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ANTHROPOMETRIC CHARACTERISTICS OF ILCA 6 SAILORS AT THE SUMMER OLYMPIC GAMES

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ABSTRACT

Abstract: This study aimed to determine the typical anthropometric profile of elite ILCA 6 class sailors at the Olympic Games. To achieve this goal, trends in key anthropometric indicators, such as weight, height, body mass index (BMI), and age of the competitors in this class were analyzed, along with their impact on the final results at the Olympic Games. A sample of 150 Olympic ILCA 6 class sailors took part in this study, with an average age of 25.59 ± 4.83 years, a body height of 171.51 ± 5.02 cm, a body weight of 66.15 ± 3.88 kg, and a BMI of 22.5 ± 1.48 kg/m². These sailors participated in the Olympic Games of 2008, 2012, 2016, and 2021. The data were collected from official results books published by the Organizing Committees of the Olympic Games, which included the age, height, and weight of all sailors. Means and standard deviations were calculated, and Spearman correlation was used to determine the relation between final performances and age, height, weight, and BMI. The findings revealed a moderate negative correlation between performance and age (r = -.336) among female ILCA 6 sailors at the Olympic Games. The results suggested that the dominant anthropometric characteristics were ages between 20 and 28 (63.8%), height between 1.65m and 1.76m (81.4%), and weight between 62 kg and 70 kg (82.7%).

Keywords: *Anthropometric profiles, dinghy sailing, Olympics, performance.*

INTRODUCTION

The ILCA 6, known as the Laser Radial, is a one-design class of small sailing dinghies. Originally manufactured by Laser Performance, these boats are now produced by builders approved by World Sailing. As a variant of the Laser Standard (ILCA 7), the ILCA 6 features a shorter mast and a smaller sail area, enabling lighter sailors to compete effectively in strong winds. This class is sailed by females, male competitors under 18, and masters and has official recognition from World Sailing. The term "Radial" stems from the radial design approach used in the sail, where the panels extend from the clew to the luff. Visually, the boats used in the Women's event can be distinguished by the red rhombus carried on the mainsail. Now known as the ILCA 6, the boat received this name after Laser sailboats lost their manufacturing rights, which were transferred to the class association.

The Laser was designed in 1969 by Canadians Bruce Kirby and Ian Bruce, and it became prominent in the early 1970s. The inaugural Laser Radial Women's World Championship was held in 1980 in Kingston, Canada, marking a significant moment for the class. The Laser Radial made its Olympic debut at the 2008 Beijing Games. Notably, all boats within this class are identical, ensuring that success is based purely on the sailor's talent and skill rather than equipment differences.

Success in sports is a combination of various factors. Although success is largely influenced by genetic factors, training, nutrition, sociocultural influences, and environment, anthropometric factors are associated with athletes' performance and

increase predispositions for success in sports (Avramov, 2015; Ilieva-Sinigerova, 2019). Sailing is a unique sport that combines high-level physical activities with knowledge of aerodynamics and hydrodynamics, navigation and meteorology, racing rules and tactics, and the ability to anticipate events and make quick, considered decisions (Bojsen-Møller & Bojsen-Møller, 2001).

In this context, the anthropometric profile and physiological fitness are crucial for athletes' performance. Therefore, success in sailing depends on a series of anthropometrical, functional, motor, and cognitive dimensions, as well as specific fitness, technical, tactical, and theoretical preparation. The anthropometric characteristics of athletes are not only the result of heredity and environmental adaptation but are also influenced by nutrition and training (Barr et al., 1994). Identifying the anthropological traits of the most successful sailors can help facilitate the selection process in younger age categories.

The anthropometric profile is a well-known parameter that characterizes differences among physical training groups (Callewaert et al., 2015). Juvenile and infantile athletes in various modalities have been described as a means of detecting talent and guiding training (Claessens et al., 2005). As asserted by Geshev (2014), the configuration of a training group profile that fulfills the necessary criteria may be a pivotal factor in determining whether a sports training program achieves a successful outcome or encounters failure. The primary objective of technical and physical trainers, in addition to that of researchers, is to adjust athletes' profiles for each modality to achieve maximum performance. Several studies have indicated a correlation between physical characteristics and athletic performance (Tan et al., 2006; Bojsen-Møller et al., 2007; Iossifov, 2012).

