ORIGINAL ARTICLE

Physical condition characteristics of junior whitewater rafting athletes in Purbalingga

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Abstract

Background and Study Aim: Physical fitness is a component supporting athlete performance in many sports, including whitewater rafting. This sport requires a combination of aerobic endurance, upper-body strength, leg explosive power, and core stability to navigate dynamic and challenging river currents. Although these physical demands are recognized in rafting practice, the characteristics of athletes' physical condition across competition categories remain a relevant aspect of training evaluation. The aim of this study was to determine the physical condition characteristics of junior rafting athletes in Purbalingga and to analyze differences in test results across competition categories.

Material and Methods: This study used an observational quantitative approach. The subjects consisted of 68 junior rafting athletes aged 15–18 years from a rafting club in Purbalingga. Physical condition measurements included the Multi-Stage Fitness Test (MFT), push-up test, pull-up test, vertical jump test, and plank test. Data analysis was performed using descriptive statistics and the Mann-Whitney and Kruskal-Wallis tests with a significance level of $p < 0.05$ in SPSS version 24.

Results: The study found that only height showed significant differences between male and female athletes ($p < 0.05$). Age, weight, and BMI did not show significant differences. In addition, there were no significant differences in any components of physical condition between rafting competition categories ($p > 0.05$). Most athletes were in the Good (43%) and Fair (31%) categories.

Conclusions: The physical condition of junior whitewater rafting athletes in Purbalingga is generally good. The training program implemented has improved the athletes' basic physical condition. However, more targeted training is still needed to optimize performance.

Keywords: physical condition, white water rafting, junior athletes, aerobic endurance, muscle strength

Introduction

Physical fitness is a component of athlete preparation in outdoor sports that involve considerable physical demands. In whitewater rafting, athletes control the boat in changing river conditions and coordinate their actions with other crew members. This activity involves several physical capacities, including endurance, muscular strength, explosive power, and trunk stability. The development and balance of these components influence movement execution and athlete performance during rafting competitions.

To support athlete performance, attention is given to various aspects that influence physical and mental abilities [1, 2]. One aspect related to performance is physical condition [3, 4]. Physical condition allows athletes to train effectively, reduces the risk of injury, and increases endurance under competitive pressure [5, 6].

Physical training forms the foundation for the development of sports performance. Technical, tactical, and psychological components develop when an athlete has undergone sufficient physical training aimed at improving physical qualities [7, 8]. A proper level of physical fitness is therefore necessary for athletes to improve and develop sports performance. Physical capacities should be developed according to the specific characteristics and requirements of each sport [9]. Many factors determine sports performance. These include the combination of physical fitness, skills, abilities, technique, determination, strategy, and psychological preparation before competition [10]. Physical fitness contributes to the development of an athlete's technical and psychological abilities [11, 12]. It is also an important component in efforts to improve performance. A high level of physical fitness supports athletic performance and enables athletes to train effectively [13, 14].

Physical fitness is a requirement for athletes to achieve performance results. It should be maintained and developed as part of the training process [15, 16]. The development of physical fitness must correspond to the characteristics and demands of the specific sport. In whitewater rafting, physical fitness includes muscular strength, cardiovascular endurance, balance, agility, and body coordination [17]. Rafting athletes navigate strong currents, maintain boat stability, and coordinate actions with teammates in a changing environment. For this reason, a structured and measurable physical fitness assessment is applied.

Whitewater rafting is a water sport that requires physical abilities, technical skills, and teamwork.

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The sport includes several disciplines: sprint, head-to-head, slalom, and downriver racing. Physical condition also relates to recovery after training or competition. Athletes have different physical characteristics that depend on age, gender, training intensity, and genetic factors [18].

