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Comparison between physical fitness of male and female Brazilian Optimist sailors

Comparação entre a aptidão física de velejadores e velejadoras de Optimist brasileiros(as)

Ana Luiza Rêgo Dias[1]
https ://orcid.org/0009-0001-5682-4688
Anderson Leandro Peres Campos[1]
https ://orcid.org/0000-0003-0288-7082
Daniell Lima Costa Muniz[1]
https ://orcid.org/0000-0001-5950-9336

Abstract – The Optimist is a sailing class for children and adolescents aged 8 to 15 years old, considered the initiation in the sport. However, there is limited scientific literature on the physical fitness of these athletes, particularly concerning sex differences. This study aimed to describe the anthropometric and physical fitness profile of Brazilian sailors in the Optimist class and compare variables between sexes. Data were collected on the eve of the Selective Championship for International Competitions in Salvador, BA, including measurements of body circumferences, anthropometry, handgrip strength, medicine ball throw, vertical jump with countermovement, and flexibility of the adductors and dorsiflexion. Sixty athletes (N = 60) were evaluated, with 18 females. Results showed significant differences between sexes in body fat percentage ($p < 0.001$), arm muscle area ($p = 0.001$), and waist circumference ($p = 0.028$). No significant differences were observed in the other variables. It is concluded that the anthropometric profile of Optimist athletes exhibits sex differences, highlighting the importance of conducting further studies to investigate other variables and compare performance between males and females.

Key words: Water sports; Physical fitness; Body composition.

Resumo – *A classe Optimist é uma categoria de vela para crianças e adolescentes de 8 a 15 anos, considerada a base do esporte. No entanto, há pouca literatura científica sobre a aptidão física desses atletas, especialmente no que diz respeito às diferenças entre os sexos. Este estudo teve como objetivo descrever o perfil antropométrico e de aptidão física de velejadores brasileiros da classe Optimist e comparar as variáveis entre os sexos. Os dados foram coletados na véspera do Campeonato Seletiva para os internacionais em Salvador, BA, com medidas de perimetria, antropometria, preensão manual, arremesso de medicine ball, salto vertical com contramovimento, e flexibilidade de adutores e dorsiflexão. Foram avaliados 60 atletas (N = 60), sendo 18 do sexo feminino. Resultados mostraram diferenças significativas entre os sexos em percentual de gordura (p < 0,001), área muscular do braço (p = 0,001) e circunferência de cintura (p = 0,028). Não houve diferenças significativas nas outras variáveis. Conclui-se que o perfil antropométrico dos atletas de Optimist apresenta diferenças entre os sexos, sendo importante realizar mais estudos para investigar outras variáveis e comparar os desempenhos entre homens e mulheres.*

Palavras-chave: *Esportes aquáticos; Aptidão física; Composição corporal.*

1 Escola Bahiana de Medicina e Saúde Pública. Salvador, BA. Brasil.

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Corresponding author
Ana Luiza Rêgo Dias.
Escola Bahiana de Medicina e Saúde Pública
Rua Doutor Clemente Ferreira, 127, 40110-200, Canela, Salvador (BA), Brasil.
E-mail: analuizaregodias1@gmail.com

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INTRODUCTION

Sailing is the sport that has earned Brazil the greatest number of Olympic gold medals. In addition to achievements in the main categories, Brazilians also stand out in the Optimist class, the most popular entry-level boat in the world, designed for children and adolescents aged 7 to 15. The sailor's physical fitness, according to the specific demands of each boat class, is considered essential – but it does not seem to outweigh skills such as tactical knowledge, technical ability, adjustments, and meteorological awareness[1]. These, in turn, encompass not only aspects related to individual health, but also motor coordination, reaction time, agility, balance, and power, which are directly influenced by body composition[2].

In the Optimist Class, sailing is characterized by steering with the tiller (which provides the boat's direction) and handling the mainsheet (the rope that adjusts the sail's opening) with the upper limbs, along with counterbalancing the wind force on the sails through the hiking movement (feet braced under a strap, performing isometric extension of the quadriceps and hips, with the trunk leaning backward). These movement patterns place high demands on the strength of the hip flexors, knee extensors[3], ankle flexors, and shoulder girdle[4], in addition to the physical capacity of muscle power, which is highly required during maneuvers such as changes of direction (tacks and jibes), starts, and "pumping" actions (movements that help the boat pass through waves)[5]. Cardiorespiratory capacity is also very important, given the increase in oxygen consumption (VO2), heart rate, and ventilation – until reaching a steady state – during the practice of sailing[6].

