Original Article

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Impact of a pre-competition aerobic and anaerobic training on the maximal aerobic capacity, anaerobic power, dynamic balance, and visual-motor coordination of rugby and soccer players

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Abstract: Pre-competition training emphasizes the development of total physical fitness components and maintains aerobic and anaerobic capacity with improved techno-tactical skills. The primary objective of this investigation was to establish the efficacy of a pre-competition training program. There were a total of 24 (12 rugby and 12 Soccer) elite players randomly selected from the Ba and Lautoka regions (Fiji). The players had a mean age of 21.45±2.34 years, body mass of 84.62±6.62 kg, stature 183.35±3.24, and body mass index of 22.62±4.31 kg/m2. This study was conducted nine weeks before the main competition. The study involved a pre-and post-test design, wherein all participants underwent two rounds of testing. The pretest was conducted before the commencement of an eight-week pre-competition training program, while the post-test was administered after the program was completed. This pre-competition training program was scheduled five times per week for 45 minutes per day. The participant's performance was measured using the Beep test, Wingate anaerobic test, star excursion balance test, and visual motor coordination test. After eight weeks of the pre-competition training program, significant improvement has occurred for maximal aerobic capacity (t=-14.79, p=<0.001), anaerobic power (t=-12.22, p=<0.001), dynamic balance (t=-7.41, p=<0.001), and visual motor coordination (t=8.38, p=<0.001) in all the players. The study confirmed that the eight weeks of pre-competition training programs containing aerobic and anaerobic workouts enhanced the performance of the Beep test, Wingate anaerobic test, star excursion, and visual motor coordination test.

Keywords: Beep test, Wingate anaerobic test, Star excursion balance test, Lower body strength test, aerobic and anaerobic workout.

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INTRODUCTION

Rugby and soccer have been mentioned as the most popular games in Fiji, and research demonstrates that the demand for elite rugby and soccer players have been increased in recent years [1]. Some essential common techno-tactical activities in rugby and soccer games include running, dribbling, kicking, jumping, dodging, and tackling, except rucking, mauling, and scrumming [2]. Athletes who participate in rugby and soccer rely heavily on their aerobic and anaerobic capacities to sustain high-intensity, repetitive movements, facilitate recovery, and maintain optimal physical fitness in order to perform at their best levels [3]. Coaches and trainers create training programs to help athletes perform at their best. These programs can include a variety of components, such as strength training, conditioning, and skill development. The specific components of a training program will vary depending on the athlete's individual needs and goals. Training that is tailored to the athlete's abilities is known to be one of the most effective ways to improve performance. This type of training has become a standard method for preparing athletes for competition [4].

Coaches and trainers must consider the helpful parameters to enhance the player's performance at the optimal level. Hence, players would be capable of physical demands during competition; they must possess performance traits such as aerobic and anaerobic fitness and have good upper and lower limb muscle strength [5]. Pre-competition training emphasizes the development of total physical fitness components and maintains aerobic and anaerobic capacity with improved techno-tactical skills [6]. Helgerud et al. revealed that an 11% improvement in aerobic capacity resulted in a 20% increase in the travelled distance during competition, an 23% increase in the time spent with ball possession, and a significant increase (100%) in the number of sprints performed [7]. Slimani et al. suggested that pre-competition training for at least ten weeks or more helps improve players' performance significantly [8]. Hermassi et al. proved that an eight-week pre-competition training program, consisting of biweekly sessions, enhanced players' jump performance [9]. Daniels et al. reported that seven-week pre-competition training helps to improve strength, endurance and power among rugby players[10]. As a result of pre-competition training, players should develop the physical attributes of balance, flexibility, speed, acceleration, strength, power, and endurance to the extent necessary to meet the demands of both games [11].

