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Effect of concurrent training on oxygen saturation, VO_2 max, and forced vital capacity of university men Kabaddi players

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Abstract
Physical exercise will root numerous changes in the human body, like oxygen levels in the blood, naturally, there are reserve of oxygen in the blood while doing physical exercise or regular systematic training.
Objectives: To evaluate the insights into the cardiovascular and respiratory adaptations associated with concurrent training among University Kabaddi Players
Aim: This study aimed to examine the impact of concurrent training on Oxygen Saturation (SpO2), VO_2 Max, and Forced Vital Capacity (FVC) in university-level Kabaddi players.
Design: In experimental research Related Group Design applied in this study.
Methods: Forty male university Kabaddi players were selected aged between 21–25 years, based on the initial observation they were dived in to two groups. Group-I (n=20) underwent concurrent training and Group-II (n=20) control. The dependent variables such as Oxygen saturation was measured via pulse oximetry, VO_2 max via the one-mile run/walk test, and FVC via Spirometer. Pre- and post-test data were collected before and after the 12 weeks experimentations and it was analyzed by analysis of covariance (ANCOVA).

Keywords: Concurrent training, oxygen saturation, vo_2 max, forced vital capacity, Kabaddi

Introduction

Kabaddi is a fast-paced, intense contact sport that demands a unique blend of strength, speed, agility, anaerobic capacity, and aerobic endurance (Singh, *et al*., 2011) [17]. Kabaddi, a sport played by two teams of seven players, consists of repeated bout of high-intensity activity with brief recoveries, which makes it physiologically and physically demanding (Kumar & Reddy, 2013) [11]. As such, elite aerobic endurance and muscular strength are essential here, as they enable players to maintain high power output during getting behind the lens and making physically demanding defensive stops.

In recent years, concurrent training, which refers to the simultaneous incorporation of both resistance (strength) and endurance training within a single training program, has gained recognition for its effectiveness in improving overall athletic performance (Hickson, 1980) [9]. This training method aims to stimulate both the cardiovascular and musculoskeletal systems, leading to enhanced oxygen transport, energy production, and muscular power—components vital for sports like Kabaddi (Baechle& Earle, 2008) [5]. VO_2 max, or maximal oxygen uptake, is a key indicator of an athlete's aerobic capacity and cardiovascular efficiency. It reflects the maximum amount of oxygen the body can utilize during intense exercise and is closely associated with endurance performance (Brooks, Fahey, & Baldwin, 2005) [6]. Improvements in VO_2 max through concurrent training can enhance the ability of Kabaddi players to sustain high-intensity activity and recover quickly between bouts.

Concurrent training, especially at high intensities, can increase the body's demand for oxygen, both at the systemic level (through heart rate and oxygen uptake) and locally within muscles. With consistent concurrent training, the body adapts, becoming more efficient at oxygen delivery and utilization, potentially improving SmO2 and overall oxygen saturation. In healthy individuals, exercising at severe and extreme intensities can cause muscle oxygen demand to surpass convective oxygen delivery, thus causing a mismatch between muscle oxygen demand and supply (Andersen and Saltin, 1985) [3].

Oxygen saturation (SpO_2), measured via pulse oximetry, indicates the percentage of hemoglobin saturated with oxygen. It provides insight into the efficiency of the respiratory and circulatory systems during exercise (Mazzeo & Marshall, 1989) [12]. While typically stable during moderate exercise, intense physical exertion may occasionally lead to slight reductions in oxygen saturation due to increased oxygen demand. Despite the individual importance of VO_2 max, FVC, and SpO_2, limited studies have explored the collective effect of concurrent training on these physiological parameters, particularly among Kabaddi players. Given the unique physical demands of Kabaddi, it is crucial to investigate how integrated training programs influence these key performance indicators. This study, therefore, aims to examine the effects of concurrent training on oxygen saturation, VO_2 max, and forced vital capacity in university-level male Kabaddi players.

Forced Vital Capacity (FVC), which measures the maximum volume of air that can be forcefully exhaled after full inhalation, serves as an important marker of pulmonary function and respiratory muscle strength (McArdle, Katch, &Katch, 2014) [13]. Increased FVC indicates improved respiratory mechanics, which is especially beneficial in sports requiring efficient breathing under stress.

Methodology

This study aimed to examine the impact of concurrent training on Oxygen Saturation (SpO2), VO_2 Max, and Forced Vital Capacity (FVC) in university-level Kabaddi players. In experimental research Related Group Design applied in this study. Forty male university Kabaddi players were selected aged between 21–25 years, based on the initial observation they were dived in to two groups. Group-I (n=20) underwent concurrent training and Group-II (n=20) control.

