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Comparison of Yo-Yo Intermittent Recovery Test Level 1 between Guards and Forwards in Basketball Players

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Abstract

- **BACKGROUND AND PURPOSE:** Yo-Yo intermittent tests are frequently used in a variety of sports and research studies to determine physical fitness. Specifically, the Yo-Yo intermittent recovery test was a valid measure of fitness performance in the manner of total covered distance in meters, maximum oxygen consumption in VO_2 Max and levels achieved which is set in the way of increasing speed in kilometer/hour with decreasing time in seconds to accelerate the test to measure and calculate the outcomes of the test. The purpose of the study is to compare the Aerobic endurance fitness using Yo-Yo Intermittent Recovery test level 1 between Guards and Forwards in basketball players. This study helped to measure an individual's ability to repeatedly perform intervals over a prolonged period of time.
- **METHOD:** Participants were explained the procedure and informed consent obtained. 137 participants who were basketball players were taken. Out of which 81 were male and 56 were female basketball players. YYIRT 1 test was performed on them. The test was continued till the participant could continue the test or if the participant gets 2 warning signals simultaneously for not reaching the end point till the beep rings and then it was stopped. Outcome measures used were total distance covered and VO_2 max which was compared between 2 groups of guards and forwards as per their playing positions.
- **Result:** This study showed that there is no significant difference in performance i.e., total distance covered, levels achieved and VO_2 max between guards and forwards basketball players in both genders.
- **Conclusion:** This study showed similar aerobic capacity between Guards and Forwards playing position with of Yo-Yo Intermittent Recovery Test Level-1. This study also found that there were significant differences between both the genders in total covered distance, VO2Max and Levels achieved of YYIRT Level-1.

Keywords: YYIR test level 1, Total covered distance, Levels achieved, VO_2Max, Guards, Forwards, Playing positions, Basketball players.

1. Introduction

The introduction of the Yo-Yo Intermittent (YYI) test as a field test method in the 1990s by the Danish soccer physiologist Jens Bangsbo and his colleagues.[1, 2], an evolution of the Yo-Yo test family has occurred. Yo-Yo intermittent recovery test is the field test method which is having repeated shuttles in pre-measured field with recovery phase in it where the participant is set to be recovered from shuttle and get ready for the next shuttle. Today, Yo-Yo test variants are extensively used to assess physical fitness in different sports and populations.[2,3]

There are three variations of the Yo-Yo intermittent recovery test: level 1, level 2 and the sub-maximal test. These variations contain Yo-Yo intermittent recovery test level 1, Yo-Yo intermittent recovery test level 2, Yo-Yo intermittent endurance test level 1, Yo-Yo intermittent endurance test level 2, Yo-Yo endurance test level 1 and lastly, Yo-Yo endurance test level 2.[4]

The Yo-Yo intermittent recovery level 1(YYIR1) focuses on an individual's ability to repeatedly perform high-intensity aerobic work.[5] The Yo-Yo intermittent recovery level 2 (YYIR2) test examines the capacity to perform intense intermittent exercise with a large anaerobic component in combination with a significant aerobic contribution. [6]

The sub-maximal yo-yo intermittent recovery test was developed as a method of monitoring performance during competitive periods (e.g., in-season), injury rehabilitation, or individuals who may struggle with performing the maximal tests.[4, 7] Here we are focusing on the yo-yo intermittent recovery test level 1.

The Yo-Yo Intermittent Recovery Test Level 1 test was designed to measure an athlete's VO2 Max which is the maximum or optimum rate at which the heart, lungs and muscles can effectively use oxygen during exercise, used as a way of measuring a person's individual aerobic capacity. Since then, it has established itself as one of the most commonly used aerobic field tests. So, this is a valid and reliable predictor of VO2 Max amongst athletes from various sports and competition-levels.[6]

The YYIR1 is also focused for athletes who possess lower aerobic capacity and this level begins at 10km/hr. Performances in the YYIR tests for young athletes have also been shown to improve with increases in age.[3, 4, 5, 6]

However, this may be more specifically related to biological maturity rather than chronological age though it is debatable even the maximum oxygen consumption regarding the fitness levels with the age factor are also sometimes debatable.[8,9] Regardless, YYIR tests have also been demonstrated to be a more sensitive measure of performance changes than maximum oxygen uptake (VO2 max).

