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The Awareness of Young Athletes about Cardiopulmonary Fitness and Its Correlation to Functional Capacity: A Survey-Based Study

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ABSTRACT

Background: Cardiopulmonary (CP) fitness is critical for optimal athletic performance and overall health. Understanding athletes' awareness of its importance can dictate and guide training and health strategies.

Objective: This study aimed to evaluate the awareness of young athletes about cardiopulmonary fitness and examine its correlation with functional capacity. **Subjects and methods:** A cross-sectional survey study involving 400 young athletes (aged 17-25) from Cairo and Giza. was conducted using structured questionnaires to assess awareness and submaximal one-mile jog field test for functional capacity and maximum oxygen uptake (VO_2 max) estimations.

Results: The mean VO_2max was 54.84 ± 4.37 ml/kg/min. Awareness levels were categorized as good (15.5%, 62 athletes), moderate (25.5%, 102 athletes), and poor (59%, 236 athletes). Female athletes had better awareness than males, with 26.2% of females showing good awareness compared to 12.7% of males ($\chi^2 = 10.19$, $p = 0.006$). A positive correlation was observed between VO_2 max and awareness levels ($r = 0.726$, $p = 0.001$). Athletes with good awareness had a VO_2 max of 58.47 ± 3.37 ml/kg/min, those with moderate awareness had 56.27 ± 2.51 ml/kg/min, and those with poor awareness had 53.22 ± 4.42 ml/kg/min. Significant differences in VO_2max were found between good and moderate awareness (+2.2 ml/kg/min, $p = 0.001$), good and poor awareness (+5.25 ml/kg/min, $p = 0.001$), and moderate and poor awareness (+3.05 ml/kg/min, $p = 0.001$). The results highlighted the role of awareness in enhancing functional capacity**.**

Conclusions: Increased awareness of CP fitness is associated with improved functional capacity. Targeted educational programs are recommended to enhance athletic performance and health outcomes.

Keywords: CP fitness, functional capacity, awareness, young athletes, VO_2 max.

INTRODUCTION

CP fitness, essential for athletic performance and health, reflects the efficiency of the cardiovascular and respiratory systems in sustaining physical activity. It is particularly vital for young athletes in combat and endurance sports, as it optimizes performance, prevents injuries, and enhances physical and psychological resilience. By improving aerobic capacity, lactate threshold, muscular endurance, energy utilization, and delaying fatigue during high-intensity exercise, cardiopulmonary fitness significantly contributes to competitive success and overall athletic ability. Despite its importance, awareness among young athletes about its role and impact on functional capacity remains limited **(1).**

Highly trained athletes with superior exercise economies demonstrate faster VO_2 recovery rates due to their efficient oxygen usage and optimized cardiovascular performance. This enhanced recovery underscores the role of cardiovascular efficiency in athletic performance. Additionally, athletes with higher cardiovascular and aerobic fitness levels experience significantly fewer injuries, particularly in high-intensity sports like boxing and wrestling. Improved cardiopulmonary fitness reduces the risk of musculoskeletal injuries by 30% and mitigates overuse injuries, which affect approximately 40% of combat sport athletes **(2).**

Assessing CP fitness requires systematic testing methods designed to evaluate the efficiency and integration of these systems under physical stress. Modern CP testing incorporates laboratory and field-based assessments, such as VO_2 max tests, submaximal exercise protocols, and standardized endurance evaluations. These tests provide valuable insights into an athlete's aerobic capacity, endurance, and overall health, enabling coaches and medical teams to design tailored training programs and monitor progress effectively. However, despite its accuracy it's costly, time-intensive, and requires specialized equipment, making it unsuitable for large-scale fitness tracking in field settings **(3).**

In addition to systematic monitoring, the 1-mile jog test serves as a valuable field assessment for evaluating cardiovascular and pulmonary fitness in competitive athletes. This test indicates an athlete's overall aerobic capacity and endurance, with the time taken to complete the mile reflecting the efficiency of the cardiovascular and respiratory systems in delivering oxygen to working muscles, thus offering practical insights into aerobic fitness levels. One of the main advantages of the 1-mile jog test is its feasibility and cost-effectiveness, as it can be conducted with minimal

