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Comparison of physiological characteristics and physical performance measures among athletes from random intermittent dynamic type sports

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim The physiological characteristics [Maximum oxygen uptake (VO2max), Peak Inspiratory Flow (PIF), Peak Expiratory Flow (PEF), Force Vital Capacity (FVC)] and physical performance measures [power, dynamic balance, flexibility, agility, and speed] are the key determinants in random intermittent dynamic type sports which enable the players to address decisive situations. Therefore, the purpose of this study was to determine the physiological and physical measures among athletes from random intermittent dynamic type sports.

Material and Methods A comparative cross-sectional study with 56 male athletes, 14 in each sport (Rugby, Soccer, Volleyball, Futsal) was conducted. The mean age was 23.59±4.27 years, body mass 71.96±10.10 kg, body height 174.71±6.82 cm, and BMI 23.51±2.38 kg/m^2. Physiological characteristics and physical performance measures were measured by using dry spirometer and functional tests respectively. A one-way analysis of variance test was performed to determine differences between athletes for physiological characteristics and physical performance measures.

Results There were significant differences for physiological characteristics (VO2max, PIF, PEF, and FVC) and physical performance measures (power, dynamic balance, flexibility, agility and speed) in athletes from random intermittent dynamic type sports.

Conclusions These findings showed significant differences for physiological characteristics and physical performance measures among athletes from random intermittent dynamic type sports. These measures are responsible for improving physiological and physical performance to achieve top athletic achievements. While constructing the training program, morphological and functional factors should be considered based on the game's nature.

Keywords: VO2max, power, dynamic balance, flexibility, agility.

Introduction

Sports like rugby, soccer, volleyball, and futsal belong to the random intermittent dynamic type sports. In these sports, skillful movement activity patterns are selected randomly at various intensities during the game [1]. Many movements and skills are involved in playing these games, and a high level of physical demands is required [2]. Physical performance abilities (strength, speed, agility, flexibility, dynamic balance) and other physiological abilities are essential components in such sports [3].

Physiological characteristics changed as an effect of regular participation in sporting activities. People who engage in at least 30 minutes of moderate-intensity exercise most days have a 20%-30% lower risk of all causes of mortality than those who do not [4]. Random intermittent dynamic sports performance depends mostly upon the aerobic component that maintains a high intensity throughout the game, delays fatigue and achieves a faster/better recovery between the matches [5]. The aerobic capacity is usually expressed in maximal oxygen uptake (VO2max). Aerobic capacity is the most reliable and valid physiological measures in exercise physiology and is also commonly used as an indicator of cardiovascular fitness during athletic performance [6]. In theory, the higher the maximum oxygen uptake better the performance — physical performance component directly related to the changes in physiological characteristics in athletes.

Physical performance is described as the capacity to engage in physical activities, ranging from activities of daily living to more complicated activities that require a combination of sports-specific skills [7]. Many physical performance tests usually measure physical performance objectively [8]. The physical performance components that affect overall performance in random intermittent dynamic-type sports include strength, endurance, power, speed, agility, and flexibility [9]. Sports participation results have been significantly

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positively correlated with physical performance components [10].

Regular monitoring and measuring athlete performances is a challenging phase in any sports training and selection process of athletes because the training load, the training schedule, and the physical "load" during training are all highly dependent on the athletes' level of fitness [11]. Regular monitoring and measuring physiological characteristics and physical performance during training and athletes' selection may provide valuable information to physical educationists, sports scientists, and coaches. This study aims to compare the physiological and physical measures among athletes from random intermittent dynamic type sports. The hypothesize stated as that there would be significant differences across athletes from random intermittent dynamic type sports for physiological and physical performance measures.

Materials and Methods

Participants

A total of 56 male participants from Ba and Lautoka region, 14 in each sport (Rugby, Soccer, Volleyball, Futsal), participated voluntarily in this study. There average age was 23.59±4.27years, body mass 71.96±10.10kg, height 176.71±6.82cm, and body mass index (BMI) 23.51±2.38 kg/m^2 (tabl. 1). The inclusion criterium had at least three-year playing experience at the university level. Exclusion criteria included participants with cardiorespiratory disorder and lower extremity musculoskeletal injury recorded in the last three months.