The typical body profile of sailors in various sailing classes has been extensively studied (Pezelj et al., 2024; Sánchez-Oliver et al., 2023; Skrypchenko et al., 2022; Prlenda et al., 2021; Lozovina, Đukić, 2017; Bojsen-Møller et al., 2007; Niinimaa et al., 1977; Plyley et al., 1985). However, there is a lack of in-depth research into the anthropometric profile of ILCA 6 female athletes at the Olympics, covering a larger number of participants. Plyley et al. (1985) argue that no "perfect profile" exists, as optimal requirements differ not only across classes but also between helmsmen and crew. Their study found no evidence that sailors fitting the supposed "perfect profile" were selected for national teams, highlighting an advantage of tall stature in generating an augmented restorative moment, particularly when coupled with a higher center of gravity.

This study aimed to determine the typical anthropometric profile of elite "ILCA 6" class sailors participating in the Olympic Games and examine the impact of these parameters on the competitors' overall performance.

METHODOLOGY

Participants

A total of 150 Olympic ILCA 6 class sailors were included in the study. The average age of the participants was 25.59 ± 4.83 years, with an average height of 171.51 ± 5.02 cm, weight of 66.15 ± 3.88 kg, and BMI of 22.5 ± 1.48 kg/m². These sailors participated in the Olympic Games of 2008, 2012, 2016, and 2021.

Research Methods

This study includes a comprehensive review and analysis of literature in Cyrillic, Latin, and online sources. Moreover, secondary data from the official result books published by the organizing committees of the Olympic Games were examined (Olympic World Library, 2018).

Methodology for calculating the total scores and final ranking for the sailing events at The Summer Olympics

The Olympic races were conducted in accordance with the Racing Rules of Sailing (RRS), as recommended by World Sailing. The race has two phases: an initial series and a medal race. At the end of the initial series, the medal races determine the winners of the medals. The Olympic sailing competition uses a "low point" scoring system. In this system, the winner of each race is awarded one point, the second-place finisher is awarded two points, and so on. If a sailor fails to finish a race or is disqualified, they are granted one more point than the number of boats in that event. To calculate a sailor's event placing after the opening series, the points from their worst race performance(s) are discarded, and the remaining points are summed. However, if a sailor earns points due to disqualification or from a specific race, these points cannot be discarded. The top ten boats from the initial series advance to the final medal race. In the medal race, the points are weighted (doubled for the boat ranked 1st, and so on) and added to the series score. Scores from the medal race cannot be discarded. If a boat does not complete the final race or is disqualified, it receives twenty-two points and cannot be ranked lower than tenth. The three boats with the best overall scores from the initial series and the medal race determine the winners. In case of a tie in the final standings, precedence is given to the competitors who performed better in the medal race. In this study, the final standing was used as a performance metric for statistical analysis.

Statistical Analysis

The survey data were analyzed using SPSS version 19.0 (IBM Corporation, Armonk, NY). Basic statistical measures, including mean, standard deviation, minimum, maximum, and range, were calculated. Distribution sensitivity measures, such as skewness and kurtosis, were determined. The normality of the distribution was assessed using the Kolmogorov-Smirnov test (K-S test). Correlation analysis (Spearman Correlation) was conducted to evaluate the relationship between anthropometric measures (weight, height, age, BMI) of the athletes and their final ranking in the sailing competition. Sturges' rule (Sturges, 1926) was applied to determine the number of groups and intervals for classifying observed parameters. The formula $N = 1 + 3.322 \log (n)$ was used, where N represents the number of groups and n is the sample size. The group width was calculated by dividing the data range (R) by the desired number of groups (N).

RESULTS

Table 1 presents the descriptive statistics for all measured variables, including the mean, standard deviation, range, minimum, and maximum values. A sensitivity analysis was performed using coefficients of skewness and kurtosis, while the Kolmogorov-Smirnov test was utilized to evaluate the normality of the distribution. The results of the Kolmogorov-Smirnov test indicate that none of the observed variables exceed the critical value of 0.11 for the sample. This finding suggests that the variables do not significantly deviate from a normal distribution, making them appropriate for further non-parametric statistical analysis.