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equipment and training, making it accessible across various settings. However, it is important to acknowledge that the test lacks the objectivity and precision of laboratory-based assessments, which can provide more accurate measurements of cardiorespiratory function (e.g., VO_2 max and lactate thresholds). Consequently, while the 1-mile jog test is both easy to administer and inexpensive, its relative lack of accuracy compared to lab tests underscores the need for more detailed evaluations or additional monitoring in situations that demand highly precise physiological data [(4)].

There is a clear relationship between knowledgeable athletes and their sports performance. Advances in sports medicine, exercise physiology, and scientific research enable well-informed athletes to monitor physiological markers, optimize training regimens, and minimize injury risk. By understanding their bodies from a medical perspective—encompassing cardiopulmonary function, musculoskeletal integrity, and metabolic processes—they can strategically apply scientific insights to enhance both performance and recovery [(5)].

A questionnaire is a structured research tool designed to gather data on human opinions, preferences, and behaviors, serving both qualitative and quantitative analysis purposes [(6)]. It consists of a series of carefully crafted questions to ensure relevance, clarity, and logical flow, which is crucial for obtaining valid and reliable data. To effectively assess the level of awareness and understanding of cardiopulmonary fitness among young athletes, it is essential to utilize reliable and structured research tools. One such tool is the questionnaire, which can capture comprehensive data on athletes' opinions, preferences, and behaviors related to their fitness and training practices [(7)]. However, despite the widespread use of structured questionnaires in various research fields, there is currently no specific instrument tailored for evaluating cardiopulmonary fitness awareness among young athletes. Therefore, this study aimed to evaluate young athletes' awareness of cardiopulmonary fitness and examine its correlation with functional capacity. Insights from this research can guide educational interventions to improve athletic performance and health.

MATERIALS AND METHODS

Study Design: It is a cross-sectional analytical study aimed to gauge the knowledge of young athletes about the value of cardiovascular fitness and its effect, and to statistically analyze and correlate the directional relationship between participants' knowledge of cardiopulmonary fitness and the estimated functional capacity.

Participants: A sample of 400 athletes aged 17-25 years was recruited from sports clubs, youth centers, and physical education faculties in Cairo and Giza.

Inclusion Criteria: Young athletes with an age range between 17 and 25 years were included in this study, encompassing both female and male athletes. The athletes participated in individual combat sports, specifically taekwondo, judo, karate, wrestling, and boxing. Additionally, participants were required to engage in regular training, with a minimum frequency of three times per week, and be affiliated with a recognized sports association.

Exclusion Criteria: Participants who had difficulties in communication skills, had musculoskeletal injuries such as fractures and sprains that could interfere with test performance, experienced acute conditions affecting performance, including, acute myocarditis on stable cardiovascular conditions, concussion as a result of injury, fever, anaphylaxis, or cellulitis; and who had comorbidities such as anemia.

Data collection tools:

I. **Questionnaire construction:** The Arabic self-structured questionnaire was designed to assess awareness levels regarding cardiopulmonary fitness among young athletes. It consisted of 12 questions divided into three sections: Knowledge of Physical Therapy and Rehabilitation (3 questions) assessed the athletes' understanding of rehabilitation techniques relevant to cardiopulmonary health, knowledge about cardiopulmonary functions and tests (6 questions) focused on their comprehension of terms such as VO_2 max, heart rate zones, aerobic fitness tests; and Holistic performance and balanced training approaches (3 questions) explored the relationship between knowledge of cardiopulmonary fitness and sports performance.

Scoring system: Each response was scored as "1" (knowledgeable) and "0" (unknowledgeable), resulting in total scores ranging from 0 to 12. Participants' overall knowledge scores were categorized using a modified Bloom's criteria cutoff point: Good (scores above 80%, > 9), Moderate (scores between 60% and 79%, 8-9), and Poor (scores below 60%, < 7) [(8)].