Research Design

This was a comparative cross-sectional study. All the tests were conducted during morning session in the physical education department's laboratory and indoor sports arena at Fiji National University, Fiji. This study was approved by the Fiji national university human research ethics committee with the approval (FNU-HREC-22-14) on 14th March 2022. All participants sign a written consent form before participating in this study.

Outcome Measures:

Anthropometric characteristics

Body height and body mass were measured by using stadio-cum-weighing scale with the participant standing in an erect position with bare feet.

Physiological Performance analysis

VO2max: The Multistage Fitness Test (MSFT) was used to measure the maximal oxygen uptake (VO2max). The MSFT was created in the early 1980s to assess the maximum oxygen consumption in children, adolescents, and adults. The test was developed to offer a useful and cost-effective prediction of maximum oxygen consumption in a field environment. According to research, the MSFT test is a reliable predictor of maximum oxygen uptake [12]. Participants in the MSFT test were instructed to run in a shuttle pattern toward and away from 20-meter areas in response to an audio cue (beep). The speed in the first minute was 8.5 km/hr and increased by 0.5 km/hr every minute — the participants were required to complete a level before the next beep was produced. Participants should complete as many shuttles as they can. If a participant fails to maintain the recommended pace for two consecutive shuttles or withdraws from the test owing to exhaustion, the test is terminated. Flouris et al. [13] formula was used to determine the maximum oxygen uptake.

Peak Inspiratory Flow (PIF), Peak Expiratory Flow (PEF), and Force Vital Capacity (FVC) were measured with the help of a portable electronic spirometer used to measure physiological measures s. Tests were conducted in laboratory settings. Participants demonstrated the experimental process and allayed their concerns. The participant conducted forced inhalation and exhalation maneuvers as advised by the American Thoracic Society while sitting on a chair with their nose plugged. Each participant used the spirometer's mouthpiece tube to make a maximal inhalation followed by a vigorous expiration until all air had been ejected. Each participant took a minimum of three tests, with the best three being used for further research. Verbal encouragement and motivation were used to get the best possible inhalation and expiration attempts from the participants. The maneuver was finished with a maximal inhale by the individual. The required data

Table 1. Anthropometric characteristics among Athletes from Random Intermittent Dynamic Type Sports.

Sports	N	Age (Year) Mean±SD	Body Mass (kg) Mean±SD	Body Height (cm) Mean±SD	BMI kg/m^2 Mean±SD
Rugby	14	24.21±3.99	79.31±9.96	179.07±4.40	24.69±2.63
Soccer	14	23.21±4.00	72.51±12.01	174.71±8.06	23.69±2.95
Volleyball	14	23.00±3.91	69.00±7.62	173.29±6.84	22.93±1.65
Futsal	14	23.93±4.96	67.01±4.33	171.79±5.06	22.72±1.41
Total	**56**	**23.59±4.27**	**71.96±10.10**	**174.71±6.82**	**23.51±2.38**

were extracted from the device that was displayed on the screen.

Physical Performance analysis

Explosive Power: The explosive power of lower limbs was measured by the double-leg vertical squat jump test. The participants were asked to stand firmly on the ground next to the Vertec, extend their arms as high as possible, and touch the highest vane. The stance height was recorded as being at this height. Participants jumped and touched the highest possible vane. The maximum vertical jump was determined using the difference between the standing reach and maximum jump height, and the result was converted to lower leg muscle explosive power. Each participant made three attempts, and the average of three jumps was calculated and used for further analysis [14].

Dynamic Balance: A functional Y Balance Test (YBT) was used to test dynamic balance. The YBT was developed to assess dynamic balance in the anterior, posterolateral and posteromedial planes. The YTB have an excellent interrater test-retest reliability (ICC=0.80-0.85) [15]. To execute the test, the participant was asked to stand barefoot with one leg in the middle of the platform and reach with another leg three times in the anterior, posterolateral, and posteromedial directions. Each trial's greatest reach distance was recorded. The trial had to be rerun if a person stumbled, raised his heel off the platform, or used any support. The absolute reach distance, which was used to analyze the overall performance of the YBT test was obtained by dividing the total of the maximal reach distance in each direction by three trials [15].