Analysis of research findings has shown that physical condition is associated with the development of athletes' performance in sports that require a combination of endurance, strength, coordination, and teamwork. Researchers indicate that the assessment of physical condition allows the identification of characteristics that influence the preparation and performance of athletes in specific sports disciplines. At the same time, the diversity of physical demands in whitewater rafting and the presence of several competition disciplines require a detailed examination of the physical condition of athletes participating in this sport. This circumstance makes it relevant to examine the physical characteristics of junior rafting athletes within the context of their competitive activity.

Analysis of research findings has shown that physical condition is associated with the development of athletes' performance in sports that require a combination of endurance, strength, coordination, and teamwork. Researchers note that the assessment of physical condition provides information about the functional capabilities of athletes and supports the organization of the training process. The characteristics of physical condition in junior athletes represent a component of sports preparation, as information about these characteristics can be used when planning training programs and monitoring athlete development. At the same time, the physical demands of whitewater rafting and the variety of competition disciplines create the need to examine the physical condition of junior athletes involved in this sport. Therefore, the aim of this study was to analyze and describe the physical condition of junior rafting athletes in Purbalingga.

Materials and Methods

Participants

The study subjects comprised 68 junior rafting athletes in accordance with the Indonesian Rafting Federation regulations. All subjects were aged 15–18 years and were from rafting clubs in Purbalingga. The athletes participated in a regular rafting training program averaging 8–10 hours per week and had approximately 2 years of rafting experience.

All study subjects were in good health, had no history of cardiovascular disease, did not have asthma, and were non-smokers. Prior to the test, all subjects consumed a light snack one hour before the measurement. They wore appropriate sports clothing and shoes. Before the study, the researchers obtained permission from the rafting club coach and prepared the necessary research instruments, including stationery and questionnaires used to measure the study variables.

In addition, verbal and written explanations regarding the research objectives, implementation procedures, and potential risks were provided to all subjects before data collection. The study received ethical approval from Semarang State University under research ethics letter number B/1913/UN37.1.6/KM.07/2025.

Study Design

The method used in this study was an observational quantitative approach aimed at identifying the characteristics of the variables under study. Height was measured using a stadiometer, with the subject facing forward and standing upright without shoes. Body weight and body mass index (BMI) were measured using an Omron Karada Scan Body Fat device [19].

To measure body capacity and strength, a series of physical fitness tests was conducted. Maximal aerobic capacity (VO_2max) was measured using the Multi-Stage Fitness Test (MFT). This test involves a 20-meter back-and-forth run to a rhythmic sound that gradually increases until the participant is unable to follow the rhythm twice in a row [20]. Upper body muscle strength and endurance were measured using the Push-Up Test. In this test, participants performed as many push-ups as possible with correct technique for 60 seconds [21]. Arm and upper back muscle strength were assessed using the Pull-Up Test. Participants performed unassisted pull-ups to their limit for 60 seconds [22]. Leg muscle explosiveness was measured using the Vertical Jump Test. Participants jumped as high as possible from a standing position [23]. Finally, core muscle strength and endurance were measured using the Plank Test. Participants maintained a plank position for as long as possible without touching the floor [24].

Statistical Analysis

This study employed descriptive quantitative analysis and nonparametric statistical tests, including the Mann-Whitney and Kruskal-Wallis tests. These analyses were used to determine differences in the average physical condition test scores of whitewater rafting athletes across competition categories. All statistical analyses were conducted using SPSS version 24 with a significance level of $p < 0.05$.

Results

The data are presented as descriptive statistics to characterize the athletes' physical condition (Table 1). The analysis also included statistical tests to determine differences in average physical condition test scores across competition categories.

The results presented in Table 1 show that, among

the variables tested, only height differed between men and women ($p < 0.05$), with men having a higher mean height than women. The variables age ($p = 0.073$), weight ($p = 0.23$), and BMI ($p = 0.81$) did not show differences ($p > 0.05$). Thus, both groups had similar characteristics in terms of age, weight, and BMI, while differences were observed only in height.

