by age, but do not specify how this matching was conducted. For example, was each selected case (athlete) matched with a control (non-athlete)? Or was matching conducted using two cases for each control? For example, for the hypertension variable, we have 137 athletes (cases) and only 100 non-athletes (controls), which does not clearly demonstrate how this matching was conducted. The authors should clarify in the methodology how this matching was done.
- As the authors describe, the results observed for BMI are expected in the literature. However, I do not believe we can talk about "expected results" when comparing athletes and non-athletes. Although the authors included athletes from various sports modalities in their sample, which could be a confounding factor, it was clear in the inclusion criteria that they were athletes, for whom a lower BMI was expected compared to the non-athlete population. The mean values for the non-athlete group were not described (perhaps because secondary data was not available), which could help elucidate the findings. This is an important piece of data that should be discussed and presented in the text. The body fat percentage (13.45% in the strength/velocity athlete group) is an important piece of data that shows the elevated BMI in this group of athletes may be related to a large muscle mass and could be used to discuss these data.
- The authors highlight that "in our study, the higher BMI in SV athletes and the non-athletic population compared to EM athletes...," but these data were not shown (mean values for the non-athlete group). Please include these data (table or text).
- In the previous paragraph, the authors made a mention of this association. I find this data important, and the authors have information to test this association. It would be interesting, besides hypothesizing, for the authors to test these associations in their data, which would enrich the study.
- As mentioned before, it is important to report the mean age of the non-athlete group to show that the

matching was conducted properly. At no point in the text was this information described, and this is an important point that provides data for the reader to verify this matching (same or similar ages = same or similar means in both groups).
- Was the inclusion of only male athletes a choice by the authors or a limitation in accessing other individuals? This should be commented on as a limitation in the conclusion.

Decision
- Substantial revisions required

Reviewer B
Anonymous

- Was any evidence of plagiarism observed in the manuscript?
- No
- Did the authors provide clarifications regarding the ethical procedures adopted for conducting the research?
- Yes

Comments to the author
- The present manuscript addresses behaviors and health risk factors among athletes and non-athletes. The topic is relevant to advancing knowledge regarding the identification of these factors and the characterization of these groups. Moreover, the importance of these findings, which according to the authors, is scarce in the literature, should be highlighted.
- Overall, the manuscript is well-written and attentive to important methodological details. However, I present some suggestions for improvement.

Abstract
- Confirm the descriptor: Life Style or Healthy Lifestyle, according to MeSH terms.
- I suggest separating the objective from the methods.

Introduction
- The objective: "(2) gain some insight into how these factors might influence the differences in longevity among sports types" – I do not believe the type of study will address this objective. I suggest removing or rephrasing it. Moreover, I did not observe results that answer this objective.

Methods
- I recommend the detailed writing of the methods section but consider it important to indicate which measures and tests were obtained from the secondary data of the PNS. I understand that not all variables were found in this database, correct?
- While reading, it seems that all procedures and instruments used in the athlete sample were also applied to the non-athlete population.
- It is worth informing how the data tabulation was conducted and the software used for data analysis. Additionally, regarding the analysis, I consider it important to describe the descriptive analyses performed, both for categorical and numerical variables, and the criteria considered significant in the methods section.

Results
- In Table 2, why not include the n for the non-athlete group?
- I could not find Figure 1.

Discussion
- I appreciated the writing in this section and highlight the importance of addressing the study's strengths and limitations.

Conclusion
- The conclusion only refers to health status. What about lifestyle differences between athletes and non-athletes? I believe it is important to include these findings in the conclusion, as it is one of the study's objectives. The conclusion seems insufficient to me.

Decision
- Minor revisions required