Validation process: The questionnaire underwent a rigorous validation process. Initially, content validation was performed by a panel of experts in sports medicine and cardiopulmonary fitness, leading to iterative revisions based on their feedback. Then, the questionnaire was reviewed by a language expert from the Center for Arabic Language and Culture at the Faculty of Arts, Cairo University. This review ensured that the language was accurate, clear, and suitable for athletes of different levels. Subsequently, pilot testing was conducted with 20 athletes to ensure clarity and reliability, with adjustments made based on participant responses.

II.Functional capacity estimation: Functional capacity was evaluated using the 1-mile jog test. The results from this test were utilized to estimate VO_2 max values, a key indicator of cardiopulmonary fitness [9].

Procedure: Participants were informed about the study objectives through a comprehensive briefing that included details on the study's goals, the importance of cardiopulmonary fitness, and the methods employed to ensure confidentiality. Written consents were obtained from all participants prior to their involvement.

Initial data collection: Each participant completed the structured questionnaire designed to evaluate awareness levels regarding cardiopulmonary fitness. Additionally, demographic information, including age, gender, and competitive level, was collected. The survey comprised 12 questions aimed at gathering insights into participants' knowledge, attitudes, and practices related to cardiopulmonary fitness.

1-Mile jog test setup: The test was conducted on a standard 400 m track. Safety protocols were strictly observed to ensure that participants were in appropriate physical condition to complete the tests. they should jog a warm-up lap of 402 meters at an easy pace [9].

Test execution: Participants were instructed to jog a distance of 1 mile (1609 meters) at a steady, submaximal pace. The elapsed time to complete the jog was recorded using a stopwatch, and their steady-state heart rate was measured immediately after the test with a pulse oximeter. Borg's 15-point scale was utilized to record each participant's rating of perceived exertion [10].

Post-Test measurements: The recorded data—heart rate (in bpm), elapsed jog time (in minutes), and RPE—were input into the following equation to estimate VO_2 max:
VO_2max (mL/kg/min)=92.91+(6.50×gender)−(0.141×body mass)−(1.562×jog time)−(0.125×heart rate) where gender was represented as 0 for females and 1 for males, body mass was measured in kilograms, jog time was recorded in minutes, and heart rate was measured in beats per minute (bpm) [9].

Safety Considerations: Participants exhibiting extreme fatigue or exceeding safe heart rate levels (>180 bpm) during the jog were instructed to stop and were subsequently excluded from the final analysis. This measure was implemented to safeguard the health of the participants and maintain the integrity of the study. By standardizing the procedure and ensuring rigorous oversight, the study maintained high reliability and validity in measuring the correlation between cardiopulmonary fitness awareness and functional capacity.

Ethical approval:
The study was approved by the Ethics Board of Cairo University and an informed written consent was taken from each participant or their parents in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis
Descriptive statistics were utilized to present the subjects' demographics and collected data. A Chi-squared test was conducted to compare young athletes' awareness about cardiopulmonary fitness between males and females. The Pearson correlation coefficient was employed to investigate the correlation between VO_2 max and awareness of young athletes regarding cardiopulmonary fitness. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 25 for Windows. $P \leq 0.05$ was deemed significant.

RESULTS
Subject characteristics: Four hundred young athletes playing combat solo sports participated in this study. The mean age, weight, height and BMI of study group were 20.41 ± 2.69 years, 74.35 ± 8.84 kg, 171.93 ± 4.21 cm and 25.16 ± 2.92 kg/m² respectively (Table 1).

Table (1): Participant characteristics

	Mean ± SD	Minimum	Maximum
Age (years)	20.41 ± 2.69	17	25
Weight (kg)	74.35 ± 8.84	52	107
Height (cm)	171.93 ± 4.21	160	180
BMI (kg/m²)	25.16 ± 2.92	16.41	33.77
Gender distribution	N	%	
Females	84	21	
Males	316	79	

SD Standard deviation, BMI body mass index.