Considering the wide range of physiological and biomechanical factors that influence performance in sailing, it is essential to establish the anthropometric and physical fitness profile of Optimist sailors, providing reference values to guide athletes, coaches, and parents in pursuing performance while safeguarding the health of children and adolescents[7]. However, the current literature on the physical fitness of Optimist sailors is scarce, being mostly restricted to descriptive analyses of anthropometry in small samples[8–11], as well as studies on cardiovascular responses to exercise and muscle fatigue[6,12]. Notably, no investigations have yet addressed upper limb strength and flexibility in this population, despite these being key components of physical fitness that directly impact sailing performance. Moreover, sex-related differences within the class remain unexplored, which is particularly relevant since boys and girls compete together in most regattas, including the World Championship, the sport's most prestigious event. Sex distinctions are applied only for award categories[13], while the qualification process for this championship occurs without gender differentiation.

Therefore, the aim of the present study was to describe the anthropometric and physical fitness profile of elite Optimist class athletes competing in the 2024 "Seletiva" Championship and to compare results between sexes in order to analyze their similarities and differences.

METHODS

Participants

This is a cross-sectional observational study, with the data collection occurring during the Brazilian Classifying Championship to IODA's International Championships, based in Salvador, Bahia, Brazil, on 2024 April. The procedures occurred during the inspection days (when the organization check the boats before the races).

The sample was selected by convenience (without previous sample calculation), and all sailors and their legal guardians were invited to participate on the research at the club where the event has been based (Yacht Clube da Bahia).

The inclusion criteria were: (1) Being an Optimist sailor; (2) being subscribed at the 2024 Classifying Championship; (3) being between 8 and 15 years-old. As exclusion criteria was defined having any physical or functional condition which imped test's application.

This project was approved by the Ethics Committee of the Bahiana School of Medicine and Public Health (CAAE: 76991823.1.0000.5544), according to the Resolution nº 466/12 of the Brazilian National Council, and respecting the principles of Helsinki Declaration. Each athlete's participation was conditioned by the signature of the free, prior, and informed consent (FPIC) of their legal responsible and the free, prior, and informed assent (FPIC) signature by the volunteers equal or older than 10 years-old.

Procedures

Data collection was done by professionals and students of Physical Education, who passed through previous practices to be familiarized to the necessary procedures, avoiding results deviation and bias. The local used for the interview and tests application was in a climatized and private environment, looking for the volunteer's integrity, privacy and comfort.

Participant age and sex were obtained through interviews. Stature (m) was measured using a wall stadiometer (Sanny). Body mass was assessed with a calibrated digital scale (Toledo). Waist, hip, and relaxed right arm circumferences (cm) were measured with a flexible measuring tape (Sanny). Triceps and subscapular skinfold thicknesses (mm) were measured using a scientific skinfold caliper (Sanny). Body fat percentage was estimated using the Slaughter et al. equation[14], validated for children and adolescents aged 7 to 17 years. From these values, fat mass was calculated as body mass (kg) × body fat percentage (%) = fat mass (kg). Arm muscle area was calculated using the Frisancho equation[15], which incorporates relaxed arm circumference and triceps skinfold thickness.

In terms of physical fitness, tests were conducted to assess three valences: strength, muscle power, and flexibility. Upper limb strength was measured using the handgrip test with an isokinetic dynamometer, performed on both hands. Three trials were carried out, and the mean value was recorded[16]. Lower limb power was assessed using the countermovement jump test on a Cefise My Jump 2.0 contact platform, considering relative power (W/kg) and jump height (cm), with the best of three attempts used for analysis[17]. Upper limb power was evaluated through a 2-kg medicine ball throw test, performed in three attempts, with the longest distance (m) recorded[18]. For flexibility, two tests were applied: hip adductor muscle flexibility[19] and the lunge dorsiflexion test[20], with results expressed in degrees (°).

Statistical analysis

Statistical analyses were conducted using Jamovi software, version 2.12.6. Normality was tested by the Shapiro–Wilk[21] test. Data are presented as mean ± standard deviation or frequency (%). Descriptive statistics were calculated for the total sample and separately by sex (female and male).

Comparisons between groups were conducted using Student's *t*-test for parametric data and the Mann–Whitney *U* test for nonparametric data. The significance level for all analyses was set at $p < 0.05$. Effect sizes were calculated using Cohen's *d*, with a 95% confidence interval.

RESULTS

A total of 60 sailors were evaluated (n = 60), including 42 males and 18 females. The mean age of the sample was 13 years, ranging from 11 to 15 years. Regarding anthropometric variables, mean body mass was 49.8 ± 7.78 kg and mean height was 1.61 ± 0.1 m. Mean waist circumference was 64.9 ± 5.23 cm, while median hip circumference was 85 cm (non-normal distribution, $p = 0.034$). Mean arm muscle area was 33.7 ± 9.16 cm^2. Median body fat percentage was 19.3% ($p = 0.007$), and mean fat mass was 10.4 ± 2.94 kg.