Intervention: Participants underwent a concurrent training program combining resistance and aerobic training over a twelve weeks period. The strength training program was a total body workout consisting of 3 sets of 6-10 repetitions on 8 exercises that trained all the major muscle groups. A percentage of each subject's one-repetition maximum for each exercise was used to determine the intensity of each week. The intensity and number of repetitions performed for each exercise changed once in two weeks. The endurance training consists of 20-40 minutes running 2-3 times per week with 65- 80% HRR. The running intensity was determined by a percentage of heart rate reserve (HRR). Every odd numbered week players performed the strength training in the morning session and endurance training in the evening session. Every even numbered week players performed endurance training in the morning session and strength training in the evening session.

Data Collection

Oxygen Saturation (SpO_2): Measured using a calibrated pulse oximetry. VO_2 Max: Estimated by the one-mile run/walk test. Forced Vital Capacity (FVC): Measured with a digital spirometer. Statistical Analysis Pre- and post-test data were collected before and after the 12 weeks experimentations and it was analyzed by analysis of covariance (ANCOVA). A significance level of 0.05 was adopted.

Results

Descriptive Statistics			
Dependent Variable: Oxygen Saturation (%)			
Groups – Pre-Test	**Mean**	**Std. Deviation**	**N**
Concurrent Training	96.82	0.62	20
Control Group	96.98	0.69	20
Groups – Post Test			
Concurrent Training	96.70	0.64	20
Control Group	96.91	0.70	20
Groups – Adjusted Post Test			
Concurrent Training	96.78	-	20
Control Group	96.83	-	20

Tests of Between-Subjects Effects					
Oxygen Saturation (%)					
Source - Pre	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	0.256	1	0.256	0.592	.446
Error	16.424	38	0.432		
Source - Post					
Group	0.441	1	0.441	0.961	.333
Error	17.435	38	0.459		
Source – Adjusted Post					
Group	0.021	1	0.021	2.986	.092
Error	0.263	37	0.007		

*Significant at $p < 0.05$

The result of the Oxygen saturation (F-Value: 2.98) showed that there is no significant difference among the concurrent training and control group.

Descriptive Statistics			
Dependent Variable: VO_2 Max			
Groups – Pre-Test	Mean	Std. Deviation	N
Concurrent Training	45.85	0.34	20
Control Group	45.96	0.43	20
Groups – Post Test			
Concurrent Training	46.97	0.37	20
Control Group	45.89	0.38	20
Groups – Adjusted Post Test			
Concurrent Training	47.00	-	20
Control Group	45.85	-	20

Tests of Between-Subjects Effects					
VO_2 Max					
Source - Pre	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	0.105	1	0.105	0.678	.415
Error	5.886	38	0.155		
Source - Post					
Group	11.632	1	11.632	81.25	.000
Error	5.439	38	0.14		
Source – Adjusted Post					
Group	12.964	1	12.96	179.21	.000
Error	2.677	37	0.072		

*Significant at $p < 0.05$

The result of the VO_2 Max (F-Value: 179.21) showed that there is a significant difference among the concurrent training and control group. Here the concurrent training effect is in positive to the Kabaddi players.

Descriptive Statistics			
Dependent Variable: Forced Vital Capacity			
Groups – Pre-Test	**Mean**	**Std. Deviation**	**N**
Concurrent Training	3.15	0.17	20
Control Group	3.08	0.10	20
Groups – Post Test			
Concurrent Training	3.60	0.17	20
Control Group	3.15	0.09	20
Groups – Adjusted Post Test			
Concurrent Training	3.57	-	20
Control Group	3.18	-	20

Tests of Between-Subjects Effects					
Forced Vital Capacity					
Source - Pre	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Group	0.050	1	0.050	2.37	132
Error	0.795	38	0.021		
Source - Post					
Group	2.021	1	2.021	97.97	.000
Error	0.784	38	0.021		
Source – Adjusted Post					
Group	1.480	1	1.480	163.23	.000
Error	0.336	37	0.009		

*Significant at $p < 0.05$

The result of the forced vital capacity (F-Value: 163.23) showed that there is a significant difference among the concurrent training and control group. Here the concurrent training effect is in positive to enhance the vital capacity of the Kabaddi players.

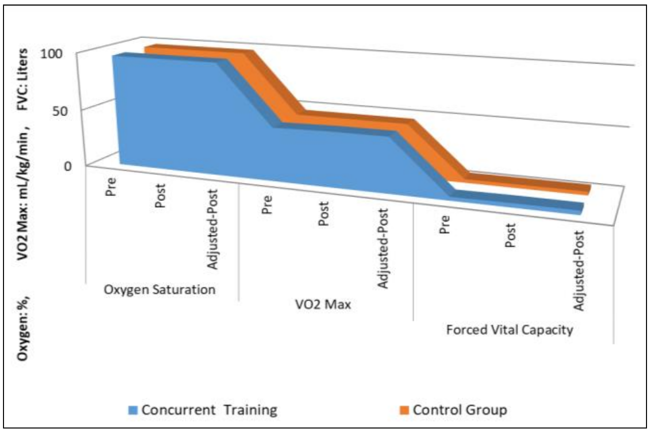

Fig 1:

Discussion and Interpretation of Results

VO_2 Max: The statistically significant improvement suggests increased aerobic capacity and cardiovascular endurance due to the training.

