Comparative physical fitness profiles of female long-distance and sprint swimmers at Petrokima Gresik Club: A descriptive study

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ABSTRACT

Background: Physical condition is a fundamental factor that affects swimmers' performance in developing techniques, tactics, and competition strategies, especially for swimmers specializing in different distances, such as sprinters and long-distance swimmers.

Objectives: This study aims to analyze the dominant physical profiles of female sprinters and long-distance swimmers, providing evaluation material for coaches to develop more targeted training programs.

Methods: The study employed a quantitative descriptive design, utilizing a survey and test approach. The research subjects consisted of 20 female swimmers from the Petrokimia Gresik Club who were selected purposively, including 10 sprinters and 10 long-distance swimmers. Data collection was conducted in 2024 through push-up tests (measuring arm muscle strength), sit-ups (assessing abdominal muscle strength), vertical jump (evaluating leg muscle explosive power), and multistage fitness tests (testing aerobic endurance). Raw scores were converted into t-scores and then categorized using the Norm Reference Scale (NRS). Data analysis was performed descriptively using means, standard deviations, and percentages. This study has obtained ethical approval from the relevant ethics committee.

Results: The analysis results show that in the sprinter group, 4 out of 10 athletes (40%) were in the "fair" physical condition category, while in the long-distance group, 5 out of 10 athletes (50%) were also in this category. In general, the components of arm muscle strength, abdominal muscle strength, leg muscle power, and aerobic endurance in both groups showed a relatively balanced distribution with a predominance of the adequate category.

Conclusions: The physical condition of female sprinters and long-distance swimmers from the Petrokimia Gresik Club was at a relatively balanced level, with a predominance of the adequate category. These findings serve as a basis for evaluating and adjusting training programs according to the characteristics of specific swimming specializations.

Keywords: long-distance, physical condition, sprinter, swimming, training evaluation.

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INTRODUCTION

Swimming is a sport that requires complex integration between the neuromuscular, cardiovascular, and biomechanical systems, making the athlete's physical condition the main determinant in achieving optimal performance (Amicta & Maidarman, 2019). International literature indicates that swimming performance is greatly influenced by aerobic capacity, muscle strength and power, as well as core stability, which plays a role in movement efficiency and reducing water resistance (Barbosa et al., 2019; Aspenes & Karlsen, 2012). Therefore, evaluating the physical condition of swimming athletes is not only important for improving performance but also serves as the scientific basis for planning, monitoring, and evaluating evidence-based training programs.

Physiologically, the physical demands of sprinters and long-distance swimmers differ significantly. Sprinters rely more on the anaerobic energy system, arm muscle strength, and leg muscle power, which play an important role in the start, turn, and initial acceleration phases (Morouço et al., 2015; West et al., 2011). Conversely, long-distance swimmers require high aerobic capacity, movement efficiency, and the ability to maintain power output over extended durations, typically represented by indicators such as VO_2max and lactate threshold (Pyne & Sharp, 2014; Massini et al., 2023). These differing characteristics underscore the need for training approaches and physical condition evaluations to be tailored to the specific swimming discipline.

Various international studies have used dry-land fitness tests as supporting indicators of swimming performance. Arm muscle strength measured through push-ups correlates with the effectiveness of the pull phase, while core strength plays a role in body stability and body rolling efficiency during swimming (Garrido et al., 2012; Crowley et al., 2017). Leg muscle power measured through vertical jumps has been reported to be related to start and turn performance, especially in sprint events (Loturco et al., 2016). Meanwhile, multistage fitness tests or VO_2max estimates are widely used as indicators of aerobic endurance, particularly in the context of training adolescent athletes and clubs (Bishop et al., 2019).

Although international evidence regarding the differences in the physical profiles of sprinters and long-distance swimmers is quite strong, most studies have been conducted on elite athletes, in laboratory settings, or at national training centers. There is still limited research documenting the physical condition profiles of female swimmers at the club level, particularly in Indonesia, using an evaluative approach that can be directly utilized by coaches as a basis for developing training programs. In addition, normative data based on simple physical condition tests that are easy to apply in clubs are still rarely reported in international or national literature.