Research has shown that soccer players' competitiveness is associated with their aerobic capacity[12]. Maximal oxygen consumption (VO2max) is considered the most reliable indicator of an athlete or team's success [13]. The measurement of VO2max is feasible in both laboratory and field environments. The multistage shuttle run test, commonly called the beep test, can be conducted in field settings to measure VO2max. The test involves running at a gradually increasing speed over a distance of 20 meters while incorporating frequent dynamic twisting and direction changes. These movements are similar to those performed in soccer and rugby[14.] Research has demonstrated that the beep test is a reliable indicator of an individual's VO2max[14]. Leger et al. found that the beep test could predict VO2max with high accuracy. The study also developed a formula that can be used to estimate VO2max based on the highest speed achieved in the beep test [15].

Anaerobic performance refers to the capacity to engage in short-duration, high-intensity physical activities. Anaerobic energy production occurs first during extended muscular activity, followed by aerobic energy production[16]. It is important in many sports, such as sprinting, jumping, and weightlifting. Endurance and explosive power are quantified that the balance should maintain, which maximizes power output over an extended period of time. Determining anaerobic energy capacity constituents can be accomplished through diverse techniques, which exhibit different levels of accuracy [17]. The Wingate Anaerobic test is a laboratory-based fitness test generally performed on a cycle ergometer that measures an individual's power outputs and anaerobic capacities

[18]. Since many sports involve high-intensity bursts of activity that persist for several seconds up to one or two minutes, these metrics can be employed in diverse training and research initiatives to evaluate and contrast the anaerobic capacity of athletes more precisely [9]. According to some researchers, the Wingate Anaerobic Test has been deemed a valid, reliable, and preeminent method for evaluating anaerobic performance [20].

Dynamic balance is the ability to maintain balance while moving. It is important in many sports, such as gymnastics, basketball, and soccer, as it allows athletes to maintain their balance while performing quick movements. In addition to engaging in sporting activities, dynamic balance can be used as an injury predictor in lower limbs [21]. Lower extremity injuries have been extensively examined as associated with dynamic balance impairment [11]. Various methods, including the Y-Balance Test, can be employed to assess dynamic balance. The Y-Balance Test is a functional assessment tool that measures dynamic balance across three distinct planes of motion, namely the anterior, posteromedial, and posterolateral directions. The Y Balance Test exhibits robust test-retest reliability (ICC = 0.80 to 0.85) [22]. Pau et al. argued that dynamic balance is crucial for achieving peak performance and minimizing injury risk. They found that dynamic balance impairment significantly predicted lower extremity injuries. Therefore, enhancing dynamic balance through training is crucial for athletes to optimize their athletic performance and mitigate the likelihood of sustaining injuries [23].

Visual motor coordination is the mind-body coordination of perceiving visual cues and generating appropriate motor responses. This is known as eye-hand coordination. This is the abilities consist of the following: walking, running, hopping, climbing, cycling, diving, using a computer, colouring, and reading-writing. Additionally, they play an important role in self-sufficiency, independence, and academic and athletic performance. Improved eye-hand coordination influences reaction time, agility, timing, body control, and balance. Developing visual motor coordination in athletes begins with directing their bodies and hands toward diverse situations within their visual field [24].

In order to perform better in competition, players often participated in various training programs characterized by different volumes, intensities, duration, and recovery phases, such as high volume and moderate intensity training that focus on improving specific abilities and skills. Because of the importance of such abilities and skills during competition, this study aims to explore the potential impact of pre-competition aerobic and anaerobic training on the performance parameters of rugby and soccer players. The study focuses on four key aspects, namely maximal aerobic capacity, anaerobic power, dynamic balance, and visual-motor coordination. The research intends to investigate how targeted training interventions can enhance athletic performance in these crucial domains, leading to improved competitive outcomes. It was hypothesized that rugby and soccer players would improve their performance parameters. The aerobic and anaerobic training program should improve maximal aerobic capacity, anaerobic power, dynamic balance, and visual motor coordination.

MATERIAL AND METHODS

Participants

This study recruited a total of twenty-four male participants (12 rugby players and 12 soccer players). Each participant was an exceptional player with at least three years of experience in competitive events. Participants who have experienced musculoskeletal and lower limb injury within the preceding three months, systemic diseases, neurological disorders, the use of any medication, and performance-impairing biomechanical anomalies were excluded from the investigation. By excluding participants with these conditions, the study centered on evaluating the impact of the training regimen on the athletic performance of high-level athletes who were free from any health conditions that could affect their performance.