Awareness of young athletes about cardiopulmonary fitness: 304 (76%) of subjects were knowledgeable about physical therapy and rehabilitation. Only 203 (50.75%) of subjects were knowledgeable about cardiopulmonary functions and tests. 268.67 (67.17%) of subjects were knowledgeable about holistic performance and balanced training approaches. The large percentage of young athletes 236 (59%) had poor awareness of cardiopulmonary fitness. Only 62 (15.5%) of young athletes had good awareness of cardiopulmonary fitness and about 102 (25.5%) had moderate awareness (Table 2).

Table (2): Overall awareness of young athletes about cardiopulmonary fitness

Overall knowledge	N (%)
Good: Scores 80% and above	**62 (15.5%)**
Moderate: Scores between 60% and 79%	**102 (25.5%)**
Poor: Scores below 60%	**236 (59%)**

Comparison of awareness of young athletes about cardiopulmonary fitness between males and females: There was a significant increase in good level of awareness about cardiopulmonary fitness among female athletes compared to that among male athletes (p = 0.001). The awareness distribution of young athletes about cardiopulmonary fitness distribution among females showed that 22 (26.2%) females had good awareness, 22 (26.2%) had moderate awareness and 40 (47.6%) females had poor awareness. While, males showed that 40 (12.7%) had good awareness, 90 (25.3%) had moderate awareness and 196 (62%) males had poor awareness (Table 3).

Table (3): The frequency distribution and Chi squared test for comparison of awareness of young athletes about cardiopulmonary fitness between males and females

	Females	Males	χ^2 value	p-value
Good	**22 (26.2%)**	**40 (12.7%)**		
Moderate	**22 (26.2%)**	**90 (25.3%)**	**10.19**	**0.006**
Poor	**40 (47.6%)**	**196 (62%)**		

χ^2, Chi squared value; P-value, Probability value.

Correlation between VO_2 max and awareness of young athletes about cardiopulmonary fitness: Ther was moderate positive significant correlation between VO_2 max and awareness of young athletes for cardiopulmonary fitness (r = 0.551, p = 0.001) (Table 4) (Figure 1).

Table 4. Correlation between VO2 max and awareness of young athletes about cardiopulmonary fitness

	Awareness of young athletes about cardiopulmonary fitness		
	r value	p value	Sig.
VO2 Max (ml./kg/min)	0.551	0.001	**S**

r value: Pearson correlation coefficient; p value: Probability value, S, Significant.

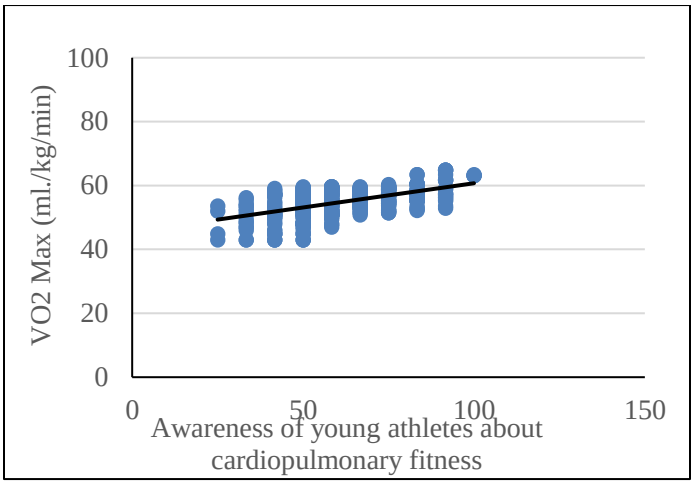

Figure (1): Correlation between VO_2 max and awareness of young athletes about cardiopulmonary fitness.

DISCUSSION

Cardiopulmonary fitness, a key determinant of athletic performance, reflects the efficiency of the cardiovascular and respiratory systems in meeting oxygen demands during exercise. It is commonly assessed through VO_2 max, where higher values indicate superior aerobic fitness [(3)].