The results of physical condition tests based on competition categories are presented in Table 2. The table summarizes the descriptive statistics of each test variable and the results of the Kruskal-Wallis test used to examine differences between competition categories.

Based on the results presented in Table 2, the Kruskal-Wallis test showed no differences in physical condition variables across whitewater rafting competition categories ($p > 0.05$). In the MFT test, the p-value was 0.41, indicating no differences in aerobic endurance across competition categories. Descriptively, the Sprint category had a higher mean value (5.26 ± 1.50) than the other categories. In the Push-Up ($p = 0.78$) and Pull-Up ($p = 0.17$) tests, no differences were observed in arm muscle strength and endurance between competition categories. The Slalom category had the highest mean Pull-Up value (32.90 ± 17.70), but this difference was not statistically confirmed. Similarly, in the Vertical Jump test ($p = 0.12$) and Plank Test ($p = 0.54$), no differences were observed in leg muscle explosive power and core muscle endurance between the competition categories.

The distribution of the overall physical condition test results is presented in Table 3. The table shows the number and percentage of athletes in each performance category for all physical fitness tests.

Based on the results presented in Table 3, the distribution of physical condition test results shows that most athletes are in the Good and

Table 1. Characteristics of the research sample

Characteristics	Men (n = 34)			Women (n = 34)			P-value*
	Min	Max	Mean ± SD	Min	Max	Mean ± SD	
Age (years)	12	18	16.74 ± 1.05	12	17	16.26 ± 1.08	0.073
Height (cm)	157	170	162.53 ± 6.20	149	165	157.50 ± 5.78	0.00*
Weight (kg)	50	66	61.88 ± 5.26	48	69	58.82 ± 5.84	0.23
BMI (kg/m^2)	19.23	26.10	23.14 ± 2.65	19.11	25.12	23.67 ± 2.49	0.81

Note: * Significant result of the Mann-Whitney U test

Table 2. Characteristics of physical condition test results based on competition category

Race Category	Variable	Min	Max	Mean ± SD	p-value
Sprint	MFT	3	9	5.26 ± 1.50	0.41
	Push-Up	15	52	30.20 ± 10.80	0.78
	Pull-Up	5	60	24.60 ± 16.30	0.17
	Vertical Jump	18	52	33.18 ± 8.80	0.12
	Plank Test	1	7	3.50 ± 1.60	0.54
Head-to-head	MFT	2	8	4.63 ± 1.50	0.41
	Push-Up	14	45	27.20 ± 9.10	0.78
	Pull-Up	2	45	14.30 ± 12.60	0.17
	Vertical Jump	15	45	27.10 ± 8.50	0.12
	Plank Test	1	8	4.06 ± 1.70	0.54
Slalom	MFT	2	6	3.88 ± 0.97	0.41
	Push-Up	16	50	30.40 ± 9.09	0.78
	Pull-Up	8	70	32.90 ± 17.70	0.17
	Vertical Jump	22	55	37.00 ± 7.40	0.12
	Plank Test	1	6	3.20 ± 1.10	0.54
Downriver Race	MFT	2	7	4.22 ± 1.40	0.41
	Push-Up	12	44	26.60 ± 10.40	0.78
	Pull-Up	3	60	21.10 ± 17.20	0.17
	Vertical Jump	16	48	30.20 ± 9.30	0.12
	Plank Test	1	7	4.00 ± 1.50	0.54

Note: p-values were obtained using the Kruskal-Wallis test.