Based on these gaps, this study aims to analyze and compare the physical profiles of female sprinters and long-distance swimmers from the Petrokimia Gresik Club using arm muscle strength, abdominal muscle strength, leg muscle power, and aerobic endurance tests. The results of this study are expected to provide practical evaluation material for coaches in designing more specific training programs according to swimming event characteristics, while also enriching empirical data on the physical condition of female swimmers in the context of club development.

METHODS

Study Design and Participants

This study used a quantitative descriptive design with a survey and test approach to describe the physical profile of female swimmers in the sprinter and long-distance categories. The descriptive approach was chosen because the purpose of the study was to map and evaluate the physical condition of athletes as a basis for developing training programs, not to test hypotheses or draw causal inferences between groups.

Inclusion criteria:

1. Female swimmers who are actively registered with the Petrokimia Gresik Club.
2. Specialize in sprinting or long-distance swimming.
3. Aged between adolescence and young adulthood (12–18 years old).
4. Have at least 1 year of experience participating in swimming training and/or competitions.
5. Participate in the club's regular training program during the research period.

Exclusion criteria:

1. Athletes who are experiencing acute or chronic injuries that limit physical activity.
2. Athletes who are unable to complete the entire series of physical condition tests.
3. Athletes who do not give their consent to participate.

The number of participants involved is 20 female athletes, consisting of 10 sprinters and 10 long-distance swimmers.

Ethical approval statement

This research has been approved by the Ethics Committee of the Universitas Negeri Malang with Number 07.11.04/UN32.14.2.8/LT/2025.

Research Instruments

Data collection was conducted at the Petrokimia Gresik Club training facility in 2024. All tests were conducted during regular training sessions and supervised by researchers and coaches to ensure safety and consistency of procedures. Athletes performed a standard warm-up for approximately 10 minutes prior to testing.

Arm muscle strength was measured using a 30-second push-up test. Push-ups were performed in a prone position, with hands flat on the floor, body straight, and feet resting on the tips of the toes (full push-up). One repetition was considered valid if the elbows bent to ±90° and returned to full extension. The number of repetitions successfully completed in 30 seconds is recorded as the test score (Malik & Marsudi, 2021).

Abdominal muscle strength is measured using a 30-second sit-up test. Athletes start from a supine position, knees bent at ±90°, soles of the feet flat on the floor, and both hands behind the head. One repetition is considered valid if the upper body is lifted until the elbows touch the thighs and then returns to the starting position. The number of repetitions in 30 seconds is recorded as the test score (Suciati & Subagio, 2022).

Leg muscle explosive power is measured using a vertical jump test with the countermovement jump method. Athletes stand upright, perform a maximum push with both feet, and the vertical jump result is measured in centimeters. The test is performed twice, and the highest value is used as the final score. This test is widely used to evaluate explosive ability relevant to the start and turn phases in swimming (Loturco et al., 2016).

Aerobic endurance is measured using the Multistage Fitness Test (Beep Test). Athletes run back and forth 20 meters following audio signals at gradually increasing speeds until exhaustion. The final score, consisting of the level and last shuttle, is converted into an estimate of VO_2max using the standard Léger formula:

$$VO_2max = 3.46 \times \text{maximum speed (km/h)} + 12.2 \quad (1)$$

The raw scores from each test are first converted into t-scores using the formula:

$$t = 50 + 10\,\frac{(X-M)}{SD} \quad (2)$$

where X is the individual score, M is the mean value, and SD is the standard deviation of the research sample group. Next, the t-score values were categorized using the Normative Reference Standard (NRS) with five categories, namely excellent, good, fair, poor, and very poor, based on the M and SD value limits (Alfath, 2019). The NRS used in this study was internal normative, based on the distribution of the research sample data, rather than external norms.

Data Analysis

Data analysis was performed descriptively, including calculations of mean values, standard deviations, frequencies, and percentages for each component of physical condition. This study did not perform inferential tests between groups due to the relatively small sample size and the research objective, which focused on mapping physical condition profiles rather than testing statistical differences. Therefore, the results of the study were interpreted descriptively without claims of inferential significance.