For strength, mean handgrip strength was 27.4 ± 7.46 kg (right hand) and 26.0 ± 7.56 kg (left hand). For lower-limb power, mean jump height was 29.1 ± 5.59 cm, with a relative power of 38.6 ± 7.64 W/kg. In the medicine ball throw, the mean distance achieved was 4.42 ± 0.88 m. Finally, for flexibility, mean hip adductor flexibility was 52.1 ± 13° (right leg) and 54.9 ± 13.9° (left leg), while mean dorsiflexion test results were 48.5 ± 8.68° (right leg) and 47.3 ± 11.3° (left leg). A full descriptive analysis of the sample is presented in Table 1.

Table 1. Sample description.

Variable	Central tendency	Shapiro-Wilk p-value
N=60		
Age (years)	13	0.002*
Body mass (kg)	51.15	0.002*
Height (m)	1.59 ± 0.11	0.223
WC (cm)	64.42 ± 5.55	0.558
HC (cm)	84.5	0.004*
BF%	19.8	< 0.001*
AMA (cm2)	33.44 ± 8.55	0.366
FM (kg)	9.93 ± 2.92	0.167
HG right (kg)	26.0 ± 7.8	0.485
HG left (kg)	24.52 ± 7.88	0.199
CMJ (cm)	27.44 ± 5.8	0.203
Relative power (W/kg)	36.53 ± 8.26	0.740
MB throw (m)	4.24 ± 0.88	0.272
Right adductor (°)	44.93 ± 10.5	0.610
Left adductor (°)	51.84 ± 11.7	0.659
Right DF (°)	45.29 ± 9.65	0.673
Left DF (°)	44.59 ± 11.2	0.161

Note: *$p<0.05$. WC: waist circumference; HC: hip circumference; BF%: body fat percentage; AMA: arm muscle area; FM: fat mass; HG: handgrip; CMJ: counter movement jump; MB: medicine ball; DF: dorsiflexion.

In relation to sex comparison, were found significant statistical differences in body composition, on the variables body fat percentage (p < 0.001), waist circumference (p = 0.028) and arm muscle area (p = 0.001), being this last one the only one higher on male sailors. In respect to the other circumferences, body mass and height, no significant statistical difference was found.

In the others physical fitness valences, there were not found any difference between groups. The statistical analysis of comparisons between male and female athletes is contained on Table 2.

Table 2. Comparisons between sexes (Male and Female).

Variable	Male mean	Female mean	p-value	Cohen's d (CI)
Age (years)[b]	12.7 ± 1.37	12.6 ± 1.46	0.791	0.08 (-0.47 – 0.63)
Body mass (kg)[b]	48.9 ± 9.29	47.0 ± 8.12	0.189	0.21 (-0.34 – 0.76)
Height (m)[a]	1.60 ± 0.11	1.57 ± 0.08	0.259	0.32 (-0.23 - 0.87)
WC (cm)[a]	65.4 ± 5.63	62.0 ± 4.66	0.028*	0.63 (0.06 – 1.19)
HC (cm)[b]	82.3 ± 6.78	82.6 ± 7.32	0.994	-0.04 (-0.6 – 0.50)
BF%[b]	19.2 ± 4.02	23.2 ± 3.46	<0.001*	-1.03 (-1.61 – 0.44)
AMA (cm2)[a]	35.7 ± 8.24	28.1 ± 6.86	0.001*	0.96 (0.38 – 1.54)
FM (kg)[a]	9.46 ± 2.78	11.0 ± 3.02	0.055	0.55 (-1.11 – 0.01)
HG right (kg)[a]	25.8 ± 7.93	26.4 ± 7.71	0.787	-0.07 (-0.63 – 0.47)
HG left (kg)[a]	24.3 ± 7.95	25.1 ± 7.92	0.724	-0.10 (-0.65 – 0.45)
CMJ (cm)[a]	27.3 ± 5.56	27.7 ± 6.47	0.818	-0.06 (-0.62 – 0.49)
Relative power (W/kg)[a]	36.6 ± 7.42	36.8 ± 10.0	0.878	-0.04 (-0.60 – 0.51)
MB throw (m)[a]	4.18 ± 0.92	4.37 ± 0.79	0.460	-0.21 (-0.77 – 0.34)
Right adductor (°)[a]	49.6 ± 10.1	50.7 ± 11.6	0.703	-0.10 (-0.66 – 0.45)
Left adductor (°)[a]	52.0 ± 11.9	51.4 ± 11.5	0.864	0.04 (0.50 – 0.60)
Right DF (°)[a]	45.5 ± 9.11	44.8 ± 11.0	0.788	0.07 (-0.48 – 0.63)
Left DF (°)[a]	45.7 ± 11.5	42.1 ± 10.4	0.262	0.32 (-0.23 – 0.87)