Flexibility test: The lower back and hamstring flexibility was measured using the sit and reach test. A standard sits and reaches box (40 X 40 X 34.5 cm) was used for the test. A scale was fixed on the top of the box. The participants were seated on the floor with their feet in a dorsiflexion position and knees fully extended shoulder-width apart. One hand was placed on the other hand, and the participant steadily extended their arms as forward as he could. At maximum reach, he holds for three seconds. The reach distance was recorded. The average score of three trials was used for further analysis in centimeters [16].

Agility Test: The agility was measured by the Illinois agility run test that Getchell developed in 1979 [17]. The test was carried out in the 10 x 5-meter defined area using eight cones. Four more cones were placed in the centre at a uniform spacing of 3.3 meters. The participant was told to lie down before the starting cone. When the command "GO." was given, the participant stood up and immediately sprinted 10 meters in front, 10 meters back, 10 meters in a zigzag pattern around four cones, and then 10 meters forward and back again toward the finishing cone. Time (in seconds) was recorded from the start to the end of the run [17].

Speed Test: The participant's speed was determined using a 20-meter dash test. This examination is a trustworthy predictor of acceleration, speed, and agility. Cones, a stopwatch, a measuring tape, and a floor with a 20-meter designation were required for this test. For this test, a maximum sprint of 20 meters will be necessary. The participant should run as fast as he can to finish this test. The two trails' average time (in seconds) to cover the 20-meter distance was recorded [18].

Statistical Analysis

Before analysis, the data were examined for missing data, outliers, normality using the Shapiro-Wilk test and homoscedasticity using the Bartlett criterion. It was found that the data for all measures were homoscedastic and had a normal distribution. Parametric tests were applied to analyze the data for inferential statistics. A one-way analysis of variance (ANOVA) test was performed to determine differences among athletes from random intermittent dynamic-type sports for physiological and physical performance measures s. Partial eta-squared was determined to see the effect. Cohen's d also calculated the effect sizes of the difference between groups. A significance level of 0.05 was used for the comparison between athletes from random intermittent dynamic-type. All analyses were completed in SPSS v-26 software (IBM Co., Armonk, NY, USA).

Results

Table 2 compares rugby, soccer, volleyball, and futsal players for physiological characteristics (VO2max, PIF, PEF, FVC). There were significant differences for VO2max ($F=65.84$, $p=0.00$, $\eta p2=.79$), PIF ($F=4.12$, $p=0.01$, $\eta p2=.19$), PEF ($F=100.27$, $p=0.00$, $\eta p2=.85$), and FVC ($F=16.50$, $p=0.00$, $\eta p2=.49$) for random intermittent dynamic type sports. Further, Post hoc (Tukey) was also applied to see where significant differences existed, and the effect size was also determined by Cohen J.

Table 3 shows the multiple comparisons among rugby, soccer, volleyball, and futsal players for physiological characteristics (VO2max, PIF, PEF, and FVC). The VO2max, PEF, and FVC show significant differences for multiple comparisons among athletes from random intermittent dynamic type sports, and these differences had a large effect size. Whereas PIF shows that rugby players have a large significant effect on soccer and volleyball players, soccer players have an insignificant effect on volleyball players, and futsal players have a small insignificant effect on soccer and rugby players while having a large significant effect on volleyball players.

Table 4 compares rugby, soccer, volleyball, and

Table 2. Changes in the body composition of the competitive runners before and after the tests

Dependent Variable	Players	Mean±SD	95% CI for Mean Lower	Upper	F	Sig.	Partial eta-squared
VO2max	Rugby	52.69±2.05	51.50	53.87	65.84	0.000*	0.791
	Soccer	47.86±1.17	47.18	48.53			
	Volleyball	43.20±1.39	42.40	44.00			
	Futsal	36.02±5.94	32.59	39.45			
PIF	Rugby	106.46±16.24	97.09	115.84	4.12	0.011*	0.192
	Soccer	118.45±21.80	105.86	131.04			
	Volleyball	128.91±17.92	118.56	139.26			
	Futsal	110.58±16.46	101.08	120.08			
PEF (L)	Rugby	4.00±.30	3.82	4.22	100.27	0.000*	0.849
	Soccer	3.41±.10	3.35	3.47			
	Volleyball	2.84±.22	2.73	2.97			
	Futsal	2.30±.38	2.08	2.52			
FVC (L)	Rugby	4.56±0.39	4.33	4.78	94.48	0.000*	0.487
	Soccer	3.76±0.18	3.65	3.86			
	Volleyball	3.28±0.21	3.16	3.40			
	Futsal	2.75±0.34	2.55	2.95			