Table 1. *Descriptive parameters of ILCA 6 female sailors.*

Olympic game	Parameter	*N*	*Mean ± SD*	Min	Max	*R*	Skew	Kurt
Beijing 2008	Age (years)	28	24.71 ± 4.61	17.00	33.00	16.00	0.202	-0.952
	Weight (kg)		65.57 ± 3.62	57.00	70.00	13.00	-0.699	-0.058
	Height (cm)		169.42 ± 4.51	162.00	177.00	15.00	-0.013	-1.356
	BMI (kg/m²)		22.87 ± 1.52	19.37	26.29	6.92	-0.434	0.479
London 2012	Age (years)	41	25.27 ± 4.47	18.00	38.00	20.00	0.776	0.455
	Weight (kg)		67.73 ± 3.91	56.00	79.00	23.00	-0.034	2.635
	Height (cm)		172.00 ± 5.08	164.00	185.00	21.00	0.284	-0.388
	BMI (kg/m²)		22.93 ± 1.53	19.37	27.99	8.62	0.384	2.173
Rio 2016	Age (years)	37	25.14 ± 4.83	17.00	37.00	20.00	0.294	-0.164
	Weight (kg)		65.81 ± 3.82	56.00	72.00	16.00	-0.678	0.365
	Height (cm)		171.72 ± 5.12	165.00	186.00	21.00	0.817	0.659
	BMI (kg/m²)		22.29 ± 1.60	19.37	25.71	6.34	0.128	-0.519
Tokyo 2021	Age (years)	44	26.61 ± 5.16	17.00	42.00	25.00	0.422	0.506
	Weight (kg)		65.65 ± 3.88	56.00	73.00	17.00	-0.025	-0.119
	Height (cm)		172.70 ± 5.12	163.00	186.00	23.00	0.367	0.226
	BMI (kg/m²)		22.01 ± 1.17	20.32	25.51	5.19	0.763	0.326
All	Age (years)	150	25.59 ± 4.83	17.00	42.00	25.00	0.456	0.097
	Weight (kg)		66.15 ± 3.88	56.00	79.00	23.00	-0.213	0.701
	Height (cm)		171.51 ± 5.02	162.00	186.00	24.00	0.414	-0.010
	BMI (kg/m²)		22.50 ± 1.48	19.37	27.99	8.62	0.280	0.441

Notes: SD—standard deviation; Min—minimum result; Max—maximum result; Skew—skewness; Kurt—kurtosis; R – Range; BMI – Body Mass Index. The limit value of the KS test for N = 150 is 0.11

Table 2. *Distribution of ILCA 6 Olympics sailors by Age.*

Age Group (years)	Beijing	%	London	%	Rio	%	Tokyo	%	All	%
17-19	2	7.1	2	4.8	5	13.5	4	9.1	13	8.7
20-22	10	35.7	11	26.8	4	10.8	4	9.1	29	19.3
23-25	5	17.9	12	29.3	12	32.4	12	27.3	41	27.3
26-28	3	10.8	6	14.7	6	16.2	10	22.6	25	17.2
29-31	6	21.4	6	14.6	7	18.9	7	15.9	24	16.7
32-34	2	7.1	2	4.8	2	5.4	6	13.6	13	8.7
35-37	0	0	0	0	1	2.7	0	0	1	0.7
38-40	0	0	1	2.4	0	0	0	0	1	0.7
41-43	0	0	0	0	0	0	1	2.3	1	0.7
Total	28	100	41	100	37	100	44	100	150	100

Table 2 provides a comprehensive overview of the age distribution of ILCA 6 sailors participating in The Olympic Games.

Table 3. *Distribution of ILCA 6 Olympics sailors by Weight.*

Weight Group (kg)	Beijing	%	London	%	Rio	%	Tokyo	%	All	%
56-58	2	7.1	1	2.4	2	5.4	1	2.3	6	4.0
59-61	1	3.6	1	2.4	2	5.4	5	11.3	9	6.0
62-64	7	25	4	9.8	10	27	16	36.4	37	24.7
65-67	8	32.1	11	26.9	10	27	10	22.7	39	26.0
68-70	10	35.7	20	48.8	11	29.8	7	16.0	48	32.0
71-73	0	0	1	2.4	2	5.4	5	11.3	8	5.3
74-76	0	0	2	4.9	0	0	0	0	2	1.3
77-79	0	0	1	2.4	0	0	0	0	1	0.7
Total	28	100	41	100	37	100	44	100	150	100

Tables 3 and 4 present the weight and height distribution of ILCA 6 sailors at the Olympic Games, with the frequency and percentage of each group calculated.