Experimental design

The current quasi-experimental designed study investigated the impact of eight-week aerobic and anaerobic pre-competition training program as shown in table 1 on maximal aerobic capacity, anaerobic capacity, dynamic balance, and lower body strength among elite soccer and rugby players using a pretest and post-test approach. This investigation utilized a probability-based sampling strategy. Only participants who volunteered and met all inclusion and exclusion criteria were chosen.

Ethical consideration

Ethical approval was granted by the human research ethics committee of the Fiji National University (FNU-HREC-22-40) for this study dated 31 October 2022. Before participating in the test, each participant signed a written consent form.

Outcome measures

Maximal aerobic capacity

In this research, the beep test assesses maximal aerobic capacity. The 20-meter shuttle run test, commonly known as the beep test, is a practical and economical method for assessing maximal aerobic capacity in a real-world environment. The subjects were instructed to perform a shuttle run task, covering a distance of 20 meters between two demarcated lines, synchronized with an auditory cue. The initial velocity was 8.5 km/h and experienced a linear increase of 0.5 km/h per minute. Participants who did not reach the line before sounding the beep were excluded from the test. The maximal aerobic capacity was determined by utilizing the count of shuttles that were successfully completed.

Anaerobic capacity

The present study utilized the Wingate Anaerobic test to assess the anaerobic capacity of rugby and soccer athletes. The Wingate test originated at the Wingate Institute in Israel in 1970. The 30-second Wingate test is an alternative name for this particular assessment. In this test, anaerobic leg power determines by using a Monark cycle ergometer for 30 seconds.

Dynamic balance

The Star Excursion Balance Test (SEBT) assessed dynamic balance. The SEBT is a functional assessment tool utilized to quantify dynamic balance across eight distinct directions, namely anterior medial, left anterolateral, left mediolateral, left posteromedial, posteromedial, right posteromedial, right mediolateral, and right anterolateral. SEBT is executed on a level surface featuring four demarcated lines on the ground. Two straight lines intersect at a right angle, horizontal and vertical. Two vertical and horizontal lines are drawn at a 45-degree angle from the perpendicular line. The final form is a star with an angle of 45 degrees between all lines. To perform the SEBT, participants stand on their dominant leg with their feet shoulder-width apart. Participants are subsequently directed to extend their non-dominant leg in each of the eight directions and reach as far as possible with their toes. The participants must ensure that their feet remain in contact with the ground and maintain their equilibrium throughout the test. SEBT has been established as a reliable and valid measure of an individual's dynamic balance. The test in question is a straightforward and readily manageable assessment tool that evaluates athletes' dynamic balance across a wide range of age groups and skill levels.

Visual motor coordination

Two-arm coordination test was used to evaluate visual motor coordination. The ball wall toss test determined the visual motor coordination [25]. This test utilized a tennis ball and a flat surface. A distance of two meters was demarcated from the wall. The participants were instructed to perform a task that involved throwing and catching a ball against a wall, utilizing alternating hands, for thirty seconds [26]. The ball was thrown with the right hand and caught with the left hand, and then thrown with the left hand and caught with the right hand; this was recorded as a single action.The number of successful catches was documented. The test was used to determine the validity among Korean children and concluded that this test is effective and valid to distinguish subject ability [27].

Procedure

All the participants were screened according to the exclusion and inclusion strategies. The tests' relative benefits and associated risks were described to every participant before the tests were executed. The floor was open to asking any questions regarding the tests. Players were independent of discontinuing the study at any stage. The participants adhered to wearing sports-specific clothing during the entirety of the test. Participants filled out a data collection form with their names, ages, gender, name of the club, positions, and years of sports participation and provided written consent. Anthropometric measurements of the participants were obtained utilizing a standardized auto-calibrated stadiometer-cum-weighing scale, which was used to measure height and weight. The Body Mass Index (BMI) calculation involves dividing an individual's weight in kilograms by the square of their height in meters, expressed as BMI= kg/m^2. Participants were granted a warm-up period of over ten minutes before the test's commencement, followed by general and specific stretching exercises. Baseline measurements were taken at the time of player recruitment, and at the completion of eight weeks of aerobic and anaerobic training, the post-measurements were also taken. The maximal aerobic capacity was determined through the beep test, while the Wingate anaerobic test was utilized to measure anaerobic capacity. The star excursion balance test was employed to evaluate dynamic balance, and eye-hand coordination was assessed through the two-arm coordination test. The researcher provided verbal encouragement throughout each test to all the participants. Five minutes of rest time was given between each test.

