

The Analysis of Arm Muscle Strength of Rafting Athletes in Semarang Regency in Preparation for The XVIIth PORPROV of Central Java

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Article Info	Abstract
Article History Submitted, 2025-11-02 Accepted, 2025-11-30 Published, 2025-12-31	Rafting is a branch of water sports that requires arm muscle strength, coordination, and physical endurance to face strong river currents. Arm muscle strength is a major factor in producing effective rowing power, boat stability, and overall team speed and rhythm. This study aims to analyze the level of arm muscle strength of rafting athletes in Semarang Regency. This study uses a qualitative descriptive method with a cross-sectional approach. The sample of this study is 18 Semarang Regency raft athletes with a total sampling technique. This research instrument uses a hand grip dynamometer to measure the strength of the right and left arms. Data were analyzed descriptively using SPSS. The results showed that the average right arm strength of all athletes was 37.2 kg, while the left arm was 32.8 kg, with an average difference of 4.4 kg (11.8%). Based on the strength category, 11.1% of athletes were in the very strong category, 38.9% in the strong category, 33.3% in the medium category, and 16.7% in the weak category. The conclusion in this study is that most rafting athletes have excellent arm muscle strength.
Keywords: Rafting, arm muscle strength, athletes, PORPROV	

Introduction

Sport is one of the essential aspects in the development of human physical and mental quality. Structured and well planned physical activity not only improves physical health but also positively influences cognitive abilities, psychological well being, and individuals’ social skills (Jafaruddin et al., 2024). In sports, physical components such as strength, endurance, speed, flexibility, and coordination are key determinants of athletic performance. Muscle strength, in particular, plays a crucial role in almost all sports, as it is closely related to the body’s ability to generate force, withstand loads, and perform movements efficiently (Koloway et al., 2021). Optimal muscle strength not only enhances athletic achievement but also helps reduce the risk of injury and accelerates recovery following intense physical activity (Santika & Perdana, 2021). Therefore, the systematic and scientific development of muscle strength has become one of the primary focuses in modern sports training.

In the context of rafting, muscle strength plays a highly dominant role because paddling activities are performed repeatedly, explosively, and in coordination while facing dynamic river currents. Rafting is a team-based water sport that requires synergy between physical strength, paddling technique, balance, and team communication. Each athlete must be capable of producing strong and consistent paddle strokes to maintain boat speed and stability amid strong currents and natural river obstacles. Consequently, the strength of the arm, shoulder, and core muscles becomes a fundamental component in determining movement effectiveness and energy efficiency during both competition and intensive training sessions.

Muscle strength can be classified into several types, including maximal strength, muscular endurance, and explosive strength. Maximal strength refers to the ability of a muscle to generate the highest possible force in a single contraction, whereas muscular endurance relates to the ability to sustain muscle contraction over a certain period of time (Rudianto, 2022). Explosive strength, or explosive power, is particularly important in sports that require rapid and sudden movements, such as throwing, striking, or pulling (Arsenal & Sahri, 2023). In rafting, these three types of strength operate simultaneously: maximal strength is required when confronting strong currents, muscular endurance is necessary to maintain paddling rhythm throughout the course, and explosive strength is essential for sudden acceleration or maneuvering to avoid obstacles. In addition to the type of strength, muscle distribution and intermuscular coordination also influence athletic performance. Neuromuscular coordination,

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joint flexibility, and body balance support the effective application of generated force in sport-specific movements (Rahayu et al., 2024). Therefore, integrated and science-based training is required to ensure balanced muscle development, optimize performance, and minimize injury risk (Antoni, 2023).

The improvement of athletes' physical capacity cannot be separated from appropriate and continuous training principles (Ruskin & Liputo, 2021). The overload principle, for example, states that the body adapts to the demands placed upon it; thus, training intensity and volume must be progressively increased to stimulate physiological adaptation. This principle is particularly relevant in rafting athlete development, given the high demands on muscular endurance and strength during river training sessions with varying current intensities and levels of difficulty. Furthermore, factors such as age, sex, genetics, and training experience influence the body's response to training programs (Sugiarto, 2023). Younger athletes tend to experience faster muscle development compared to adults due to more active growth and muscle cell regeneration processes. Differences in sex, associated with hormonal factors and muscle mass composition, are also important considerations in designing proportional and effective training programs. By understanding these principles of sports physiology, coaches can design training programs that not only enhance muscle strength but also develop endurance, flexibility, and optimal movement coordination (Insanistyo et al., 2023).