Table 3. Characteristics of overall test results

Category	Types of tests									
	MFT N	MFT %	Push-Up N	Push-Up %	Pull-Up N	Pull-Up %	Vertical Jump N	Vertical Jump %	Plank Test N	Plank Test %
Very Good	7	10%	9	13%	6	9%	8	12%	10	15%
Good	31	46%	28	41%	22	32%	30	44%	27	40%
Fair	24	35%	20	29%	25	37%	21	31%	18	26%
Poor	9	13%	7	10%	10	15%	6	9%	8	12%
Very Poor	10	15%	4	7%	5	7%	3	4%	5	7%
Total	68	100%	68	100%	68	100%	68	100%	68	100%

Fair categories across most tests. In the MFT test, most athletes were in the Good category (46%), followed by Fair (35%), and 10% were in the Very Good category. In the Push-Up test, the largest proportions were also observed in the Good (41%) and Fair (29%) categories, while 13% of athletes were in the Very Good category. In the Pull-Up test, the largest distribution was in the Fair (37%) and Good (32%) categories, indicating moderate to good arm muscle strength and endurance. In the Vertical Jump test, most athletes were in the Good (44%) and Fair (31%) categories. In the Plank Test, the Good (40%) and Fair (26%) categories were also the most frequent, while 15% of athletes were in the Very Good category.

The overall physical condition of the athletes is presented in Table 4.

Table 4. Characteristics of the overall physical condition of whitewater rafting athletes

Category	N	%
Very Good	8	12%
Good	29	43%
Fair	21	31%
Poor	6	9%
Very Poor	4	6%
Total	68	100%

Based on the results presented in Table 4, the overall physical condition of junior rafting athletes in Purbalingga shows that 29 athletes (43%) are in the Good category. In addition, 21 athletes (31%) are in the Fair category, and 8 athletes (12%) are in the Very Good category. The number of athletes in the Poor and Very Poor categories is smaller, with 6 athletes (9%) and 4 athletes (6%), respectively.

Discussion

The aim of this study was to analyze and describe the physical condition of junior rafting athletes in Purbalingga. The results showed that the overall physical condition of the athletes was mainly classified in the Good and Fair categories. The analysis of physical fitness tests across competition categories also showed no differences in aerobic endurance, upper body strength and endurance, leg muscle explosiveness, or core muscle endurance.

In addition, the results indicate that the anthropometric characteristics of junior whitewater rafting athletes in Purbalingga were generally similar between male and female groups, except for height, which showed a difference. This finding aligns with the results reported by Albaladejo-Saura et al. [25]. The study indicated that differences in height during adolescence are influenced by variations in pubertal development between boys and girls. These differences are related to hormonal changes and differences in biological maturity between the sexes. Height is an anthropometric characteristic that may influence rowing efficiency because body segment length can affect lever length during the rowing stroke [26].

Research by Gäbler et al. [27] on kayak and canoe athletes showed that anthropometric factors such as height, muscle mass, and body composition are related to performance in paddling sports because they affect the ability to generate thrust in the water and the efficiency of paddle movement. However, similarities in age, weight, and BMI in this study indicate that most athletes have comparable basic physical characteristics. This is relevant because uniformity in the basic characteristics of the sample can provide a more objective basis for evaluating the physical condition of athletes.

The findings of this study also indicate that there were no differences in physical condition components between the rafting competition categories: sprint, head-to-head, slalom, and downriver race. Physiologically, whitewater rafting requires a combination of upper-body strength, aerobic endurance, and core stability. Paddling movements involve repeated muscle contractions in the arms, shoulders, back, and core and therefore require a balance of strength and endurance [28]. Research by Manna et al. [29] on kayak athletes showed that paddling requires a combination of strength, power, and endurance and involves both anaerobic and aerobic energy systems. Therefore, the absence of differences across competition

categories in this study may be explained by similarities in physiological demands between categories. In addition, during the developmental stage of adolescent athletes, training programs usually focus on the development of general physical condition before specialization in specific abilities. The results also showed that several competition categories had different mean scores for specific physical tests. One observation was that the sprint category had a higher mean Multistage Fitness Test score than the other categories. This may be related to the demands of sprint events, which require athletes to produce speed and endurance over a short duration with high work intensity.