Note: [a]Student's t-test; [b]Mann-Whitney U-test; *p < 0.05. WC: waist circumference; HC: hip circumference; BF%: body fat percentage; AMA: arm muscle area; FM: fat mass; HG: handgrip; CMJ: counter movement jump; MB: medicine ball; DF: dorsiflexion; CI: confidence interval.

DISCUSSION

The present study aimed to describe the anthropometric and physical fitness profile of Brazilian Optimist class sailors, and to compare the values obtained by male and female sailors, analyzing the differences and similarities between them. Our results show significant differences between sexes on the body fat percentage, waist circumference and arm muscle area, being just the last one higher on males.

About the body composition and physical fitness profile, our results can be compared to previous studies conducted in different occasions. At the 2003 Optimist Worlds Championship[11] the mean of body mass (48.8 ± 6.37) and height (1.60 ± 0.054) of the elite sailors (between the 45 first on the final result) were similar to the found in our research, 21 years after and in national level. Regarding muscle power, vertical jump mean height was higher than the found for infantile category male sailors (11 to 12 years-old), but lower than the found for juvenile category males (13 to 15 years-old). The same tendency was observed on the handgrip strength test in this occasion[10].

About parameters which had not been studied in this population, as dorsiflexion, the measured mean values were similar to under-18 judokas[22] and ballerinas of the same age range[23]. This indicates the possible relevance of this valence for sport practice and performance on sailing, mainly by the demand on the ankle joint on hiking[4]. Furthermore, studies relate a positive correlation between ankle dorsiflexion range of motion and dynamical balance, necessary for a good execution of movements on unstable surface (boat's floor)[24]. But in the case of hip adductors flexibility, previous studies in this age range population were not found, what demonstrate the need of more studies about this valence on young sailors, who need to achieve a great hip joint mobility and muscular flexibility at maneuver moments[4].

Besides, about the sex differences found in this occasion, there was calculated a prediction equation for trunk and upper limbs maximal strength, based on values of arm muscle area, with strong concordance for adults[25].

In a study focused on teenager swimmers, it was also possible to calculate a predictive equation for propulsive force by AMA for male subjects[26], demonstrating the relation between this index and strength. This capacity is strongly associated to the "dynamic-hiking" and trimming, constant actions of dinghy sailors. About body fat, there are already found negative association between cardiorespiratory capacity and total fat[27], demonstrating that the analyzed female sailors can have a methabolical disvantage in relation to the male sailors, which can be more evident in strong winds regimen.

Observed differences on the results of the previous mentioned parameters are already known as biological differences between sexes, but are deservedly highlighted in this occasion, since boys and girls compete together in sailing. This study is the first step of the discussion about the fleet divisions around the world, and the fairness of the mixed competitions (even though, there are specific gender awards). Therefore, the authors recommends the conduction of longitudinal studies to analyze the relationship between the anthropometric and functional profile of girls and boys in Optimist sailing along time.

As study limitations, there's the numerical difference between the groups sample. Although, this can be justified by the relative lower presence of female sailors in relation to male sailors. It can also be observed the heterogenous data for body mass, height, waist circumference and body fat percentage, which presented non-parametric distribution. However, this can be an indicator of athlete's morphological heterogeneity, since that is an initiation class very traditional in Brazil, and it is often after 15 years old (Optimist's competitive limit age) when athletes choose sailing classes more adequate for their body type[28].

CONCLUSION

We conclude that the analyzed Optimist sailing athletes presented differences on anthropometric measured between sexes, that can influence on physical fitness valences, as cardiovascular resistance and muscle fatigue. It is evident the need of deeper analysis of the biological sex differences in young sailors, and its influence on athlete's performance. Therefore, this will give resources for manage the sportive initiation and competitive participation on sailing, respecting the principle of fairness between genders, and promoting equality.

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COMPLIANCE WITH ETHICAL STANDARDS

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Data Availability Statement

Research data is only available upon request.

Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee –Bahiana School of Medicine and Public Healht, and the protocol (CAAE: 76991823.1.0000.5544) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: ALRD, DLCM; Performed the experiments: ALRD, DLCM; Analyzed the data: ALRD; Contributed reagents/materials/analysis tools: ALRD, DLCM, ALPC; Wrote the paper: ALRD, DLCM, ALPC.

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