Beyond physical aspects, sport also requires mental capacity and strategic thinking. In rafting, athletes are not only required to be physically strong but must also make rapid decisions when facing changing currents, rocks, and river obstacles. Optimal muscle strength becomes more beneficial when accompanied by good movement control, focus, and high body awareness. The coordination between physical strength and mental control is essential to produce consistent performance under various conditions (Rahmat et al., 2025). This applies to nearly all sports, whether individual or team-based (Arvajs et al., 2024). However, in team sports such as rafting, balance of strength among team members, synchronization of paddling movements, and adaptability to river environmental conditions are critical factors. Therefore, muscle strength development should not only be conducted individually but must also consider athlete interaction and team dynamics to ensure that each member contributes maximally to team success (Mawaddah et al., 2023).

With advancements in sports science, methods for measuring athletes' physical abilities have become increasingly diverse and accurate. Modern instruments such as hand grip dynamometers, isokinetic machines, and digital sensor devices enable coaches to objectively monitor muscle strength, endurance, and coordination (Setiawan et al., 2021). In rafting, the measurement of grip and arm muscle strength is particularly relevant, as it directly relates to the ability to control the paddle and maintain a stable grip during river navigation. These data serve as a basis for evaluating training effectiveness, determining physical capacity improvement needs, and designing specific and measurable training programs. Through this scientific approach, each athlete can receive training tailored to their physical condition, address weaknesses, and enhance existing strengths (Izzuddin et al., 2022).

Research on arm muscle strength has been widely conducted across various sports. For example, a study by Hasyiyati and Winarno (2021) in the *Jurnal Olahraga Pendidikan* entitled "The Correlation between Arm Muscle Strength, Power, and Coordination on Pencak Silat Athletes' Striking Ability" analyzed the relationship between arm muscle strength, power, and coordination in university Pencak Silat athletes in Malang. The findings indicated that arm muscle strength significantly contributed to striking performance. Another study by Aulria (2025) in the *Jurnal Pendidikan Kepelatihan Olahraga* entitled "50 Meter Freestyle Swimming in Relation to Arm Muscle Strength among 10 Year Old Garuda Laut Athletes" demonstrated a positive correlation between arm muscle strength and swimming speed. Meanwhile, Rahmat et al. (2025) in the *Jurnal Ilmiah STOK Bina Guna* analyzed arm and abdominal muscle strength performance based on age and sex, finding that physiological factors significantly influenced muscle strength. Based on these studies, it can be concluded that arm muscle strength is a fundamental aspect affecting performance in various sports, including rafting, which relies heavily on explosive, repetitive, and well coordinated paddling movements within a team setting.

The primary problem addressed in this study is the limited empirical data regarding the arm muscle strength of rafting athletes in Semarang Regency prior to the 2026 Central Java PORPROV. Although rafting is a sport that demands arm muscle strength as a primary component of paddling technique, no indepth study has specifically measured and analyzed the athletes' muscle strength levels in this region. The absence of accurate information regarding actual muscle strength conditions makes it difficult for coaches to design evidence based training programs. Moreover, the lack of comparison between right and left arm strength may result in muscle imbalances that could affect paddling effectiveness and increase injury risk. These conditions provide a strong rationale for conducting a systematic and measurable investigation of arm muscle strength among rafting athletes in Semarang Regency.

The main objective of this study is to analyze the level of arm muscle strength of rafting athletes in Semarang Regency in preparation for the 2026 Central Java PORPROV. This study aims to identify differences in strength between the right and left arms, assess the distribution of strength levels among athletes, and provide a quantitative overview of their physical readiness. The findings are expected to serve as a reference for designing specific arm muscle training programs, enabling coaches to adjust training intensity and patterns according to individual athlete needs. Thus, this research is not only descriptive in nature but also applicable in enhancing athlete performance through a scientific based training approach.