This may be related to the requirements of the sprint category, which require athletes to perform fast, powerful, and repetitive rowing movements over a short race distance. These findings are supported by Tomiak et al. [30], who reported that in the sprint competition category athletes perform rowing movements with high speed and power repeatedly. The study also showed that increased strength and stroke rate can be achieved through training with external loading and the use of visual feedback. This approach has been shown to improve the efficiency of athlete movements during the race. These conditions indicate that the sprint event requires a combination of aerobic and anaerobic energy systems so that athletes can maintain rowing speed and rhythm during the race. Athletes with greater aerobic endurance capacity tend to maintain high work intensity, delay the onset of fatigue, and sustain stable performance during competition [31].

The overall physical condition test results showed that most athletes were in the Good and Fair categories across most physical test components. This indicates that the physical condition of the junior rafting athletes in this study supported training and competition. In the aerobic endurance component measured by the MFT test, most athletes were in the Good category. Aerobic endurance is a component of whitewater rafting because paddling is sustained and requires a stable energy supply. Research by Wang and Zhao [32] on kayaking reported that cardiorespiratory capacity, such as VO_2max and the ventilatory threshold, distinguishes higher-level from club-level athletes. Athletes with greater aerobic capacity tend to maintain work intensity for longer and achieve better performance.

The results of these physical condition measurements indicate that cardiovascular endurance and arm muscle endurance are developed among whitewater rafters. This finding aligns with research by Aristiyanto et al. [33], which reported that cardiovascular endurance and arm muscle endurance are physical condition components in whitewater rafting. Cardiovascular endurance is related to the ability of the heart and lungs to support physical activity for a given duration [34]. Therefore, physical condition and VO_2max are factors that support the ability of whitewater rafters to maintain work intensity during the race. Furthermore, arm muscle endurance supports the performance of rafting athletes. Muscle endurance is the ability of a group of muscles to contract repeatedly while holding submaximal loads for a given period of time [35]. This ability allows muscles to maintain consistent movement and generate the force required during rowing activities [36]. Without adequate arm muscle endurance, rowing movements may be limited, which can affect movement efficiency and athlete performance [37].

In addition, the plank test results showed that most athletes had good core muscle endurance. Core muscles play a role in transferring force from the lower to the upper body during rowing movements, which contributes to movement efficiency and may reduce the risk of injury [38]. Core muscle activation during rowing movements can reach approximately 85% of maximal contraction in several core muscle groups, indicating the role of body stability in whitewater rafting [39]. Thus, the development of core muscle endurance should remain part of the training program for whitewater rafting athletes to support performance and body stability during rowing activities.

Limitations and future research

This study has several limitations that should be considered when interpreting the results. The sample consisted of athletes from one rafting club in Purbalingga, which limits the generalization of the findings to other athlete populations. In addition, the participants represented junior athletes within a specific age range. The study design was cross-sectional and reflects the physical condition of the athletes at the time of measurement. Future studies may include athletes from different clubs or regions and examine changes in physical condition during the training process to provide a broader understanding of the physical characteristics associated with whitewater rafting performance.

Conclusions

The results of this study show that the physical condition of junior rafting athletes in Purbalingga is generally classified in the Good and Fair categories across several physical components, including aerobic endurance, arm muscle strength, leg muscle explosive power, and core muscle endurance. The analysis also showed no differences in physical condition between rafting competition categories, which indicates similar basic physical abilities among athletes at the junior development stage.

These results suggest that the training program implemented for the athletes has supported the development of their basic physical condition. At the same time, the results indicate the need for

continued development of training programs that include aerobic endurance, upper body muscle strength, core muscle stability, and rowing technique to support athlete performance in training and competition.

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Conflict of Interest

The authors declare no conflict of interest.

Generative AI Use Statement

Artificial intelligence (AI), specifically ChatGPT (OpenAI), was used to assist in improving the academic English of the manuscript, including grammar, writing style, and clarity of presentation. The use of AI was assistive and conducted under the authors' supervision. It did not influence the scientific content, data analysis, interpretation of results, or conclusions of the study.

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