Yo-Yo Intermittent Recovery Test Level 1 involves running between two markers 20 meters apart, following audio cues which dictate the running speed required. After each 40 meters run, the participants have an active break of 10 seconds before running 40 meters again. At regular intervals, the required running speed increases. The test continues until the participants are no longer able to keep up with the required pace.[9, 10]

It is becoming a popular test for many team sport athletes, with even the Indian cricket team using it as a selection criteria. The Australian football draft combine have replaced the beep test on their testing program with the yo-yo test, and we may see this happen more as the yo-yo test is seen more specific for the intermittent type field running sports.[10]

Reliability: Reliability would depend on how strictly the test is run, and the previous practice allowed for the subject. Moreover, even a test with sufficient validity and reliability will still have some degree of error/inconsistency, but understanding how much is a crucial part of the data analysis.[8]

The good performance and better results in YYIR test level 1 can be achieved by understanding the test properly, repeating intermittent running practice, resistance training, high-intensity interval training. Technical training regarding with the beep sound shuttle running test and weekly test sessions will also help to improve physical ability and fitness in the body and mental awareness. It helps to evaluate the different physical capacities in individuals and their sensitivity to training under the Yo-Yo intermittent recovery test level 1.[10,11,12]

Basketball is an intermittent sport which the players need to involve physical fitness ability, precision motor skill, team tactics, and individual and group motivation. The basketball players can go anywhere freely in the court where it divides into upper zone and lower zone and therefore, they may need to change in direction together with dribbling, jump shot and passing on even or hard surfaces. All of the skills above required the players to have great joint acceleration from jump landings and cutting manoeuvres.[13]

Therefore, many of the basketball players were trained to run, jump and landing more compared with the athletes of other sports. The players required to reproduce high intensity sprints, they also need to be strong and powerful, run fast, agile and keep running for extended periods (high aerobic endurance). The physiological demands of the game of basketball may also be determined by the playing position, level of play, the officiating style of the referee and the tactics used. In basketball, playing 5 and substitute 7 players are there in which they are divided in 3 playing positions which are guard, forward and center positions.[13]

Through the evolution of basketball over time three playing positions were defined: guard, forward and center; and each has its own characteristics and role in the game. The nature of each position is reflected in the anthropometric, situational and functional peculiarities of the players. The players in center positions move mostly near the basket, and with their body domination they perform jumps and movements in the area, while on the other hand, the guards have an important role in the organization of the game and activities in the external position. Forwards are tasked to support the guards in the offense and the centers in the defense, thereby their role is a little more complex. Due to the different roles and tasks that must be manifested in the game, the players are also different according to their physiological aspect. The energy systems that are involved are different for each playing positions. So, the maximum oxygen consumption varies from position to position.[14]

So, in this study, guards and forward position players are included as keeping nature of the game in count. Male and Female both guard players as well as Male and Female both forward players are included in this study to check the fitness ability by measuring the YYIRT Level- 1.

In YYIRTL 1, the heart rate increases progressively during test, thus reflecting an increase in their VO2max. Test is therefore stimulating the aerobic system maximally as well as activating the anaerobic system as the muscle lactate concentration at the end of the test noted higher in the YYIRT level -1[1]. Also, a higher average rate of muscle glycogen utilization reported during the Yo-Yo IR test level 1 suggests that the rate of glycolysis is more pronounced during the Yo-Yo IR1 test. So, players playing positions and levels of playing in both genders regarding the intermittent sports like football and basketball showed the variations in aerobic as well as anaerobic fitness performance.[1] Therefore, need of the study is to compare the aerobic capacity YYIRT Level-1 of basketball players between forward and guard playing positions.