The urgency of this study is considerable, given that preparation for the 2026 Central Java PORPROV requires optimal physical and technical readiness. In rafting, arm muscle strength directly influences paddling efficiency, boat acceleration, and stability when confronting strong currents and high difficulty rapids. Without accurate muscle strength profiling, training processes may become ineffective and potentially lead to overtraining or muscle injuries due to disproportionate training loads. Furthermore, this study contributes to the development of sports coaching science at the regional level, particularly in rafting, which remains underrepresented in scientific research compared to more popular sports such as swimming, pencak silat, and tennis. With the empirical data obtained, coaches and sport organizations can formulate data driven training policies to enhance athlete performance and competitiveness at provincial and national levels.

The novelty of this research lies in its focus on analyzing the arm muscle strength of rafting athletes in Semarang Regency in preparation for the 2026 Central Java PORPROV. Unlike previous studies that primarily examined arm muscle strength in individual sports such as swimming, tennis, or pencak silat, this study investigates muscle strength within a team-based water sport that requires coordination, synchronized paddling movements, and adaptation to dynamic river currents. The approach employed is mixed descriptive quantitative, combining qualitative descriptions with numerical data analysis derived from muscle strength measurements. Additionally, this study provides significant local based contributions by examining the contextual physical condition of regional athletes, which may serve as a model for similar research in other areas. Therefore, the results of this study are expected to enrich the scientific literature on competitive sports, particularly in the field of water sport physiology.

Methods

This study employed a quantitative descriptive method with a cross-sectional approach. The subjects consisted of 18 rafting athletes from Semarang Regency who were undergoing an intensive training program in preparation for the 2026 Central Java PORPROV. The subjects were selected using a total sampling technique, in which all athletes who were members of the Semarang Regency rafting team were included as research participants. The sample comprised both male and female athletes aged 17–28 years who actively participated in regular training sessions.

The study was conducted at the Semarang Regency Rafting Training Center, located around the Gading River, which serves as the primary training site for the athletes. Data collection was carried out from July to August 2025. The primary instrument used in this study was a hand grip dynamometer to measure arm muscle strength. This instrument was utilized to assess maximum grip strength, which reflects the strength of the lower arm muscles, particularly the biceps, triceps, and forearm muscles. Measurements were conducted individually, with three trials performed for each hand (right and left). The average value of the three trials was calculated and recorded as the final data.

In addition, observation sheets and data recording forms were used to document the measurement results and visually record the data collection process to ensure the accuracy and reliability of the measurements. The data were analyzed using a quantitative descriptive statistical approach with the assistance of SPSS software.

Results and Discussion

The This research was carried out on 18 Semarang Regency rafting athletes consisting of 10 male and 8 female athletes, all of whom are active athletes who are members of the official Semarang Regency FAJI team and are undergoing a preparation program for the 2026 Central Java PORPROV. The age range of athletes ranges from 17 to 28 years old, with levels of competition experience varying from 2 to 6 years.

Table 1. Result of Measuring Arm Muscle Strength of Rafting Athletes

Yes	Athlete's Name	Right Arm (kg)	Left Arm (kg)	Average (kg)	Difference (Right–Left)
1	CWN	43.2	31.1	37.15	12.1
2	MH	42.3	37.7	40.0	4.6
3	MRAM	47.8	44.9	46.35	2.9
4	KRA	24.2	26.3	25.25	-2.1

5	VPB	37.1	27.9	32.5	9.2
6	ANA	29.9	26.5	28.2	3.4
7	ADM	43.2	37.7	40.45	5.5
8	BL	43.5	36.7	40.1	6.8
9	DK	42.5	37.2	39.85	5.3
10	WD	44.2	35.5	39.85	8.7
11	SNW	47.9	45.5	46.7	2.4
12	HMDW	25.5	24.9	25.2	0.6
13	AO	23.1	22.5	22.8	0.6
14	YNA	28.9	26.2	27.55	2.7
15	RJDN	36.5	27.4	31.95	9.1
16	PDC	35.2	27.2	31.2	8.0
17	RSN	33.9	27.2	30.55	6.7
18	MSSP	33.5	27.5	30.5	6.0

Based on the table above, the average athlete's right arm muscle strength is 37.2 kg, while the average left arm muscle strength is 32.8 kg, indicating an average difference of 4.4 kg. These results show the dominance of force in the right arm, which can be associated with right-hand dominance in rowing activities. The athlete with the highest strength is SNW (47.9 kg right, 45.5 kg left), while the lowest strength is AO (23.1 kg right, 22.5 kg left). This shows a fairly wide range of muscle strength between individuals, which indicates that there is a difference in fitness level and muscle mass between athletes.

