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Comparative Analysis of Aerobic Capacity (Vo₂max) Between University-Level Judo and Football Players

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ABSTRACT

Aerobic capacity, measured by VO₂max, is a key indicator of cardiovascular efficiency and endurance, essential for athletic performance. Football primarily involves sustained aerobic activity, whereas judo combines aerobic demands with high-intensity anaerobic bursts. This study aimed to compare VO₂ max levels between university-level football and judo players, highlighting differences in cardiovascular endurance across these sports. A total of 60 male athletes (football = 30; judo = 30) from the University of Delhi participated in the study. All participants were aged between 18 to 24 years and had participated at the inter-university level. VO₂ max was estimated using the Cooper 12-Minute Run Test. Descriptive statistics and a t-test were conducted to compare the groups. The analysis revealed that football players exhibited significantly higher VO₂max values compared to judo players ($p < 0.05$). This finding aligns with the distinct physiological requirements of the sports: football demands prolonged aerobic activity, while judo emphasizes intermittent anaerobic effort with recovery phases predominated by muscular endurance. This study highlights significant differences in VO₂max between football and judo players, with football players demonstrating superior aerobic capacity. The findings emphasize the importance of sport-specific demands in evaluating cardiovascular endurance and offer insights for optimizing training programs for different athletic disciplines.



1. INTRODUCTION

Aerobic capacity, quantified as maximal oxygen uptake (VO₂ max) [1,2] is a critical determinant of an athlete's endurance and overall performance [3]. VO₂ max represents the maximum rate at which an individual can consume oxygen during intense exercise [2], reflecting the efficiency of the cardiovascular and respiratory systems in oxygen delivery and utilization [4]. Higher VO₂ max values are indicative of superior aerobic fitness, which is essential for sustained physical activity and has been linked to reduced risks of cardiovascular diseases and increased longevity [1,2,3,5].

The assessment of VO₂ max can be performed through direct laboratory measurements [6] however, these methods are often resource-intensive and may not be feasible in all settings [4]. Consequently, field tests like

Cooper's 12-Minute Run Test have been developed as practical alternatives. Introduced by Kenneth Cooper in 1968, this test requires individuals to cover the maximum possible distance within 12 minutes, with the distance covered serving as an indirect estimate of VO₂max [7, 8]. Research has validated the efficacy of this test in estimating VO₂ max [7], demonstrating strong correlations between the distance covered and directly measured VO₂ max values [4, 9]. In the realm of sports, different disciplines impose varying demands on an athlete's aerobic capacity [10]. Football, for instance, involves continuous movement interspersed with high-intensity sprints [1, 11, 12], necessitating a well-developed aerobic system to support prolonged activity and facilitate recovery during intermittent bursts [2]. In contrast, judo is characterized by short, intense bouts of activity with periods of rest, [12, 13] relying more heavily on anaerobic energy systems

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and muscular endurance [14, 15]. Understanding these sport-specific physiological demands is crucial for optimizing training regimens and enhancing athletic performance [1].

Despite the obvious importance of customizing training to meet the specific needs of each sport, there is a lack of research comparing the aerobic capacities of athletes from different disciplines, especially between football and judo at the university level [1]. Such comparative analyses are essential for developing targeted conditioning programs that address the specific energy system requirements of each sport. The present study aims to bridge this gap by employing the Cooper 12-Minute Run Test to compare the VO_2 max levels of university-level football and judo players.

2. MATERIAL AND METHOD

2.1. Subjects

The study involved a total of 60 male athletes (30 football players and 30 judokas) aged between 18 to 24 years, randomly selected from colleges affiliated with the University of Delhi. The inclusion criteria were as (i) male gender; (ii) age between 18 and 24 years; (iii) absence of any acute or chronic illness; (iv) enrolment as a student at the University of Delhi; and (v) participation in inter-university competitions (football and judo respectively). Participants were excluded if they had any acute or chronic conditions, failed to complete the data collection process, or lacked a valid medical certificate and college identity card. All procedures were conducted anonymously and adhered strictly to the ethical principles outlined in the Declaration of Helsinki.

2.2. Tool

The 12-minute Cooper Run Test was employed to measure VO_2 Max, using the formula: $VO_2 \text{ Max} = (\text{Distance covered in meters} - 504.9) / 44.73$. Cones were placed at 10-meter intervals to mark the distance, and a standard stopwatch was used to record the test duration.

2.3. Variables

Aerobic capacity (VO_2) Max served as the dependent variable for the study, measured using the 12-minute Cooper Run Test to assess the athletes' aerobic capacity.

2.4. Data Collection Procedure

The data collection process took place on a standard 400-meter track. Prior to participation,

informed consent and a liability release form were obtained from all participants, who were also informed of their right to withdraw at any point if they experienced discomfort. Participants were briefed on the study's purpose and provided with clear instructions and protocols to follow during the data collection. The track was set up with a starting line, and cones were positioned at 10-meter intervals to aid in measuring the distance covered. To encourage maximum effort, participants were motivated before the test began. At the first beep, participants started running and continued for a duration of 12 minutes. The evaluator recorded the number of full laps completed by each participant. At the second beep, signalling the end of the test, participants halted at their exact position on the track. The total distance covered by each participant was determined by adding the number of completed laps to the distance marked by the cone where they stopped at the second beep.