2. Materials and Methodology:

1. **STUDY DESIGN:** Cross Sectional Study
2. **SAMPLING METHOD:** Purposive Sampling
3. **STUDY SETTING:**
   - **i.** Majuragate Basketball Academy, Surat, Gujarat.
   - **ii.** Adajan Sports Complex, Surat, Gujarat.
   - **iii.** Sarfaraz school of basketball, Surat, Gujarat.
4. **SAMPLE SIZE:**

Formula: sample size estimation was 190 samples as per our initial pilot study.

$\alpha = 0.05$
$\beta = 0.80$
$d = 0.40$

Due to Covid-19 situation, only 137 samples were collected

a. 81 Male Basketball Players
b. 56 Female Basketball players

5. Study Subjects:

i. Competitive basketball players who are playing at guard and forward positions between 18 to 30 years of age.
ii. Gender - Male and Female players

6. STUDY DURATION: 2 years.

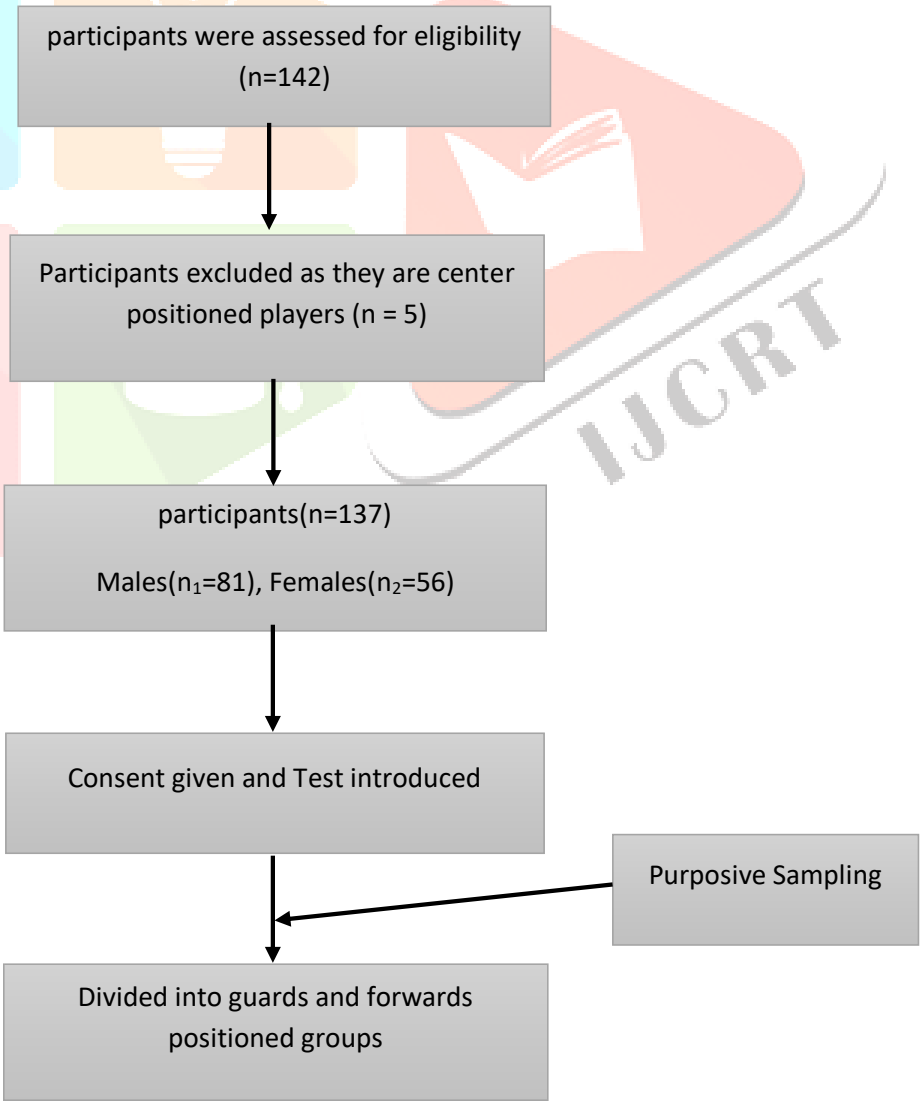
7. Inclusion Criteria:

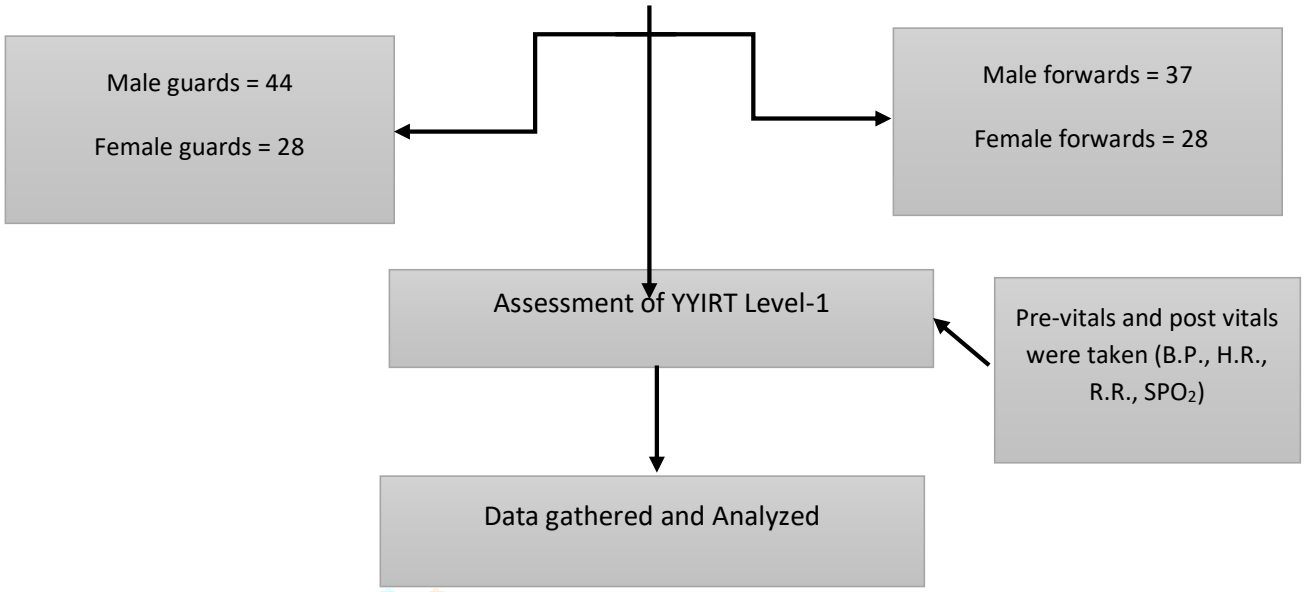
i. Years of playing basketball - Minimum 3 or more years of playing competitively.
ii. Participated at – Club, District, State, National and University levels.

8. Exclusion criteria:

i. Participants with any musculoskeletal and/or neuro-muscular Problems.
ii. Participants with any respiratory injury and cardiovascular disease.
iii. Participants with any associated systemic involvement.

Methodology flow chart





9. Material/Methodology and plan of Study: -

- **MATERIALS AND APPARATUS:**

- Flat and non-slip surface, at least 30m long.
- Measuring tape of at least 20 meters.
- Marker cones (Big cones and small cones).
- Audio CD or mp3
- CD or mp3 player, Loud speakers.
-Data recording sheets.
- Pen, Pencil, Paper, Writing pad, Cuff sphygmomanometer, Stethoscope, Pulse oximeter, Chairs.
- Clothing: comfortable loose-fitting clothing, running shoes with good grip.
- Drink Bottle: some athletes may wish to drink in their recovery area during the yo-yo intermittent tests for occasional small drinks to keep hydrated.