Table 2. Average Arm Muscle Strength by Gender

Gender	Number of Athletes	Average Right Arm (kg)	Average Left Arm (kg)	Average Total (kg)
Male	10	44.3	38.6	41.45
Female	8	30.7	26.6	28.65

The data showed a significant difference between the arm muscle strength of male and female athletes. The average muscle strength of men's right arm is 44.3 kg, while in women it is only 30.7 kg. This difference is 13.6 kg or about 44% higher in male athletes. Physiologically, this is in line with the theory of muscle mass distribution, in which men have higher muscle mass and testosterone levels, contributing directly to the strength of muscle contraction. In addition, the weight training program that male athletes undergo usually has a higher intensity compared to women. These differences are important to be used as a basis for the preparation of different training programs between gender groups to be proportionate and effective.

Table 3. Distribution of Athlete Arm Muscle Strength Category

Category	Range (kg)	Frequency (Athlete)	Percentage (%)
Very Powerful	≥ 45	2	11.1%
Strong	38–44.9	7	38.9%
Keep	30–37.9	6	33.3%
Weak	< 30	3	16.7%
Total		18	100%

The distribution of muscle strength levels showed that most athletes (38.9%) were in the strong category, followed by 33.3% of athletes in the medium category, 11.1% very strong, and 16.7% weak. The two athletes who are in the very strong category are SNW and MRAM, both senior male athletes who have more than five years of training experience. The three athletes who are included in the weak category are all from the women's group, namely AYS, HMDW, and KRA. This data illustrates that while most teams already have a good foundation of muscle strength, there are still about 17% of athletes who need additional strength building programs to achieve optimal team balance.

Table 4. Analysis of Individual Based on Arm Muscle Strength

Strength Interval (kg)	Frequency	Percentage (%)	Category
20.0 – 27.9 (weak)	4	22.2%	Weak
28.0 – 35.9	6	33.3%	Keep
36.0 – 43.9	5	27.8%	Strong
44.0 – 48.0	3	16.7%	Very Powerful
Total	18	100%	

Table 4 shows that the majority of athletes have muscle strength in the range of 28–43.9 kg, which includes the medium and strong categories. Only 3 athletes broke through the figure above 44 kg, indicating that only about 16.7% of athletes had optimal muscle performance for high competition standards. Four athletes were under 28 kg, which indicates the need for

progressive overload training to improve their arm muscles. This distribution pattern describes the condition of the team that is heterogeneous in terms of strength, so the coach needs to make an individualized strength training program approach.

Table 5. Analysis Recommendation of Individual Based on Arm Muscle Strength

Yes	Athlete's Name	Strength (kg)	Category	Information
1	CWN	37.15	Keep	Potency increases with additional strength training.
2	MH	40.0	Strong	Stable and consistent in both arms.
3	MRAM	46.35	Very Powerful	Core athletes, dominant and balanced forces.
4	KRA	25.25	Weak	There is a need for increased weight training.
5	VPB	32.5	Keep	The balance is quite good, it can still be improved.
6	ANA	28.2	Weak	It is still below the optimal strength standard.
7	ADM	40.45	Strong	Stable, competition-ready.
8	BL	40.1	Strong	Be consistent and proportionate.
9	DK	39.85	Strong	Stable performance with slight left muscle imbalance.
10	WD	39.85	Strong	Good durability, even strength.
11	SNW	46.7	Very Powerful	Highest performance, ideal example.
12	HMDW	25.2	Weak	Basic reinforcement training is needed.
13	AO	22.8	Weak	Lowest grade, focus on improving basic strength.
14	YNA	27.55	Weak	It needs to improve the core technique and strength.
15	RJDN	31.95	Keep	Stable strength, still can be improved.
16	PDC	31.2	Keep	It is necessary to increase the strength of the left arm.
17	RSN	30.55	Keep	Muscle endurance training is required.
18	MSSP	30.5	Keep	The performance is adequate, still in the improvement stage.