PIF – Peak Inspiratory Flow, PEF – Peak Expiratory Flow, FVC – Force Vital Capacity; * - The mean difference is significant at the 0.05 level.

Table 3. Post-Hoc (LSD) and effect-size Analysis of physiological output values of athletes from random intermittent dynamic type sports.

Dependent Variable	(I) Players	(J) Players	Mean Difference (I-J)	Std. Error	Sig.	Effect Size	
VO2max	Rugby	Soccer	4.83*	1.24	.000	1.00	Large
		Volleyball	9.49*	1.24	.000	1.00	Large
		Futsal	16.66*	1.24	.000	1.00	Large
	Soccer	Rugby	-4.83*	1.24	.000	1.00	Large
		Volleyball	4.66*	1.24	.000	1.00	Large
		Futsal	11.84*	1.24	.000	1.00	Large
	Volleyball	Rugby	-9.49*	1.24	.000	1.00	Large
		Soccer	-4.66*	1.24	.000	1.00	Large
		Futsal	7.18*	1.24	.000	1.00	Large
	Futsal	Rugby	-16.66*	1.24	.000	1.00	Large
		Soccer	-11.83*	1.24	.000	1.00	Large
		Volleyball	-7.18*	1.24	.000	1.00	Large
PIF	Rugby	Soccer	-11.99	6.90	0.008	1.00	Large
		Volleyball	-22.45*	6.90	0.002	1.00	Large
		Futsal	-4.12	6.90	0.553	0.38	Small
	Soccer	Rugby	11.99	6.90	0.008	1.00	Large
		Volleyball	-10.46	6.90	0.135	0.10	Very Small
		Futsal	7.87	6.90	0.259	0.38	Small

Table 3 (continued)

Dependent Variable	(I) Players	(J) Players	Mean Difference (I-J)	Std. Error	Sig.	Effect Size	
	Volleyball	Rugby	22.45*	6.90	0.002	1.00	Large
		Soccer	10.46	6.90	0.135	0.10	Very Small
		Futsal	18.33*	6.90	0.01	1.00	Large
	Futsal	Rugby	4.12	6.90	0.553	0.38	Small
		Soccer	-7.87	6.90	0.259	0.38	Small
		Volleyball	-18.33*	6.90	0.01	1.00	Large
PEF (L)	Rugby	Soccer	.59*	0.10	.000	1.00	Large
		Volleyball	1.16*	0.10	.000	1.00	Large
		Futsal	1.70*	0.10	.000	1.00	Large
	Soccer	Rugby	-.59*	0.10	.000	1.00	Large
		Volleyball	.57*	0.10	.000	1.00	Large
		Futsal	1.11*	0.10	.000	1.00	Large
	Volleyball	Rugby	-1.16*	0.10	.000	1.00	Large
		Soccer	-.57*	0.10	.000	1.00	Large
		Futsal	.54*	0.10	.000	1.00	Large
	Futsal	Rugby	-1.70*	0.10	.000	1.00	Large
		Soccer	-1.11*	0.10	.000	1.00	Large
		Volleyball	-.54*	0.10	.000	1.00	Large
FVC (L)	Rugby	Soccer	.79*	0.11	.000	1.00	Large
		Volleyball	1.27*	0.11	.000	1.00	Large
		Futsal	1.80*	0.11	.000	1.00	Large
	Soccer	Rugby	-.79*	0.11	.000	1.00	Large
		Volleyball	.47*	0.11	.000	1.00	Large
		Futsal	1.01*	0.11	.000	1.00	Large
	Volleyball	Rugby	-1.27*	0.11	.000	1.00	Large
		Soccer	-.47*	0.11	.000	1.00	Large
		Futsal	.53*	0.11	.000	1.00	Large
	Futsal	Rugby	-1.80*	0.11	.000	1.00	Large
		Soccer	-1.00*	0.11	.000	1.00	Large
		Volleyball	-.53*	0.11	.000	1.00	Large