Methodology:

137 male and female guard and forward positioned basketball players of minimum participation in school / club level were recruited. They were informed about the nature and course of the study and gave their consent to participate in the research conducted on their basketball court itself. Written ascent was given in writing followed by their consent to participate in this study. The research proposal was approved by the ethics committee of D.Y PATIL Deemed to be UNIVERSITY, School of Physiotherapy, Navi Mumbai.

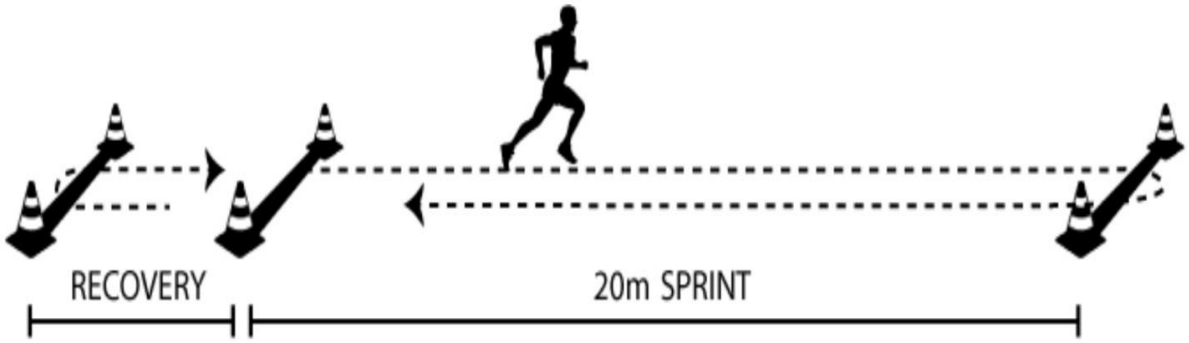
Test Procedures:

Subjects were acquainted with all test procedures before starting of data collection. The basketball players were divided into two groups as per their playing positions. Forward positioned basketball players (Male and female both) and Guard positioned basketball players (Male and female both). Pre and post vitals of both the groups were taken, fitness ability performance in YYIRT Level-1 were taken.

In this test marker cones were used to mark out two lines 20 meters apart as per the diagram. The subjects started with their foot behind of the lines and begin running when instructed. They continued running between the two lines, turning when signalled by the recorded beeps. After each minute or so, the pace got quicker. If the line was not reached in time the subject must run to the line turn and try to catchup with the pace within 2 more 'beeps'. The test was stopped if the subject failed to catch up with the pace within the two ends.

Course layout:

Agility marker cones and saucer cones were used to mark out the desired course. For the intermittent versions, three parallel lines were needed, two 20 meters apart and another line another 5m (recovery) away from the starting end.



Preparations: -

The participants were adequately prepared well-rested, hydrated and fuelled, and familiar with the test procedure and motivated to perform maximally. Clear and standardized instructions about the test were given and what was expected of them including the importance of keeping in time to the recording and completing the full 20m run. Pre-vital signs, Post-vital signs (Immediate vitals and After 3 minutes Vital signs) had been taken to check the vital signs were at normal levels or not.

Verbal Instructions for the Yo-Yo Test: -

- To ensure good reliability for conducting the yo-yo test, consistent instructions were provided to the participants prior to conducting the test.
- Standard script which is given below to use when explaining and introducing the test, particularly for those performing the test for the first time.

Introducing the test:

- "You will be performing the yo-yo intermittent recovery test level 1."
- "The aim of the test is to run as many times as possible back and forth between the markers, following the speeds indicated by the signals on the recording."
- "After each back and forth run, you have ten seconds to jog around the marker placed behind the starting line."
- "It is important that you come to a complete stop at the starting line before you start the next run."
- "The running speed is quite slow in the beginning, but increases rapidly as the test progresses. An increase in speed will be indicated."