Statistical Analysis

The statistical analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) version 21.0 for Windows. Descriptive and interferential statistics were provided through means and standard deviations. The normality and homogeneity of the data were assessed through the utilization of Shapiro-Wilk's and Leven's tests, respectively, with a significance level set at $p>0.05$. An independent t-test was utilized to compare the variables of age, height, weight, and BMI among the players. The outcome measures (Maximal aerobic capacity, anaerobic capacity, dynamic balance, and visual motor coordination) differences before and after eight weeks of the aerobic and anaerobic pre-competition training program were measured by paired t-test (two-tails). After eight weeks, the outcome measures differences between rugby and soccer groups were compared with an independent t-test (two-tails). A significance level of 0.05 was employed to establish statistical significance. The formula given by Cohen also determined the effect size [27]. The general guidelines given by Cohen were followed for interpreting the effect size (r): a value of 0.2 indicates a minor effect, 0.5 indicates a moderate impact, and 0.8 indicates a large effect [28].

Table 1. Eight-week aerobic and anaerobic pre-competition training program schedule for rugby and soccer players.

Day	Training type	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Monday	Aerobic	30 min MI cardio*	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio
	Anaerobic	-	-	-	-	-	-	-	-
Tuesday	Aerobic	-	Strength training 3 x 8-12 rep	Strength training 3 x 10-15 rep	Strength training 3 x 12-16 rep	Strength training 3 x 14-18 rep	Strength training 3 x 16-20 rep	Strength training 3 x 18-22 rep	Strength training 3 x 20-24 rep
	Anaerobic	HIIT training 4 x 20s sprint, 10s rest	HIIT training 4 x 30s sprint, 20s rest	HIIT training 4 x 40s sprint, 30s rest	HIIT training 4 x 50s sprint, 40s rest	HIIT training 4 x 60s sprint, 50s rest	HIIT training 4 x 70s sprint, 60s rest	HIIT training 4 x 80s sprint, 70s rest	HIIT training 4 x 90s sprint, 80s rest
Wednesday	Aerobic	-	-	-	-	-	-	-	-
	Anaerobic	Strength training 3 x 8-12 rep	Strength training 3 x 10-15 rep	Strength training 3 x 12-16 rep	Strength training 3 x 14-18 rep	Strength training 3 x 16-20 rep	Strength training 3 x 18-22 rep	Strength training 3 x 20-24 rep	Strength training 3 x 22-26 rep
Thursday	Aerobic	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio	30 min MI cardio
	Anaerobic	-	-	-	-	-	-	-	-
Friday	Aerobic	-	-	-	-	-	-	-	-
	Anaerobic	HIIT training 4 x 25s sprint, 15s rest	HIIT training 4 x 35s sprint, 25s rest	HIIT training 4 x 45s sprint, 35s rest	HIIT training 4 x 55s sprint, 45s rest	HIIT training 4 x 65s sprint, 55s rest	HIIT training 4 x 75s sprint, 65s rest	HIIT training 4 x 85s sprint, 75s rest	HIIT training 4 x 95s sprint, 85s rest
Saturday	Active recovery	Light cardio#	Light cardio#	Light cardio#	Light cardio#	Light cardio#	Light cardio#	Light cardio#	Light cardio#
Sunday	Rest	Rest	Rest	Rest	Rest	Rest	Rest	Rest	Rest