RESULTS

The research data was obtained from the results of physical condition tests conducted on 20 female swimmers from the Petrokimia Gresik Club, consisting of 10 sprinters and 10 long-distance swimmers. All athletes underwent four types of physical fitness tests, namely arm muscle strength (push-ups), abdominal muscle strength (sit-ups), leg muscle power (vertical jump), and aerobic endurance (beep test). All percentages reported in this section use a denominator of n = 10 athletes per group, unless otherwise stated. Table 1 and Table 2 present descriptive statistics (mean, maximum value, minimum value, and standard deviation) of the physical condition test results for sprinters and long-distance swimmers.

Table 1. Physical Fitness Test Results for Sprinters from the Petrokimia Gresik Club

No	Physical Components	Mean	Max	Min	SD
1	Arm Muscle Strength	34,9	38	32	2,23358
2	Abdominal Muscle Strength	24,9	36	19	6,1183
3	Leg Muscle Power	37,1	51	27	8,10281
4	Endurance	32,6	33,9	31	0,977525

In general, the standard deviation values for abdominal muscle strength and leg muscle explosive power components show greater variation than other components, both in the sprinter and long-distance groups. This indicates that there are quite wide individual differences in these two components, while aerobic endurance tends to be more homogeneous, especially in the long-distance group.

Table 2. Physical Fitness Test Results for Athletes of the Petrokimia Gresik Long Distance Club

No	Physical Components	Mean	Max	Min	SD
1	Arm Muscle Strength	34,4	38	32	1,776388
2	Abdominal Muscle Strength	24,9	36	19	5,566766
3	Leg Muscle Power	38,2	52	27	7,743097
4	Endurance	46,7	47,1	46,5	0,2366432

Table 3. Distribution of Athletes' Physical Condition Categories (%)

Test Components	Group	A (%)	B (%)	C (%)	D (%)	E (%)
Push-ups (Arm Muscle Strength)	Sprinter	0	30	30	40	0
	Longdistance	10	10	40	40	0
Sit-ups (Abdominal Muscle Strength)	Sprinter	10	10	50	30	0
	Longdistance	10	20	30	40	0
Vertical Jump (Leg Muscle Power)	Sprinter	20	0	40	40	0
	Longdistance	20	0	60	20	0
Beep Test (Aerobic Endurance)	Sprinter	0	30	40	20	10
	Longdistance	20	0	40	40	0

Categories were derived from t-score transformation and PAN classification as described in the Methods section
Description:
A = Excellent, B = Good, C = Fair, D = Poor, E = Very Poor
Sprinter (n = 10), Longdistance (n = 10)

Based on Table 3, the physical condition profiles of sprinters and long-distance swimmers are mostly concentrated in the moderate (C) and poor (D) categories for most test components. For arm muscle strength and leg muscle power, the proportion of athletes below the good category is higher in both groups, indicating that upper and lower body strength capacity is still moderate and developing unevenly. Abdominal muscle strength shows a slightly better distribution, especially in sprinters, where half of the athletes are classified as adequate. In contrast, aerobic endurance shows a clearer pattern of specialization: long-distance swimmers have a higher proportion of athletes in the very good category, while sprint swimmers show a more scattered distribution, including athletes classified as poor and very poor. Overall, these findings suggest that although general physical fitness levels are mostly moderate in both groups, specific components appear to align with the physiological demands of each swimming specialization.

DISCUSSION

In general, the results of this study indicate that the physical condition profile of female swimmers at the Petrokimia Gresik Club, both sprinters and long-distance swimmers, is dominated by the fair to poor categories in most test components, with the most notable difference seen in the aerobic endurance component. These findings indicate that even though the athletes have followed a regular training program, there is still significant room for development of physical condition that is more specific to the characteristics of swimming events (Bompa & Buzzichelli, 2021).

The results show that the majority of long-distance swimmers and sprinters are in the adequate and inadequate categories in terms of arm muscle strength. These findings are relevant to international literature which confirms that upper body strength is an important determinant in the pull phase and swimming propulsion efficiency (Morouço et al., 2015; Crowley et al., 2017). For long-distance swimmers, adequate arm strength is necessary to maintain thrust over long durations, while for sprinters, this strength plays a major role in acceleration and short-distance swimming speed. The dominance of the lower-middle category in both groups indicates that arm strength training adaptation is likely not yet optimal, in terms of volume, intensity, and dry-land training specificity.