The present study stated that after exploring the link between cardiopulmonary fitness awareness and aerobic capacity in 400 young combat athletes, it was found that there were significant variations in knowledge, alongside measurable differences in VO_2 max performance. Specifically, over half of the participants (59%) exhibited poor awareness, while only 15.5% demonstrated good understanding. Moreover, a moderate positive correlation (r = 0.551, p = 0.001) emerged between awareness levels and VO_2 max scores, suggesting that athletes with a stronger grasp of cardiopulmonary principles tended to exhibit higher aerobic capacity. Gender-based comparisons further revealed that females reported a higher percentage of "good" awareness (26.2%) compared to males (12.7%). These findings underscore the importance of incorporating educational strategies into training programs, as enhancing athletes' understanding of cardiopulmonary fitness may lead to improvements in both knowledge and performance outcomes.

Novelty and Research Gap: This study introduced a novel approach to evaluate cardiopulmonary fitness in young combat athletes by integrating both cognitive and physiological dimensions, a perspective often overlooked in traditional sports research. The dual emphasis on assessing both functional capacity and awareness of cardiopulmonary fitness addresses a significant deficiency in existing literature. While, physiological metrics such as VO_2 max have been extensively examined as indicators of performance, the cognitive understanding of these metrics among athletes received comparatively

little attention. By examining both dimensions simultaneously, this study highlighted the importance of knowledge integration within athletic training, potentially enhancing the alignment between awareness and performance outcomes [1]. Previous studies have heavily focused on physical training interventions aimed at improving measurable outcomes such as VO_2 max, lactate thresholds, and recovery rates. For instance, **Smith *et al.*** [3] demonstrated that higher VO_2 max levels correlate with enhanced endurance in athletes. However, this study did not evaluate whether athletes were aware of their VO_2 max levels or how this knowledge could be applied to optimize their training. This oversight is crucial, as greater awareness might not only enhance training adherence but also foster a deeper understanding of recovery and performance optimization. The current study filled this void by introducing a structured awareness assessment that links cognitive understanding to measurable physical outcomes [3, 4].

Another area of novelty is the focus on a specialized demographic—young combat athletes—who face unique physiological and cognitive demands compared to athletes in other sports. Combat sports require a distinct blend of aerobic and anaerobic fitness to support repeated bouts of high-intensity activity interspersed with recovery periods. While, research on endurance athletes often prioritizes sustained aerobic performance, this study tailored its approach to the intermittent nature of combat sports. This specificity enhances the applicability of the findings and establishes a foundation for sport-specific educational interventions. Statistical analyses highlighted differences across age groups, gender, years of training, and competition levels, reflecting the multifaceted nature of cardiopulmonary fitness. Notably, VO_2 max scores were positively associated with awareness in athletes who had longer training histories or competed at higher levels, underscoring the value of integrating educational components into athletic development programs.

Studies in relation: A study that was conducted in the Jazan region of Saudi Arabia assessed awareness and knowledge of physical activity guidelines among 1018 adults through a self-administered online survey. The findings revealed that while 48% of participants reported being aware of the guidelines, only 38% correctly identified recommendations for moderate-intensity physical activity, and just 23% understood the muscle strength guidelines. Those aware of the guidelines exhibited higher physical activity levels, measured in MET minutes per week, underlining the positive role of awareness in adherence to fitness guidelines**.** Both studies highlighted that individuals who are more informed tend to demonstrate better engagement in fitness-related behaviors (higher MET levels vs. higher VO_2 max). The difference in populations (general vs. specialized athletes) may explain variations in overall awareness levels but reinforces the central idea that awareness can enhance adherence and performance [11].

Similarly, a previous study explored the relationship between body awareness, physical activity levels, and strength in young athletes, which was conducted on 76 male participants with an average age of 17.30 years, the study utilized the body awareness questionnaire (BAQ) to measure awareness, the international physical activity questionnaire-short form (IPAQ-SF) for physical activity levels, and strength tests such as the hand grip strength test (HGST). The results revealed a significant positive correlation between body awareness and physical activity levels ($p < 0.05$), the r value as well as specific strength measures like dominant hand grip strength ($p < 0.05$). These findings align with the current study by demonstrating how awareness-related attributes, such as body awareness and cardiopulmonary fitness awareness, play a crucial role in improving physical performance metrics. This highlighted the importance of integrating cognitive dimensions, like awareness, into athletic training to enhance functional outcomes. Like the current study, which links cardiopulmonary fitness awareness to VO_2 max, this study underscored how awareness in this case, body awareness can positively influence physical metrics (activity levels, strength) [12].