* e.g., Jogging, Running, Cycling, MI cardio = moderate-intensity cardio, HIIT training = High Intensity Interval training, rep = repetitions of each exercise, ss = seconds of sprinting, sr = seconds of rest, # yoga, stretching, or recreational game

RESULTS

The statistics of all anthropometric characteristics, normality of data, and differences between outcome measures (Maximal Aerobic Capacity, Anaerobic Power, Dynamic Balance, and Visual Motor Coordination) between the rugby and soccer players were assessed. The anthropometric characteristics of the participants did not exhibit any significant differences, and the normality test for outcome measures did not reveal any significant differences between rugby and soccer players. The study found notable differences in the outcome measures between the pretest and post-test phases, attributed to the impact of pre-competition training programs involving aerobic and anaerobic exercises for rugby and soccer players.

The anthropometric characteristics of soccer and rugby players were compared in Table 2. The results indicated that there were no statistically significant differences between the two groups in terms of age (p=0.308), weight (p=0.652), height (p=0.277), and BMI (p=0.012), using a significance level of 0.05. Table 2 indicated that all participants from rugby and soccer games have similar anthropometric characteristics, and there is no significant difference between rugby and soccer players.

Table 3 demonstrated that the normality statistics value test is close to 1, and no significant differences ($p \geq 0.05$) were found in the Shapiro-Wilk test for outcome measures between rugby and soccer players. Therefore, it is assumed that the outcome measures data for rugby and soccer players were normally distributed, and the parametric tests were utilized for further analysis.

Table 4 presents statistically significant differences between pretest and post-test results for maximal aerobic capacity (t=-9.93, p=<0.001) and (t=10.65, p=<0.001), anaerobic power (t=8.13, p=<0.001) and (t=9.5, p=<0.001), dynamic balance (t=5.39, p=<0.001) and (t=4.94, p=<0.001), and visual motor coordination (t=6.00, p=<0.001) and (t=5.74, p=<0.001) among rugby and soccer players. The mean scores showed improvement in outcome measures as an effect of aerobic and anaerobic pre-competition training programs for rugby and soccer players.

Table 5 demonstrated significant differences between the pretest and post-test for maximal aerobic capacity (t=-14.79, p=<0.001), anaerobic power (t=-12.22, p=<0.001), dynamic balance (t=-7.41, p=<0.001), and visual motor coordination (t=8.38, p=<0.001) in all the players. The mean values showed improvement in outcome measures as an effect of aerobic and anaerobic pre-competition training programs.

Table 6 demonstrated no statistically significant variations between rugby and soccer players in maximal aerobic capacity (t=.48, p=0.63) and anaerobic power (t=1.26, p=0.22). The effect size observed was small. Significant differences existed between rugby and soccer players for dynamic balance (t=2.77, p=0.010) and visual motor coordination (t=2.81, p=0.009) with a large effect size. The results of the inferential statistical analysis indicated that no statistically significant improvement was observed in the maximal aerobic capacity and anaerobic power. Simultaneously, there was a notable enhancement in dynamic balance and visual motor coordination. At the same time, compare the end effect of an aerobic and anaerobic pre-competition training program for eight weeks between rugby and soccer athletes

Table 2. The anthropometric characteristics of the participants.

Indicator	Rugby Players (Means ±SD)	Soccer Players (Means ±SD)	SE Difference	t-value	p
Age (Years)	22.80±2.56	21.27±2.22	0.51	1.03	0.308
Weight (kg)	68.62±6.78	67.54±7.18	2.59	-0.47	0.652
Height (cm)	176.53±4.44	173.24±6.42	2.29	1.21	0.277
BMI (kg/m^2)	23.24±2.15	22.43±0.37	0.35	2.64	0.012

SD = standard deviation, SE = standard error, p = statistical significance

Table 3. Normality test for Maximal Aerobic Capacity, Anaerobic Power, Dynamic Balance, and Visual Motor Coordination among soccer and rugby players.