PIF - Peak Inspiratory Flow, PEF - Peak Expiratory Flow, FVC - Force Vital Capacity; * - The mean difference is significant at the 0.05 level.

futsal players for physical performance measures (power, dynamic balance, flexibility, agility, and speed). There were significant differences for power (F=16.50, p=0.00, ηp2=.49), dynamic balance (F=11.78, p=0.00, ηp2=.40), flexibility (F=28.92, p=0.00, ηp2=.63), agility (F=7.45, p=0.00, ηp2=.30) and speed (F=3.86, p=0.01, ηp2=.18) for random intermittent dynamic type sports. Further, Post hoc (Tukey) was also applied to see where significant differences existed, and the effect size was also determined by Cohen J.

Table 5 shows the multiple comparisons among rugby, soccer, volleyball, and futsal players for physical performance measures (power, dynamic balance, flexibility, agility, and speed). The power, dynamic balance, flexibility, agility, and speed show significant differences for multiple comparisons among athletes from random intermittent dynamic type sports. These differences distinguished (large, medium, small, and very small) effect sizes.

Discussion

This study comparing among athletes from random intermittent dynamic-type sports for physical performance measures and physiological characteristics. Multiple comparisons have been

Table 4. Comparison of Physical Performance Measures among Athletes from Random Intermittent Dynamic Type Sports.

Dependent Variable	Players	Mean±SD	95% CI for Mean Lower	Upper	F	Sig	Partial eta-squared
Power	Rugby	1770.43±77.30	1725.80	1815.06	16.50	0.001*	0.487
	Soccer	1632.71±115.73	1565.89	1699.54			
	Volleyball	1541.86±72.73	1499.86	1583.85			
	Futsal	1608.50±81.52	1561.43	1655.57			
Dynamic Balance	Rugby	82.20±3.87	79.97	84.44	11.78	0.012*	0.404
	Soccer	94.06±2.21	92.79	95.34			
	Volleyball	87.96±9.25	82.62	93.30			
	Futsal	91.04±4.08	88.68	93.39			
Flexibility	Rugby	25.14±4.70	22.43	27.86	28.92	0.001*	0.625
	Soccer	16.14±1.88	15.06	17.23			
	Volleyball	16.93±2.64	15.40	18.46			
	Futsal	17.29±1.27	16.55	18.02			
Agility	Rugby	14.15±0.53	13.85	14.46	7.45	0.011*	0.300
	Soccer	15.84±0.79	15.38	16.29			
	Volleyball	15.15±1.56	14.25	16.05			
	Futsal	15.37±0.68	14.98	15.76			
Speed	Rugby	3.31±0.28	3.15	3.47	3.86	0.014*	0.182
	Soccer	3.67±0.42	3.42	3.91			
	Volleyball	3.70±0.26	3.55	3.85			
	Futsal	3.47±0.39	3.25	3.69			

* - The mean difference is significant at the 0.05 level.

Table 5. Post-Hoc (LSD) and effect-size Analysis of physical performance output values of athletes from random intermittent dynamic type sports.

Dependent Variable	(I) Players	(J) Players	Mean Difference (I-J)	Std. Error	Sig.	Effect Size	
Power	Rugby	Soccer	137.71*	33.44	0.00	0.96	Large
		Volleyball	228.57*	33.44	0.00	1.00	Large
		Futsal	161.93*	33.44	0.00	1.00	Large
	Soccer	Rugby	-137.71*	33.44	0.00	0.96	Large
		Volleyball	90.86*	33.44	0.01	0.70	Medium
		Futsal	24.21	33.44	0.47	0.09	Very Small
	Volleyball	Rugby	-228.57*	33.44	0.00	1.00	Large
		Soccer	-90.86*	33.44	0.01	0.70	Medium
		Futsal	-66.64	33.44	0.05	0.63	Medium
	Futsal	Rugby	-161.93*	33.44	0.00	1.00	Large
		Soccer	-24.21	33.44	0.47	0.09	Very Small
		Volleyball	66.63	33.44	0.05	0.63	Medium
Dynamic Balance	Rugby	Soccer	-11.86*	2.09	0.00	1.00	Large
		Volleyball	-5.76*	2.09	0.01	0.83	Large
		Futsal	-8.83*	2.09	0.00	1.00	Large
	Soccer	Rugby	11.86*	2.09	0.00	1.00	Large
		Volleyball	6.10*	2.09	0.01	0.67	Medium
		Futsal	3.03	2.09	0.15	0.68	Medium