Individual analysis showed that 11 of the 18 athletes (61.1%) were already in the moderate to strong category, while 7 athletes (38.9%) were still in the weak category. The dominance of power is still held by senior male athletes such as SNW and MRAM, who have a value of over 46 kg and are the team's main assets. Athletes with the weak category generally come from the female group and have a relatively young age, indicating that the aspect of muscle strength is still in the stage of physiological development and training adaptation. This supports the theory of muscle adaptation that increasing strength requires a consistent, gradual long-term training process.

The results of this study show that the arm muscle strength of rafting athletes in Semarang Regency varies quite significantly between individuals, and there are striking differences between male and female athletes. In general, male athletes show higher arm muscle strength values than female athletes, with an average difference of about 44%. This phenomenon is in line with the theory of sports physiology which states that men have greater muscle mass and higher levels of the hormone testosterone than women, so muscle contractions can produce greater muscle power. In addition to physiological factors, this difference is also influenced by the intensity and type of exercise that each athlete undergoes. Male athletes typically follow more intensive weight training and resistance training, while female athletes tend to have lighter training loads, so the adaptation of muscle strength is slower.

Further analysis of the data showed that the average muscle strength of the right arm was greater than that of the left arm, with a difference of about 11.8%. This indicates the presence of a right-handed dominance that is commonly found in most individuals, which affects the distribution of power when performing rowing movements. In rafting, the dominance of the right arm is not always a weakness, but too large a difference can lead to an imbalance in the rhythm of the rowing and the stability of the boat. Therefore, trainers are advised to implement a symmetrical strength training program that emphasizes strengthening the non-dominant arm muscles to achieve physical balance. This approach supports the bilateral theory of strength balance, where the balance between the dominant and non-dominant sides plays an important role in performance optimization and injury prevention.

The distribution of muscle strength categories shows that most athletes are in the medium to strong category, with only 11.1% of athletes reaching the very strong category. This condition indicates that even though the team has an adequate strength base, most athletes still

need increased explosive power to face the challenge of heavy river currents. This data is consistent with the findings of Hasyati and Winarno (2021) in their study on pencak silat athletes, which showed that arm muscle strength and power directly contributed to the effectiveness of punches. In rafting, the analogy is that arm muscle strength determines the efficiency of the paddle movement, the acceleration of the boat, as well as the ability to resist strong currents.

In addition, previous research such as by Aulria (2025) on freestyle swimmers also emphasized a positive correlation between arm muscle strength and movement speed. This is relevant to the results of current research, where athletes who have high muscle strength tend to be able to row at a faster and more stable pace, generating optimal thrust without wasting excessive energy. An important point that emerged from the two studies was that arm muscle strength is not only about the amount of kilograms lifted, but also about muscle coordination, movement rhythm, and biomechanical efficiency when performing sport-specific movements.

In a biomechanical perspective, the rowing movement in rafting involves the biceps, triceps, deltoids, as well as the muscles of the upper back (trapezius, latissimus dorsi). Athletes who have better neuromuscular coordination can utilize muscle strength efficiently, so that each pull results in maximum acceleration of the boat with minimal effort. Research data show that some athletes, especially those in the medium category, have a considerable gap between the right and left arms, which has the potential to decrease the efficiency of water pull. This phenomenon confirms the importance of symmetrical training and strengthening of non-dominant muscles to improve the stability and rhythm of rowing.

Furthermore, the results of individual analysis show that female athletes tend to be in the medium to weak category. This is related to physiological factors such as smaller muscle size, lower maximum capacity (maximal voluntary contraction), and training adaptation that is still developing. This does not mean that female athletes are not competitive. With intensive training that focuses on resistance training, plyometric paddling, and muscular endurance enhancement, female athletes can significantly improve their performance.

From the perspective of the competition, this data provides an overview of the readiness of the Semarang Regency team to face the 2026 Pre-PORPROV and PORPROV. Athletes with very strong categories, such as Sandy Bagus Woro and Muhammad Rafi Al-Mulary, are important assets because they are able to provide maximum thrust in the critical phase of the current. Strong and medium category athletes can serve as supports that stabilize the boat and maintain the rhythm of rowing. Meanwhile, athletes in the weak category need special training interventions to improve basic strength and muscle endurance, so that their contribution to the overall team is optimal.