Outcome Measures	Test	95% Class Interval		Shapiro-Wilk		
		Lower	Upper	Statistics	df	p
Maximal Aerobic Capacity	Pre	51.76	59.73	0.955	30	0.127
	Post	59.89	67.12	0.954	30	0.211
Anaerobic Power	Pre	286.48	310.46	0.952	30	0.190
	Post	332.07	356.53	0.938	30	0.079
Dynamic Balance	Pre	36.58	37.95	0.943	30	0.064
	Post	37.46	39.12	0.932	30	0.054
Visual Motor Coordination	Pre	26.17	27.16	0.939	30	0.084
	Post	24.91	25.88	0.918	30	0.072

p = statistical significance

Table 4. Descriptive and inferential statistics of pre and post-measurements for maximal aerobic capacity, anaerobic power, dynamic balance, and visual motor coordination in rugby and soccer players.

Outcome Measures	Players	Pretest Mean±SD	Post-test Mean±SD	t-value	p
Maximal Aerobic Capacity	Rugby	57.96±10.37	64.60±9.74	-9.933	<0.001
	Soccer	56.20±8.15	62.97±8.75	-10.651	<0.001
Anaerobic Power	Rugby	311.47±32.76	351.73 ±36.17	-8.129	<0.001
	Soccer	285.47±26.46	336.87±28.19	-9.498	<0.001
Dynamic Balance	Rugby	38.07±1.83	39.27±1.67	-5.392	<0.001
	Soccer	36.47±1.51	37.71±1.49	-4.938	<0.001
Visual Motor Coordination	Rugby	26.00±1.19	24.80±1.32	6.000	<0.001
	Soccer	27.33±1.11	26.00±1.00	5.739	<0.001

SD = standard deviation, p = statistical significance

Table 5. Descriptive and inferential statistics of pre and post-measurements for maximal aerobic capacity, anaerobic power, dynamic balance, and visual motor coordination.

Outcome Measures	Pretest	Post-test	SE Difference	t-value	p
Maximal Aerobic Capacity	57.08±9.21	63.79±9.13	0.453	-14.790	<0.001
Anaerobic Power	298.47±32.11	344.30±32.74	3.749	-12.223	<0.001
Dynamic Balance	37.27±1.84	38.47±1.76	0.162	-7.413	<0.001
Visual Motor Coordination	26.67±1.32	25.40±1.30	0.151	8.382	<0.001

SD = standard deviation, SE = standard error, p = statistical significance

Table 6. Descriptive and inferential statistics of post-measurements for maximal aerobic capacity, anaerobic power, dynamic balance, and visual motor coordination between rugby and soccer players.

Outcome Measures	Players	Post-test Mean±SD	SE Mean	t-value	p	Effect Size
Maximal Aerobic Capacity	Rugby	64.60±9.74	2.51	0.483	0.633	0.176
	Soccer	62.97±8.75	2.25			
Anaerobic Power	Rugby	351.73±36.17	9.34	1.256	0.220	0.458
	Soccer	336.87±28.19	7.28			
Dynamic Balance	Rugby	39.27±1.67	0.43	2.766	0.010*	1.010
	Soccer	37.67±1.49	0.39			
Visual Motor Coordination	Rugby	24.80±1.32	0.34	2.806	0.009*	1.025
	Soccer	26.00±1.00	0.26			

SD = standard deviation, SE = standard error, p = statistical significance, *Significant at 0.05 level

DISCUSSION

This study aimed to investigate the effectiveness of an aerobic and anaerobic pre-competition training program on maximal aerobic capacity, anaerobic capacity, dynamic balance, and visual motor coordination among elite rugby and soccer players. The findings of the study revealed an enhancement in maximal aerobic capacity, anaerobic power, dynamic balance, and visual motor coordination in rugby players than soccer players while compared by pretest and post-test as a result of intervention (aerobic and anaerobic training) program. Findings revealed that rugby players were better in the abovementioned outcome measures than soccer players. The findings also revealed no significant improvement differences between rugby and soccer players for the anaerobic power and maximal aerobic capacity; these outcome measures had a small effect on each other. In contrast, significant improvement differences existed between rugby and soccer players for dynamic balance and visual motor coordination and greatly affected each other.