Table 5 (continued)

Dependent Variable	(I) Players	(J) Players	Mean Difference (I-J)	Std. Error	Sig.	Effect Size	
	Volleyball	Rugby	5.76*	2.09	0.01	0.83	Large
		Soccer	-6.10*	2.09	0.00	0.67	Medium
		Futsal	-3.07	2.09	0.15	0.21	Small
	Futsal	Rugby	8.83*	2.09	0.00	1.00	Large
		Soccer	-3.02	2.09	0.15	0.68	Medium
		Volleyball	3.07	2.09	0.15	0.21	Small
Flexibility	Rugby	Soccer	9.00*	1.11	0.00	1.00	Large
		Volleyball	8.21*	1.11	0.00	1.00	Large
		Futsal	7.86*	1.11	0.00	1.00	Large
	Soccer	Rugby	-9.00*	1.11	0.00	1.00	Large
		Volleyball	-0.78	1.11	0.48	0.15	Very Small
		Futsal	-1.14	1.11	0.31	0.48	Small
	Volleyball	Rugby	-8.21*	1.11	0.00	1.00	Large
		Soccer	0.78	1.11	0.48	0.15	Very Small
		Futsal	-0.36	1.11	0.75	0.07	Very Small
	Futsal	Rugby	-7.86*	1.11	0.00	1.00	Large
		Soccer	1.14	1.11	0.31	0.48	Small
		Volleyball	0.36	1.11	0.75	0.07	Very Small
Agility	Rugby	Soccer	-1.68*	0.37	0.00	1.00	Large
		Volleyball	-.99*	0.37	0.01	0.62	Medium
		Futsal	-1.22*	0.37	0.00	1.00	Large
	Soccer	Rugby	1.68*	0.37	0.00	1.00	Large
		Volleyball	0.68	0.37	0.07	0.31	Small
		Futsal	0.46	0.37	0.21	0.39	Small
	Volleyball	Rugby	.99*	0.37	0.01	0.62	Medium
		Soccer	-0.68	0.37	0.07	0.31	Small
		Futsal	-0.22	0.37	0.54	0.07	Very Small
	Futsal	Rugby	1.22*	0.37	0.00	1.00	Large
		Soccer	-0.46	0.37	0.21	0.39	Small
		Volleyball	0.22	0.37	0.54	0.07	Very Small
Speed	Rugby	Soccer	-.35*	0.13	0.01	0.39	Small
		Volleyball	-.39*	0.13	0.00	0.52	Medium
		Futsal	-0.16	0.13	0.23	0.12	Very Small
	Soccer	Rugby	.35*	0.13	0.01	0.39	Small
		Volleyball	-0.03	0.13	0.79	0.04	Very Small
		Futsal	0.19	0.13	0.14	0.26	Small
	Volleyball	Rugby	.39*	0.13	0.00	0.52	Medium
		Soccer	0.03	0.13	0.79	0.04	Very Small
		Futsal	0.23	0.13	0.09	0.45	Small
	Futsal	Rugby	0.16	0.13	0.23	0.12	Very Small
		Soccer	-0.19	0.13	0.14	0.26	Small
		Volleyball	-0.23	0.13	0.09	0.45	Small

* - The mean difference is significant at the 0.05 level.