- "The first time that you are unable to complete the back and forth run within the given time, you will receive a warning. The next time it occurs, your test is over."
- "Your final speed level, as well as the number of back-and-forth shuttles at that level, is recorded as your score."
- "This is a maximal test, at the end it will be very tiring, and you will need to push yourself as hard as you can to get your best score." "Do your best and good luck!"

Starting the Test: -

All participants should line up along the starting line. The athletes start with a foot behind the starting line, and begin running when instructed by the audio recording. The athlete turns when signalled by the recorded audio beep at the line 20 meters away, and returns to the starting point. For the endurance test, the athletes continue running in time with the audio signals with no rest period. For the intermittent tests, they walk or jog to the next line and back to come to a complete stop at the starting line again, before starting off with indicated.

During the test:

For the intermittent tests, there is an active recovery period of 5 or 10 seconds between every 40 meters run, during which the subject must walk or jog to the next line and return to the starting point. At regular intervals, the running speed will increase, as indicated on the recording.

Finishing the test:

The participants must continue for as long as they can. Some of the participants will choose to stop when they have reached their physical limit. For others, one should need to give a warning as they drop behind the required pace or make one of the errors listed below. On the second infraction one should pull them out of the test.

One should give a warning when the participant;

- Starts the run before the audio signal.
- Does not reach either line before the audio signal.
- Turns without touching or going over the line (therefore running short).
- Does not come to a complete stop before starting the next 40m run

Outcome Measure:

Total distance is much simpler to understand, calculate and widely used, whereas level achieved is more complex as the test begins at level 5 and then skips to level 9 at the beginning.

1. Total Distance

This is the simplest, most common, and perhaps the most reliable method of reporting YYIR test performance.

To calculate total distance, the simplest method is to record the number of shuttles completed by the participant and then multiply that number by 40 (40 = 2 x 20m shuttles [the run from cone B to cone C = 20m, then run back from cone C to cone B = 20m]).

For example, if an athlete performs 30 shuttles, this number can then be multiplied by 40 to calculate their total distance (e.g., 30 x 40 = 1,200m)

2. Level Achieved

To calculate the levels which are achieved by the player is according to the speed is one of the ways to evaluate the test result. (5,9,11,12,13,14 to 23)

It is calculated as the table which is given below;