Forced Vital Capacity: The enhancement in FVC implies better lung function and respiratory mechanics.

Oxygen Saturation: The non-significant change and lower post-test value may point to measurement errors, acclimatization issues, or a physiological anomaly.

The present study revealed significant improvements in VO_2 max and Forced Vital Capacity (FVC) among university-level male Kabaddi players following a concurrent training intervention. These results align with numerous prior studies emphasizing the benefits of integrating resistance and aerobic exercises for enhancing cardiorespiratory and pulmonary efficiency.

VO_2 Max

Concurrent training can improve VO2 max, with some research indicating that combined aerobic and resistance training leads to the most significant improvements. This may be due to the combined effects of enhanced cardiovascular adaptations from aerobic activity and improved muscular endurance from resistance exercises. (Astha, *et. al.*, (2025). Aerobic exercise programs are a type of physical activity that needs oxygen in order to produce energy and enhances performance of the cardiovascular system (Al-Azzawi and Farhan, 2024) [2].

The significant enhancement in VO_2 max observed in this study can be attributed to physiological adaptations such as increased stroke volume, capillarization, and mitochondrial density common outcomes of aerobic training (Kenney, *et al*., 2019) [10]. Similar findings were reported by Gore, *et al*. (1999) [7], who noted that athletes engaging in structured endurance and resistance training experienced marked gains in oxygen uptake efficiency. Moreover, Hickson (1980) [9] first demonstrated that despite the potential interference effect, concurrent training can produce meaningful improvements in aerobic performance if programmed correctly. For Kabaddi players, who engage in repeated high-intensity efforts, enhanced VO_2 max supports quicker recovery between bouts and sustained performance throughout the match.

Forced Vital Capacity (FVC)

The increase in FVC is indicative of improved respiratory muscle strength and lung compliance. These outcomes are consistent with findings by McArdle *et al*. (2014) [13], who documented that both aerobic and resistance training could significantly elevate pulmonary function. Sheel *et al*. (2004) [16] further explained that physically trained individuals often exhibit superior lung volumes and flow rates, largely due to respiratory muscle conditioning and thoracic expansion. For Kabaddi players, improved FVC translates to better oxygen exchange and reduced respiratory fatigue during prolonged play. Muthuraj and Wise (2011) [14] examined Effect of concurrent strength and endurance training and detraining on vital Capacity. Result showed that concurrent strength and endurance training improved vital capacity (5.91%). Guner, *et al*., (2018) investigated the effect of aerobic and core strength exercises on forced vital capacity in sedentary women. The aerobic and forced vital capacities of the sedentary women show a parallel increase as a result of the applied 12-week aerobic and core strength exercises, it can be said that the RHR, VO2max, FEV, and FEV1 respiratory parameters also improved in a positive manner.

Oxygen Saturation (SpO_2)

Interestingly, the post-test oxygen saturation levels declined slightly and were not statistically significant. This result deviates from typical expectations, as moderate to high-intensity training usually maintains or slightly enhances SpO_2 under normoxic conditions. However, as Mazzeo and Marshall (1989) [12] suggested, during intense physical exertion, some highly trained individuals may exhibit marginal drops in SpO_2 due to ventilation-perfusion mismatch or rapid muscle oxygen extraction exceeding the replenishment rate. Additionally, external variables such as measurement timing, sensor placement, or temporary fatigue could have influenced the post-test readings. Wagner (1996) [20] also pointed out that oxygen saturation is generally stable during submaximal exercise, but variations can occur in response to acute exertion or environmental factors. Sepriadi. Monica and Rika (2023) [15] the effect of oxygen saturation on students before and after physical basketball training. The results of statistical calculations, there was no notable change in oxygen saturation values after basketball physical training.

Support from Sport-Specific Studies

Baechle and Earle (2008) [5] highlighted that athletes involved in multidimensional sports like Kabaddi benefit substantially from concurrent training, especially when sessions are carefully periodized. Similarly, Turner, *et. al.*, (2015) [19] emphasized the importance of integrating strength and endurance components in training for team-sport athletes, noting measurable improvements in both aerobic capacity and muscular function without adverse interference effects.

Summary

In sum, the present study's findings reinforce the value of concurrent training in improving VO_2 max and FVC among Kabaddi players. While the changes in oxygen saturation were not significant, they open avenues for further exploration especially in terms of measurement protocols and participant responses to acute vs. chronic training stress.

Future studies should consider larger sample sizes, longer intervention periods, and real-time game-based assessments to gain more practical insights.

Conclusion

The conclusion of the study showed that concurrent training significantly enhances VO_2 max and forced vital capacity in male university Kabaddi players, thereby boosting overall cardiorespiratory fitness. Oxygen saturation levels, however, did not show significant change.

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