made among rugby, soccer, volleyball, and futsal players for physiological characteristics (VO2max, PIF, PEF, and FVC). The VO2max, PEF, and FVC show significant differences for multiple comparisons among athletes from random intermittent dynamic type sports, and these differences had a large effect size. Whereas PIF shows that rugby players have a large significant effect on soccer and volleyball players, soccer players have an insignificant, very small effect on volleyball players, and futsal players have a small insignificant effect on soccer and rugby players while having a large significant effect on volleyball players. Most researchers have regarded VO2max as the best indicator of aerobic capacity. This single measurement indicates the functional capacities of the cardiovascular and respiratory systems and physiological performance. VO2max is one of the most important factors influencing the success of endurance performance. Different level's players have a distinguished level of VO2max. The hypothesis of this study was accepted as there was significant differences across athletes from sports characterized by random intermittence dynamic activity for physiological characteristics and physical performance measures.

Our findings were consistence with the findings of previous studies. Reilly et al. reported that elite soccer players have exceptional aerobic power with a VO2max range of 55-70 ml/kg/min [19]. There is a variation in aerobic power in soccer players. This variation is due to their playing position, as midfielders have much higher aerobic power levels for outfield players, whilst central defenders have the lowest values. Gabbett indicated that first-grade rugby players have a VO2max range between 45-55 ml/kg/min, whereas second-grade rugby players have 40-49 ml/kg/min [20]. The comparison between playing positions among rugby players showed that back players have greater aerobic power than forward players [21]. Boone et al. [22] found the maximal aerobic power values of 289 professional soccer players playing in the first league of Belgium in 2003-2010 to be 57.7±4.7 ml. kg/min. Mohammadi et al. [23] found the aerobic power of Iranian soccer players to be 52.78±0.98 ml. kg/min. Baroni and junior found that the mean values of VO2max in futsal players were 58.00±6.37 mL/kg/min [24]. Charitonidis et al. [25] revealed that the VO2max values were better in male volleyball players (56.32±6.36 ml/kg/min) than in female volleyball players (44.78±3.65 ml/kg/min). Insufficient aerobic capacity will negatively affect sports performance, especially at the end of the game. It should be observed that the athletes from random intermittent dynamic type sports differ statistically significantly. This suggests that the athletes' physiologies have changed due to the training connected with each sport. Tareq et al. found that the forced vital capacity in soccer players was 90.2±8.8, and in futsal players, 88.5±6.9 [26]. Mazic et al. [27] found that there were significant differences between the control group and other team players for FVC as rugby players (4.89±1.0), soccer players (5.69±1), volleyball players (5.29±1), and control group (5.58±0.6). Ostojic [28] found the FVC of professional soccer players playing in the national first league to be 5.6±0.8 lt. and amateur soccer players to be 5.4±0.9 lt. Tareq et al. [26] found that the peak expiratory flow in soccer players was 98.6±4.8, and in futsal players, 88.9±6.0, and there was a significant difference. A study by the West et al. showed that paralympic rugby players have PIF of 7.14±1.11 and PEF of 6.61±2.54 L/s. [29]. Mazic et al. [27] showed PFI average values for rugby players (9.21±2.23), soccer (10.33±2.51), volleyball (9.25±1.85), handball (9.21±2.23) and control group (11.17±1.43). Taylor et al. [30] reported the PIF 6.50±1.10 PEF 6.32±1.95 l/s in paralympic wheelchair rugby players. PEF 7.7±1.48 experimental group and 6.36±1.61control group for soccer players. The experimental group performed additional inspiratory muscle training for eight weeks with a commercially available respiratory muscle trainer [31]. Bostanci et al. [32] revealed no significant difference between the male (307.32±43.92) and females (304.91±44.81) for peak expiratory flow among athletes.

Comparing physical performance measures (power, dynamic balance, flexibility, agility, and speed) demonstrated significant differences among rugby, soccer, volleyball, and futsal players. The results showed that rugby players have higher power values than the rest, soccer players have higher power values than futsal and volleyball players, and volleyball players have lower power values than the other players. All of them also have significant differences. The power, dynamic balance, flexibility, agility, and speed show significant differences for multiple comparisons among athletes from random intermittent dynamic type sports. These differences have distinguished (large, medium, small, and very small) effect sizes.