Yo-Yo Intermittent Recovery Test - Level 1

Speed Level	Shuttle No.	speed (km/hr)	level time (s)	accumulated shuttle dist (m)	Cumulative Time* (s)	Approx Vo2max (mL/min/kg)
5	1	10	14.4	40	00:24	36.74
9	1	12	12.5	80	00:46	37.07
11	1	13	11.1	120	01:07	37.41
11	2	13	11.1	160	01:29	37.74
12	1	13.5	10.7	200	01:49	38.08
12	2	13.5	10.7	240	02:10	38.42
12	3	13.5	10.7	280	02:31	38.75
13	1	14	10.3	320	02:51	39.09
13	2	14	10.3	360	03:11	39.42
13	3	14	10.3	400	03:31	39.76
13	4	14	10.3	440	03:52	40.10
14	1	14.5	9.9	480	04:12	40.43
14	2	14.5	9.9	520	04:32	40.77
14	3	14.5	9.9	560	04:51	41.10
14	4	14.5	9.9	600	05:11	41.44
14	5	14.5	9.9	640	05:31	41.78
14	6	14.5	9.9	680	05:51	42.11
14	7	14.5	9.9	720	06:11	42.45
14	8	14.5	9.9	760	06:31	42.78
15	1	15	9.6	800	06:51	43.12
15	2	15	9.6	840	07:10	43.46
15	3	15	9.6	880	07:30	43.79
15	4	15	9.6	920	07:50	44.13
15	5	15	9.6	960	08:09	44.46
15	6	15	9.6	1000	08:29	44.80
15	7	15	9.6	1040	08:48	45.14
15	8	15	9.6	1080	09:08	45.47
16	1	15.5	9.3	1120	09:27	45.81
16	2	15.5	9.3	1160	09:47	46.14
16	3	15.5	9.3	1200	10:06	46.48
16	4	15.5	9.3	1240	10:25	46.82
16	5	15.5	9.3	1280	10:44	47.15
16	6	15.5	9.3	1320	11:04	47.49
16	7	15.5	9.3	1360	11:23	47.82
16	8	15.5	9.3	1400	11:42	48.16
17	1	16	9	1440	12:01	48.50
17	2	16	9	1480	12:20	48.83
17	3	16	9	1520	12:39	49.17
17	4	16	9	1560	12:58	49.50
17	5	16	9	1600	13:17	49.84
17	6	16	9	1640	13:36	50.18
17	7	16	9	1680	13:55	50.51
17	8	16	9	1720	14:14	50.85
18	1	16.5	8.7	1760	14:33	51.18
18	2	16.5	8.7	1800	14:52	51.52
18	3	16.5	8.7	1840	15:10	51.86
18	4	16.5	8.7	1880	15:29	52.19
18	5	16.5	8.7	1920	15:48	52.53
18	6	16.5	8.7	1960	16:07	52.86
18	7	16.5	8.7	2000	16:25	53.20
18	8	16.5	8.7	2040	16:44	53.54
19	1	17	8.5	2080	17:03	53.87
19	2	17	8.5	2120	17:21	54.21
19	3	17	8.5	2160	17:39	54.54
19	4	17	8.5	2200	17:58	54.88
19	5	17	8.5	2240	18:16	55.22
19	6	17	8.5	2280	18:35	55.55
19	7	17	8.5	2320	18:53	55.89
19	8	17	8.5	2360	19:12	56.22
20	1	17.5	8.2	2400	19:30	56.56
20	2	17.5	8.2	2440	19:48	56.90
20	3	17.5	8.2	2480	20:07	57.23
20	4	17.5	8.2	2520	20:25	57.57
20	5	17.5	8.2	2560	20:43	57.90
20	6	17.5	8.2	2600	21:01	58.24
20	7	17.5	8.2	2640	21:19	58.58
20	8	17.5	8.2	2680	21:38	58.91
21	1	18	8.0	2720	21:56	59.25
21	2	18	8.0	2760	22:14	59.58
21	3	18	8.0	2800	22:32	59.92
21	4	18	8.0	2840	22:50	60.26
21	5	18	8.0	2880	23:08	60.59
21	6	18	8.0	2920	23:26	60.93
21	7	18	8.0	2960	23:44	61.26
21	8	18	8.0	3000	24:02	61.60
22	1	18.5	7.8	3040	24:19	61.94
22	2	18.5	7.8	3080	24:37	62.27
22	3	18.5	7.8	3120	24:55	62.61
22	4	18.5	7.8	3160	25:13	62.94
22	5	18.5	7.8	3200	25:31	63.28
22	6	18.5	7.8	3240	25:48	63.62
22	7	18.5	7.8	3280	26:06	63.95
22	8	18.5	7.8	3320	26:24	64.29
23	1	19	7.6	3360	26:42	64.62
23	2	19	7.6	3400	26:59	64.96
23	3	19	7.6	3440	27:17	65.30
23	4	19	7.6	3480	27:34	65.63
23	5	19	7.6	3520	27:52	65.97
23	6	19	7.6	3560	28:09	66.30
23	7	19	7.6	3600	28:27	66.64
23	8	19	7.6	3640	28:45	66.98

* Cumulative time includes 10 second recovery period between shuttles

3. VO_2Max

Though the YYIR1 has been shown to be a moderately reliable predictor of VO2 Max, it is advised to use the test for what it was originally developed for – identifying an individual's ability to repeatedly perform high-intensity aerobic work, which has proven to be a more sensitive measure of changes in performance than VO2 Max.