2.5. Statistical Analysis

The analysis included calculating the mean, minimum value, maximum value, and performing a t-test with the level of significance set at 0.05. All data were transferred to SPSS software (version 21) for statistical processing.

3. FINDINGS

The result has been documented in the Table 1 and Figure 1.

Table 1. VO_2 Max Result of Cooper 12 Minute Run Test

Sport	VO_2 Max (ml/kg/min)		Maximum Value	Minimum Value
	Mean	S.D.		
Football	42.36	7.43	53.99	15.32
Judo	27.17	11.36	51.31	11.07

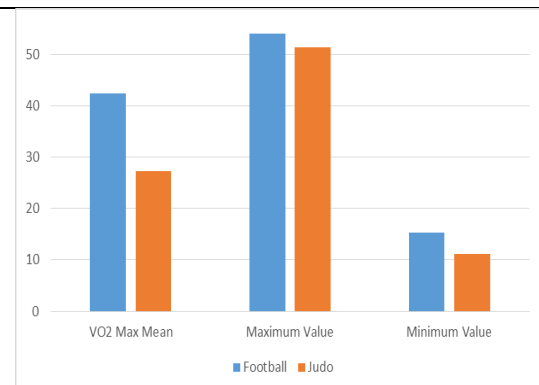


Figure 1. Result of Cooper 12 Minute Run Test

Table 1 and Figure 1 presents the descriptive statistics of the Cooper 12-Minute Run Test, demonstrating that the VO_2 max, minimum, and maximum values were higher among football players compared to judokas.

Table 2. Comparison between Football and Judo Players in regard to VO_2 max

Variables	Mean		Mean Difference	SED	t-value	p-value	Remarks
	Football	Judo					
VO_2 Max	42.36	27.17	15.19	2.61	5.82	0.002	*Significant

Note. Rounded to two digits after the decimal; SED= Standard Error of Difference; *Significant at 0.05 level

The Table 2 displays the t-test results, indicating a mean difference of 15.19, a t-value of 5.82, and a p-value of 0.002. These findings reveal a significant difference at the 0.05 level.

4. DISCUSSION

The present study examined the comparative analysis of aerobic capacity (VO_2 max) between university-level judo and football players. The study identified significant differences ($p < 0.05$) in VO_2 max between university-level football and judo players, with football players demonstrating superior aerobic performance. Different studies reported similar findings with higher VO_2 max levels in football players compared to judo athletes [1, 16]. Such results highlight the distinct physiological demands intrinsic to these sports, which shape the athletes' aerobic and anaerobic profiles based on their training and performance requirements.

Triki et al. [17] found no significant differences in VO_2 max or ventilatory threshold among prepubertal footballers, judokas, and control groups, suggesting that physiological adaptations to training become more prominent after puberty. These contrasting outcomes emphasize the importance of training intensity, duration, and physiological maturity in influencing aerobic capacity. Additionally, Jabeen et al. [1] observed that while judo players possess higher anaerobic capacities than sedentary individuals, their anaerobic performance remains comparable to football players. These findings highlight the sport-specific adaptations driven by the distinct training demands of football and judo.

The higher VO_2 max observed in football players can be attributed to the aerobic nature of the sport, which involves continuous running, high-intensity sprints, and sustained cardiovascular activity. Such training promotes key physiological adaptations, including increased stroke volume, capillary density, and

mitochondrial efficiency [4, 9]. In contrast, judo emphasizes short, explosive bouts of activity that rely predominantly on anaerobic energy systems, [12, 13] facilitating the development of muscular strength and power. These sport-specific demands account for the superior aerobic capacity in football players and the comparable anaerobic performance across groups.

These findings have practical implications for training and performance optimization in football and judo. Football players should prioritize aerobic endurance training, incorporating high-intensity interval training (HIIT) and continuous running exercises. For judo athletes, incorporating aerobic conditioning could enhance recovery and endurance without compromising anaerobic performance. Additionally, these insights may contribute to talent identification by highlighting VO_2 max as a critical factor for success in sports requiring high aerobic capacity.

Strengths and Limitations of the Study

The key strength of the study is the use of the Cooper 12-Minute Run Test, a simple and reliable method for estimating VO_2 max, which enhances the applicability of the results in real-world settings. The focus on comparing football and judo players is another strength, as it helps address a gap in research by studying two sports with very different physical demands. Including athletes who competed at the inter-university level makes the findings more relevant to competitive sports. However, the study has some limitations. Its cross-sectional design means it only provides a snapshot of aerobic capacity differences and cannot show long-term training effects or causes. Some factors, like nutrition, recovery habits, and stress, were not controlled and could have affected the results. Lastly, while the study focused on VO_2 max, it did not include other important factors like anaerobic capacity or body composition, which could give a clearer picture of the differences between the athletes.

5. CONCLUSION

The study which examined the comparative analysis of aerobic capacity (VO_2 max) between university-level judo and football players resulted in significant differences in aerobic capacity between football and judo players, with football players exhibiting superior VO_2 max levels due to the aerobic demands of their sport. Judo players, however, demonstrated comparable anaerobic performance. These findings highlight the importance of designing training programs to

match the specific physiological needs of each sport.

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Conflict of Interest

The authors declare no conflicts of interest.

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