Muscular power and strength are key attributes of rugby, soccer, volleyball, and futsal players due to the collision and contact factors of the games. All players must have well-developed power, dynamic balance, flexibility, agility, and speed to cope with the heterogeneous demands of the game [33]. A high level of muscular power rapidly enables players to perform more effectively during rucking, wrestling, tackling, jumping, smashing, sprinting, and changing direction [34]. A study showed that the peak power values of lower leg muscles for rugby players were found as 3603.80±144.63 (watts), and for soccer players, 3386.88±605.52 (watts) [35]. It showed that rugby players have more power than soccer players, consistent with our findings. A study showed that the average squat jump flight was 544.0±35.49 in male futsal players [36]; they also stated that their study showed lower values and further mentioned that these differences can be attributed to varying levels of training and competition [36]. A significant weakness in elastic-explosive strength training, which is essential for futsal play, maybe the cause. Rugby players have a higher degree of flexibility than futsal players, volleyball players, and soccer players. The present study findings identified the differences in sit and reach flexibility test. A study with volleyball players indicated that the average flexibility scores were 17.81±3.42 [37]. Another study reported that the sit-and-reach test score (Flexibility) was 18.21 for volleyball players [3]. These findings were consistence with our findings. Palaniappan & Deivendran [38] reported that stretching parameters have positive effects on jumping performance. Whereas Lee et al. [39] supported that sit and reach test positively correlates with the vertical jump scores. Rugby league "professional" players scored higher on agility tests than amateurs, according to research by Till et al. [40], but they included U14 players. Milanović et al. [41] study revealed no significant differences between soccer players and futsal players for the specific agility test.

Further, they reported that soccer players showed better results than futsal players. A study on volleyball players showed average agility values of 15.11±0.93 [37]. Another study showed that the mean agility score was 18.37 for volleyball players, resulting from the Illinois agility run test [3]. Rugby players can move quickly in attack and defense because speed is frequently cited as an essential physiological trait. Speed has also been connected to match the success and execution of game abilities like tackling [42]. A study showed that rugby back players are faster than forward players compared to 40-meter sprint [43]. Hansen et al. found rugby squad sprint data for 30 m 4.400.25 sec [44]. Crewther et al. [45] found 3.16±0.10 sec for 20 m sprint time for forward rugby players. Ferro et al. [46] demonstrated that the competitive soccer player's average time score was 3.8±0.1 sec for the 20 m speed test and their findings were consistent with others' findings over the 20 m speed test. Cometti et al. [47] reported that professional soccer players were faster than amateurs players compared with a distance of 30 m, but there was no significant difference. Tanyeri and Oncen [48] revealed that the average pre and post 20 m speed test scores were 3.46 0.164 and 3.39 0.162 sec, respectively, for futsal players). A study on volleyball players showed speed average values were 3.31±0.21 [37]. The study findings demonstrated that rugby, soccer, volleyball, and futsal have similar physical performance characteristics. It is unknown whether these differences were brought about by a particular training regimen or physical adaptation to the sports type. A possible explanation for this research findings could be observed differences in physical performance characteristics among players from random intermittent dynamic sports.

This study has some limitations when performing functional tests to measure players' performance—first, this study design. A cross-sectional study design was adopted to conduct this study. There was no cause-and-effect relationship determined. Second, the study recruited only male participants. The generalization of the result is limited. Third, the sample size for the present study was limited. If the sample size is huge, the sampling error will be less. Fourth, few performances assessment tests. Players are more familiar with these tests, which may lead them to perform movements requiring less energy. The physical performance tests (MSFT, VC, PIF, PEF, FVC, vertical jump, YBT, sit and reach Illinois agility, and 20-meter dash) should be used with great caution regarding evaluating rugby, soccer, volleyball, and futsal players' performance. Indoor and outdoor modes of test, time, and location of the test should be considered when generalizing the result of the present study.

Conclusions

This study revealed important information about the effect of various intermittent dynamic activities on physiological characteristics and physical performance measures. There are significant differences among athletes from random intermittent dynamic type sports for physiological and physical performance characteristics. Additionally, this information can be utilized to make training suggestions and monitor athlete's progress afterwards. While constructing the training program, morphological and functional factors should be considered based on the nature of activities.

Conflict of interest

There is no conflict of interest among authors.

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