The primary objective of any per-competition training program is to maximize performance during competition. To accomplish this objective, the coach/trainer must develop and implement a complete conditioning program that enables players to meet the physical and physiological demands of the game and outshine their performance to achieve success in competition. This study also investigated the effectiveness of aerobic and anaerobic pre-competition training programs on the outcome measures in rugby and soccer players. The effectiveness of maximal aerobic capacity is widely understood in rugby and soccer. In order to achieve success in these sports, players need to possess the necessary power, strength, endurance, acceleration, speed, coordination, and flexibility.

The aerobic capacity of soccer and rugby players to attain and maintain a high level during the preseason and regular season has become paramount [29]. Youcef et al. conducted a study investigating the training effects on anaerobic and aerobic capacities in soccer players [30]. They provided the training twice weekly for twelve weeks and found that aerobic and anaerobic capacities were significantly higher than before training. Similar findings were reported by Caldwell and Peters, who discovered that the maximal aerobic capacity of semiprofessional soccer players was much higher during the other season than at the outset of pre-competition training [29]. Reilly et al. revealed that the maximum oxygen uptake of professional soccer players experienced an increase towards the conclusion of the pre-competition phase [31]. Several research findings suggest that young soccer players exhibit comparable outcomes in terms of their aerobic capacities. Rahkila and Luthanen observed similar maximal aerobic capacity values in Finnish national soccer team players [32]. McMillan and colleagues found that the maximal aerobic capacity of professional youth soccer players experienced an increase following ten weeks of high-intensity aerobic interval training [33]. Research conducted on rugby athletes has demonstrated that the most significant enhancements in aerobic capacity and decrease in skinfold thickness are observed during the initial phase of the training season [34]. During the preseason, professional rugby union players increased their squat strength by 10% and their 20-meter sprint time by 0.2 seconds after eight weeks of preseason training [35]. Non-elite rugby league players exhibited comparable responses to the preseason period. Non-elite rugby league players increased their squat strength by 8% and their 40-yard dash time by 0.1 seconds after eight weeks of preseason training [36]. The results of these investigations indicate that high-intensity aerobic interval training may be efficacious in enhancing the aerobic fitness of soccer and rugby players. These findings also suggest that the preseason is important for athletes to improve their aerobic fitness, strength, and speed.

The pre-competition training works well to improve the strength and endurance among rugby and soccer players. Current research findings demonstrated that anaerobic power increased in rugby and soccer players. The research results aligned with the findings Daniels and colleagues reported. They discovered that small to moderate improvements were observed in maximal bench presses, prone pull-ups, and back squats as a result of seven weeks of preseason training in elite rugby players [10]. Argus et al. reported that professional rugby union players demonstrated an approximate seven per cent increase in anaerobic performance following a four-week preseason period [37]. The impact of short-term preseason training on soccer players was examined by Meckel et al. They reported a negative effect on the anaerobic performance of soccer players due to short-term (five days duration) preseason training [38. In contrast, Rogerson et al. have reported that upon completion of the 4-week training regimen, there were no statistically significant variations in anaerobic power between the two cohorts of football players [39]. Gomes reported that anaerobic power is a complex trait that takes three-month training to develop. Therefore, the training duration utilized in this study may have been optimal for determining rugby and soccer players' anaerobic power [40]. Eight weeks probably provide optimal loading for adaptation, but four weeks may limit adaptation due to insufficient recovery and increasing residual fatigue [41]. Due to the fact that rugby and soccer players are needed to execute short sprints, tackles, doges, scrummaging, and rucking that involve accelerations and decelerations during gameplay, players must be able to perform anaerobic movements intermittently.