The distribution of abdominal muscle strength categories shows that most athletes fall into the adequate category, both in the sprinter and long-distance groups. Biomechanically, core muscle strength plays a role in body stability, body rolling efficiency, and force transmission from the lower to upper extremities during swimming (Garrido et al., 2012). These findings are consistent with previous research showing that core muscle weakness can increase body drag in water and reduce swimming technique efficiency (Crowley et al., 2017). Thus, even though athletes' abdominal muscle performance is at a moderate level, improving core capacity is still necessary to support technique quality and movement efficiency.

In terms of leg muscle explosive power, both sprinters and long-distance runners showed a moderate dominance, with the proportion of athletes in the good category still limited. This finding is important considering that leg muscle explosive power plays a significant role in the start and turn phases, which significantly affect race performance, especially in sprint events (Loturco et al., 2016; West et al., 2011). The suboptimal distribution of categories among sprinters indicates that explosive training stimuli may not have been provided consistently or in a structured manner. Meanwhile, for long-distance swimmers, although the explosive demands are relatively lower, this ability remains relevant for efficient starts and direction changes.

The most obvious difference between the two groups was seen in aerobic endurance, where long-distance swimmers showed a better and more homogeneous distribution of categories compared to sprinters. This finding is consistent with international evidence showing that long-distance swimmers have higher aerobic capacity (VO_2max) as a result of adaptation to moderate to high-intensity training loads over long durations (Pyne & Sharp, 2014; Massini et al., 2023). Conversely, the more varied category distribution among sprinters reflects training characteristics that are more anaerobically oriented, so that the development of aerobic endurance is often less of a priority.

The lack of significant differences in several physical components between sprinters and long-distance runners may be influenced by several factors that were not measured in this study. These factors include body composition, biological age, maturation status, training experience, and the phase of training periodization at the time of data collection. Additionally, swimming technique and biomechanical efficiency may also moderate the relationship between physical condition and performance, as reported in a previous study (Barbosa et al., 2019).

Based on the findings of the study, coaches are advised to implement more specific and structured training programs. For sprinters, neuromuscular explosive training (e.g., plyometric and resistance training) is recommended twice a week to improve start and acceleration performance. Meanwhile, long-distance swimmers need to focus on progressive upper body strengthening to maintain propulsion efficiency over long distances. Core muscle strengthening should be performed periodically for both groups. Monitoring physical condition is recommended every 8–12 weeks as part of the training program evaluation.

Limitations of the study

This study has several limitations that need to be considered in interpreting the results. First, the relatively small sample size and the use of purposive sampling limit the generalization of the findings to a wider population of swimmers. Second, this study was conducted at only one club, so the results are highly contextual. Third, the reliability and validity of the test instruments were not re-tested in the context of this study sample. Fourth, the cross-sectional design does not allow for the assessment of long-term exercise adaptation or causal relationships between variables.

Further research should use larger samples and multiple clubs to improve generalizability. Longitudinal or prospective cohort designs are needed to observe the adaptation of physical condition to training. In addition, the integration of body composition measurements, lactate parameters, and swimming technique analysis will provide a more comprehensive understanding of the determinants of swimmer performance.

CONCLUSIONS

In this limited sample (n = 20), both sprinters and long-distance swimmers showed relatively similar physical condition profiles, dominated by the adequate category in most test components. Given the limitations of the descriptive design, small sample size, and data collection at a single club, these findings need to be confirmed through research with a larger sample and additional measurements, such as body composition and technical aspects of swimming. Practically, coaches are advised to develop individual training programs that emphasize upper body strengthening and structured improvement of leg muscle power based on the results of the athletes' physical condition evaluation.

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DATA AVAILABILITY

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available because they contain information that could compromise the privacy of research participants

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CONFLICT OF INTEREST

The author officially certifies that there are no conflicts of interest with any party with respect to this research.

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