In agreement with the current study a previous comprehensive review study of cardiopulmonary exercise test (CPET) parameters in athletic populations. The results showed that athletes with greater awareness of their fitness metrics were assessed through their ability to interpret CPET data and apply it in training programs, as reported in studies included in the review. Awareness was inferred from athletes' and coaches' use of key CPET parameters, such as ventilatory thresholds and VO_2 max, to tailor training intensities and monitor progress. For example, athletes who consistently trained at intensities aligned with their ventilatory thresholds demonstrated improved endurance and performance outcomes, indicating a functional understanding of these metrics. These findings were derived from intervention studies and observational analyses where CPET data was integrated into training regimens, with measurable outcomes like a 15-20% increase in endurance capacity and reduced recovery times. Despite, different methodologies (full CPET vs. field tests) both highlighted that informed athletes leverage knowledge of physiological indicators to optimize training [2].

In contrast, in a longitudinal study of 100 elite-level combat athletes examined the relationship between awareness of fitness metrics and performance. The study found no significant correlation ($r = 0.10$, $p = 0.45$) between cognitive understanding of VO_2 max and measurable improvements in functional capacity over 12 months. Instead, it emphasized structured training programs and physiological assessments as primary drivers of performance, suggesting that awareness alone

may not significantly impact outcomes in competitive settings. These findings contrast with this study's results, which highlighted the interplay between awareness and performance. This study focused on elite combat athletes over a longer period, while the current study included younger participants (17–25 years) with varied competitive levels in a cross-sectional design. A moderate positive correlation (r = 0.551) emerged here, unlike in the elite group, possibly because highly structured training at elite levels minimizes the effect of awareness on performance [(13)].

In contrary to the results of the current study, a study reviewed the role of structured training programs in enhancing athletic performance among 150 collegiate athletes. They reported no significant correlation (r = 0.15, p = 0.52) between knowledge of VO_2 max and performance improvements over six months. The authors emphasized the importance of evidence-based physical training over cognitive awareness of fitness metrics. These findings diverge from this study's emphasis on the role of awareness in improving functional capacity and athletic performance. Varying training intensities, sport-specific demands, and measurement methodologies (self-reported VO_2 max awareness in this study vs. a validated awareness questionnaire in the current study) could account for the lack of correlation in their findings compared to the current study [(14)].

STUDY LIMITATION

A primary limitation of this study was the reliance on self-reported questionnaires to assess awareness levels, which may introduce response bias and affect data accuracy. In addition, the cross-sectional design restricted the ability to establish causation between cardiopulmonary fitness awareness and functional capacity, suggesting that a longitudinal follow-up could provide more definitive insights. The sample was confined to young combat athletes aged 17 to 25 years, limiting the generalizability of the results to other age ranges or sports disciplines. Moreover, functional capacity was estimated via a single field test (the one-mile jog) and VO_2 max was derived from an equation rather than measured directly in a laboratory setting, potentially overlooking a broader range of performance indicators relevant to combat sports.

CONCLUSION

In conclusion, this study underscored the importance of integrating awareness-based training into physical conditioning programs for young combat athletes. The inverse relationship between VO_2 max and awareness suggested that while physical conditioning is essential, the cognitive understanding of cardiopulmonary fitness could further optimize performance and recovery. Future research should explore the long-term effects of awareness-focused interventions, particularly in young athletes, to determine their impact on both physical performance and overall health. By addressing this gap, this study opened up new avenues for more holistic training approaches that integrate both physical and cognitive components, ultimately fostering better athlete development and performance outcomes.

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