Table 4. *Distribution of ILCA 6 Olympics sailors by Height.*

Height Group (cm)	Beijing	%	London	%	Rio	%	Tokyo	%	All	%
162-164	5	17.9	2	4.9	0	0	2	4.5	9	6.0
165-167	5	17.9	6	14.6	9	24.3	7	16.0	27	18.0
168-170	4	14.3	9	22.0	6	16.2	5	11.4	24	16.0
171-173	8	28.5	9	22.0	11	29.7	16	36.4	44	29.4
174-176	5	17.9	8	19.5	7	18.9	7	16.0	27	18.0
177-179	1	3.6	4	9.7	1	2.7	3	6.8	9	6.0
180-182	0	0	2	4.8	1	2.7	3	6.8	6	4.0
183-185	0	0	1	2.4	1	2.7	0	0	2	1.3
186-188	0	0	0	0	1	2.7	1	2.3	2	1.3
Total	28	100	41	100	37	100	44	100	150	100

Table 5. *Spearman Correlation Coefficient Hemi-Matrix of anthropometric characteristics and age indicators of Olympic sailors with sailing race results using Spearman Correlation ($p < .01$).*

		Age	Height	Weight	BMI	Position
Age	*r*	1.000				
Height	*r*	.121	1.000			
Weight	*r*	.178*	.812**	1.000		
BMI	*r*	.168*	.225**	.689**	1.000	
Position	*r*	-.336**	-.100	-.075	-.007	1.000

$p < .05$* $p < .01$**

We used the Spearman correlation coefficient to examine the relationship between performance, anthropometric characteristics, and age among ILCA 6 sailors at the Olympic Games. Analysis of Table 5 revealed a moderate negative correlation between age and position ($r = -.336$) for female ILCA 6 sailors ($p < .01$).

DISCUSSION

This research examined the relationship between the anthropometric characteristics and the age of ILCA 6 Olympic sailors and their final rankings. A comprehensive literature review revealed a correlation between body composition, physical traits, and athletic performance, highlighting the significance of height, weight, and other anthropometric measurements in determining a sailor's success on the water. The review identified numerous studies that underscored the importance of these anthropometric indicators for sailors' performance. For instance, Santos et al. (2016) demonstrated that body weight has a significant impact on sailor performance, particularly in moderate to strong wind conditions. In addition, Tan et al. (2006) found a strong negative correlation between body weight and sailing performance (r = -.69; p < .05) among male Laser racers. A similar correlation was also identified by Skrypchenko et al. (2022) in the "Laser Radial" category at the Tokyo Olympic Games, with a strong negative correlation between race results and body weight (r = -.515; p < .05). This can be ascribed to the fact that a decrease in body weight can reduce hydrodynamic drag on the vessel during planning conditions. Consequently, this allows sailors to achieve higher speeds under optimal conditions by reducing hull contact with water.

The findings of this study reveal no substantial correlation between the weight of ILCA 6 sailors and their performance at the Olympic Games. This can be explained by the fact that 82.7% of all participants fell within the weight group of 62-70 kg, and 31.4% were in the optimal weight group of 66-68 kg (Fletcher, 2008). The mean weight of ILCA 6 competitors was 66.15 ± 3.88 kg, with a standard deviation that remained consistent across all Olympic Games. This finding suggests that an increasing number of sailors are achieving optimal weight for their respective classes, thereby emphasizing the significance of this anthropometric parameter in determining competitive performance.

Plyley et al. (1985) proposed that body proportions are crucial for optimal performance, suggesting that sailors should have a slender physique, tall stature, and a high center of gravity. In a subsequent study, Callewaert et al. (2015) examined the morphological differences between elite and non-elite sailors in the laser radial class, finding no significant differences in height and weight between the two groups. While elite sailors demonstrated higher mean body mass, no significant disparity in height was observed between the two groups, a finding corroborated by the current study, which also found no significant correlation between the height of Olympic sailors and their performance. The study revealed that the average height of ILCA 6 sailors for all Olympic Games is 171.51 ± 5.02 cm, indicating a trend of increasing height over the years. The mean height of ILCA 6 sailors was 169.42 ± 4.51 cm in 2008 and 172.70 ± 5.12 cm in 2021, a trend attributed to the heightened competitive environment. Although a taller height is advantageous, it is not a result of training; instead, it is a consequence of pre-selecting competitors.