In terms of methodology, the use of hand grip dynamometers provides objective data on arm muscle strength, which can be interpreted as an indicator of athletes' physical ability in general. In rafting, increased arm muscle strength not only affects rowing ability, but also contributes to energy efficiency, heart endurance, and aerobic capacity during competition. This is important because rafting is a sport that requires a combination of muscular strength, explosive power, and cardiorespiratory endurance.

A more detailed analysis of frequency and percentage data shows that the majority of athletes (about 72.2%) have average muscle strength in the range of 30–44.9 kg, which belongs to the medium and strong categories. Only a small percentage of athletes break through the number above 45 kg. This condition indicates a heterogeneity in the fitness level of the team, which is natural given the variation in age, training experience and physiological factors. This heterogeneity also emphasizes the need for an individualized training program, in which each athlete gets an intensity and focus of training tailored to his or her physical condition.

In addition, the average difference between the right and left arms of 4.4 kg (11.8%) indicates a muscle imbalance that is still within normal limits. In rafting, balance between the arms is important to maintain stroke symmetry, which is an even rhythm of pull on both sides of the boat. Excessive unevenness can cause the boat to tilt to one side, reduce rowing efficiency, and increase the risk of injury to the shoulder or wrist joint. Therefore, the exercise program should include proportionally non-dominant arm strengthening exercises, such as single-arm row, dumbbell press, and unilateral resistance exercises.

In addition to the physical aspect, the results of the research can also be related to sports psychology. Athletes who know the strength of their arm muscles objectively tend to have more targeted motivation and training strategies. They can evaluate weaknesses, such as the difference between the right and left arms, and focus on specific improvements. This is in line with the principle of self-efficacy in sports psychology, where the perception of self-ability is related to actual performance. With a data-driven approach (data-driven training), coaches can provide clear feedback, increase athletes' awareness of training needs, and adjust rowing techniques according to each individual's physical capacity.

The results of this study confirm that arm muscle strength is a determining factor in rafting performance, which affects rowing efficiency, boat acceleration, and team endurance. The data shows that most athletes already have an adequate level of strength, further improvement in

the medium and weak categories is necessary for the entire team to achieve optimal performance when facing the competition. The study also highlights the importance of a scientific approach and individualization of exercise, as well as regular measurement of muscle strength as a tool for evaluating athletes' performance.

Conclusion and Recommendations

This study aimed to analyze the level of arm muscle strength of rafting athletes in Semarang Regency in preparation for the 2026 Central Java PORPROV, identify differences between the right and left arms, and describe the distribution of strength levels among athletes. The results indicate that the average right arm strength (37.2 kg) was higher than the left arm strength (32.8 kg), with a mean difference of 4.4 kg (11.8%), showing the presence of dominant-side asymmetry. Based on strength classification, the majority of athletes were in the strong (38.9%) and moderate (33.3%) categories, while 11.1% were very strong and 16.7% were weak. Male athletes demonstrated higher average arm muscle strength than female athletes, reflecting physiological and training-related differences. Overall, the findings show that most rafting athletes in Semarang Regency possess adequate arm muscle strength to support paddling performance; however, disparities between individuals and between dominant and non-dominant arms indicate the need for targeted improvement.

Based on these findings, coaches are encouraged to implement progressive and individualized resistance training programs, especially for athletes categorized as weak and moderate, in order to enhance maximal and explosive arm muscle strength. Unilateral training exercises should be incorporated to reduce right–left strength imbalance and improve paddling symmetry, boat stability, and injury prevention. Training loads and intensities should also be adjusted according to gender-specific physiological characteristics to optimize performance outcomes. Regular monitoring and evaluation of arm muscle strength using objective measurement tools are recommended to track athlete development and ensure training effectiveness leading up to the competition. Future research is suggested to involve a larger sample size and include additional physical components such as muscular endurance, explosive power, and aerobic capacity to provide a more comprehensive understanding of rafting athlete performance development.

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