The current investigation examined the efficacy of pre-competition training programs that focus on aerobic and anaerobic exercises concerning dynamic balance. The present study's findings demonstrated that dynamic balance improved compared to before and after the aerobic and anaerobic pre-competition training program in rugby and soccer players. This finding regarding dynamic balance is consistent with findings from other studies indicating that anaerobic performance was reduced in soccer players with longer training ages [42]. The dynamic balance is primarily responsible for decreasing the risk of lower extremities injury. Several previous studies using a similar balancing training approach have been done. Hrysomallis reported that six to eight weeks of preseason training has significantly enhanced dynamic balance in professional Australian Rules players [43]. Similar results were seen in other research; for instance, Pancar et al. observed significant changes in dynamic balance in young boys following an anaerobic exercise session [44]. After a six-week training program, Balogun et al. reported improved lower extremity static balance and anaerobic power in sedentary healthy male adults [45]. Maganaris reported significant changes in dynamic balance ability among soccer players after the twelve-week training program compared to the control group [46]. Hrysomallis found that male soccer players benefited from preseason training for dynamic balance that prevents ankle and anterior cruciate ligament injuries. So, it is essential to determine the balance ability of players so that they can train more efficiently and prepare for competitions in a manner that minimizes the danger of injury [47]. In addition, balance is required for the execution of all other skills, such as speed, agility, dodge, coordination, etc. When the players have better abilities, it is easier to balance their motions. This demonstrated that all these abilities and balances are interdependent. Erkmen et al. demonstrated that young adult soccer players have a significant correlation between dynamic balance and anaerobic endurance. According to the study, activities requiring anaerobic power may reflect the ability to maintain stability during dynamic balance [48].

This research aimed to investigate the effectiveness of pre-competition training involving aerobic and anaerobic exercises on eye-hand coordination. In the present study, hand-eye coordination was better in rugby than soccer players. As the effect of pre-competition training intervention, eye-hand coordination was improved in rugby and soccer players. Coordination of the eyes and hands influences timing, reaction speed, agility, body control, and dynamic balance. Numerous sports-related studies have demonstrated that athletes have superior eye-hand coordination compared to non-athletes. In addition, research has demonstrated that it is a characteristic that differentiates players' expertise levels [49,50]. Millard et al. reported that first-division rugby players have superior hand-eye coordination compared to non-athletes [51]. Paul et al. demonstrated that players' eye-hand coordination and sports skills improved after the training [52]. The phenomenon of heightened hand-eye coordination and the cultivation of adaptable visual attention, decision-making, and action execution in athletes is common in open-skill sports like rugby and soccer. This can be attributed to the need for athletes to process information in a dynamic and unpredictable environment. Such skills are not typically observed in non-athletes [53]. Eye-hand coordination improves a player's ability to execute complex movements, respond to environmental inputs, and create fluent movement. Eye-hand coordination is important for many sports, including rugby and soccer. Training can improve eye-hand coordination and lead to improved performance in these sports.

LIMITATIONS

In terms of the current study's limitations, this study did not include factors such as history, hours of training, playing duration, and playing position. The field setting was adopted to measure the player's aerobic fitness, anaerobic power, dynamic balance, and visual motor coordination. Sample size was small in this study. The study did not analyze players who may have to switch games due to an extended absence, which could have skewed the findings. No female players were included; the study's findings cannot be generalized to both gender of players. In this study, participants were selected from only rugby and soccer games. To generalize the study findings, a larger and more diverse population from different sports, including female athletes and different sports individuals, should be studied using different functional tests. Future research could explore long-term training effects, investigate different training protocols, and include female athletes to expand the scope of the study. Additionally, a follow-up study could assess the transferability of the training effects to real-game performance and competitive success.

CONCLUSION

The study hypothesis was confirmed that an eight-week aerobic and anaerobic pre-competition training program, three times a week, can get effective results in maximal aerobic capacity, anaerobic capacity, dynamic balance, and visual motor coordination among elite rugby and soccer players. Aerobic and anaerobic workouts during the pre-competition period have the potential to improve aerobic capacity, anaerobic capacity, dynamic balance, and visual motor coordination, particularly in male rugby and soccer players. It is recommended that sports trainers, sports scientists, team coaches, and fitness instructors design aerobic and anaerobic training for athletes during the pre-competition phase, as this type of training may be an effective method to enhance performance during competition.

Conflicts of Interest: The authors declare that they have no conflict of interest. Each of the authors has read and concurs with the contact in the final manuscript. This study did not receive financial support. All authors read and approved the final version of the manuscript.

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