Regarding BMI, Sánchez-Oliver et al. (2023) found that sailors in the high-level group had lower BMI values compared to the total sample. In a separate study on Laser-class sailors, Spurway et al. (2007) demonstrated that sailors with higher BMIs, within normal weight ranges, exhibited enhanced boat stability in high wind conditions. However, it is crucial to acknowledge that sailing is a sport heavily influenced by unpredictable weather conditions, and success is contingent upon an individual's ability to comprehend and anticipate these conditions. Consequently, a higher BMI could hinder performance in light to me-

dium winds due to increased frictional resistance from a larger wet surface area, thereby slowing the boat down. The study also noted that BMI values for female ILCA 6 sailors remained relatively stable, with average BMIs ranging from 22.01 in Tokyo to 22.97 in London, indicating a downward trend, with the lowest recorded BMI of 22.01 in Tokyo. This observation aligns with the findings from similar studies in various Olympic sports, including aquatics, athletics, badminton, and cycling (Skrypchenko et al., 2022).

When considering the role of age as a factor in success, it is essential to note that this is not contingent upon training, nor can it be developed in conjunction with other physical, technical, tactical, and mental abilities. The results of this study indicate that the majority of the participants fall within the 23-25 age group, except for the Beijing Games, where the majority of participants are within the 20-22 age group (Table 2). This is likely because ILCA 6 has been used at the Olympic Games for the first time, resulting in a higher participation rate among younger athletes. In a study by Skrypchenko et al. (2022), a strong negative correlation was identified between sailor age and race performance in the Laser Radial at the Tokyo Olympic Games. The findings indicated that older helmsmen exhibited superior performance in the competition, including in the final stages of all Olympic classes. In this study, a moderate negative correlation was found between age and position (r = -.336) of ILCA 6 female sailors ($p < .001$). The average age increased from 24.71 ± 4.61 years in 2008 to 26.61 ± 5.16 years in 2021. The underlying reason for this finding is the remarkable sports longevity exhibited by several competitors. Despite the finding that the mean age of ILCA 6 female sailors at the Summer Olympics was 25.59 ± 4.83 years, it is believed that the integration of physical, technical, tactical, and psychological factors is conventionally necessary for performance success. Consequently, the relationship between age and sports performance merits further investigation, with caution advised regarding the establishment of a causal link between the two factors. Nonetheless, it can be posited that experience frequently constitutes a substantial element in achieving success in sailing competitions.

The mean values for height, weight, and age of ILCA 6 Olympic sailors are 171.51 ± 5.02 cm, 66.15 ± 3.88 kg, and 25.59 ± 4.83 years, respectively. The small standard deviations in all components indicate that an increasing number of ILCA 6 sailors are approaching the optimal values of the studied parameters. This highlights the importance of these anthropometric measures in enhancing competitive performance. In light of the findings, it can be suggested that the most successful sailors at the forthcoming Games may range in height from 165 to 176 cm, in body weight from 62 to 70 kg, and in age from 20 to 28 years.

The results of this study corroborate the assertion that the anthropometric characteristics of sailing competitors are of utmost importance for talent identification and for guiding young sailors in selecting an appropriate class. Furthermore, we hypothesize that specific physical characteristics are a prerequisite for enhanced performance.

CONCLUSION

The anthropometric profiles of elite ILCA 6 class female sailors at the Olympics have been determined, and this study has examined the relationship between performance and anthropometric variables, such as height, weight, and BMI (body mass index), among ILCA 6 sailors competing in the Olympic Games. The findings indicate no statistically significant correlation between performance metrics and

the aforementioned anthropometric variables. However, a moderate negative correlation was observed between age and performance (r = -.336). The study hypothesizes that the majority of ILCA 6 sailors participating in future Olympic Games may possess specific anthropometric characteristics: height, 165-176 cm (81.4%); weight, 62-70 kg (82.7%); and age, 20-28 years (63.8%). The study proposes that a combination of chronological age, biological maturity, experience, individual differences, and the dynamic nature of sailors' development impact physical adaptations.

It is essential to interpret the data in this article with caution, given the limited information available on other parameters that may influence performance. While age, height, and weight are factors in sailor selection, well-developed endurance, agility, upper-body strength, core stability, and power are crucial for achieving elite sailing performance. The results highlight the importance of specific anthropometric characteristics in determining athletic performance. Understanding the biological traits of elite ILCA 6 sailors will enable the tailoring of training programs for the class in anticipation of the 2028 Olympic Games in Los Angeles.

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