The **equation for calculating VO_2 Max** is:

YYIR1 test: VO_2 Max (mL * kg^{-1} * min^{-1}) = IR1 distance (m) × 0.0084 + 36.4

Figure 1: Agility marker cones and saucer cones and Measuring tape(30m)

Figure 2: CD, CD player, Speaker, Cuff Sphygmomanometer, Pulse oximeter, Writing pad, Recording sheet and consent form, Pen, Pencil.

Figure 3: YYIRT Level-1 field set up as 20m markings between the running phase and 5m marking area is for recovery phase.

Figure 4: Player at the starting line to begin the YYIRT Level-1

Figure 5: Player is approaching the recovery phase.

Advantages: Large groups can perform this test all at once for minimal costs.

Disadvantages: Practice and motivation levels can influence the score attained, and the scoring of when a person is out of the test can be subjective. As the test is usually conducted outside, the environmental condition can also affect the result. The test CD must be purchased.

3. Observation and Result:

Statistical Analysis

The data obtained were analysed with IBM SPSS v26 ® statistical software.

The data showed non normal distribution. The Kolmogorov-Smirnov test and Shapiro-Wilk Test showed Significant difference $p < 0.05$

Tests of Normality

Outcome	Groups	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Distance	Forwards	.179	65	.000	.881	65	.000
	Guards	.182	72	.000	.887	72	.000
VO2Max(mL/min/kg)	Forwards	.179	65	.000	.881	65	.000
	Guards	.182	72	.000	.887	72	.000

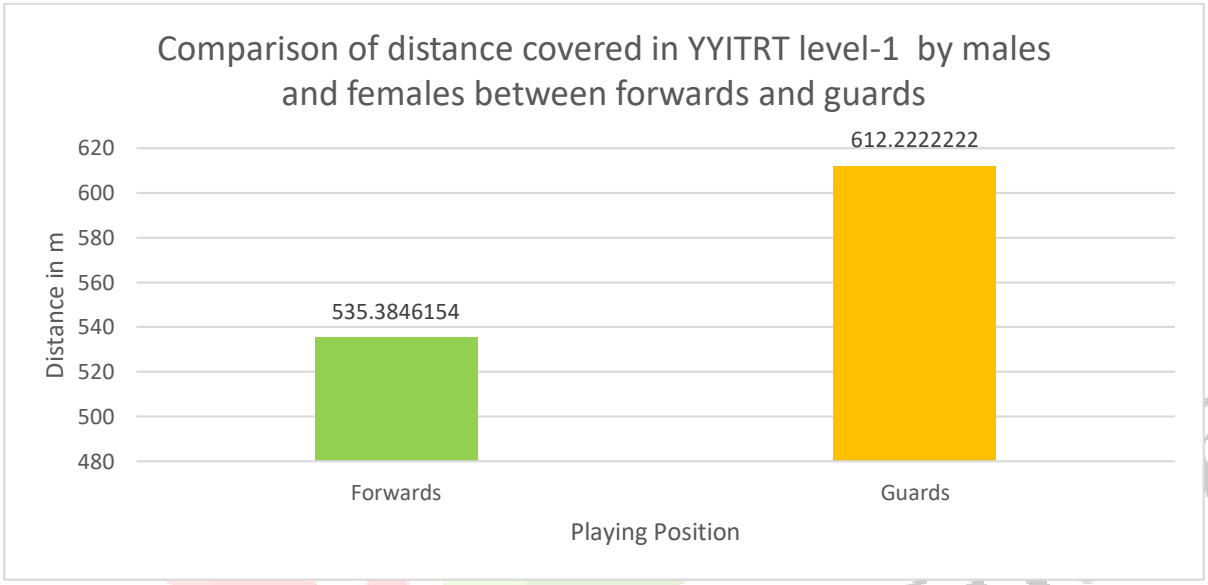
a. Lilliefors Significance Correction

Difference between Guards and Forwards (in male and female both) were examined using the Non-parametric test which includes **Mann-Whitney U test** in Total covered distance, VO2Max and the levels achieved between the groups (Forwards and Guards) in YYIRTL1.

p was set at **0.05** and differences were considered significant if *p* was less than **0.05**

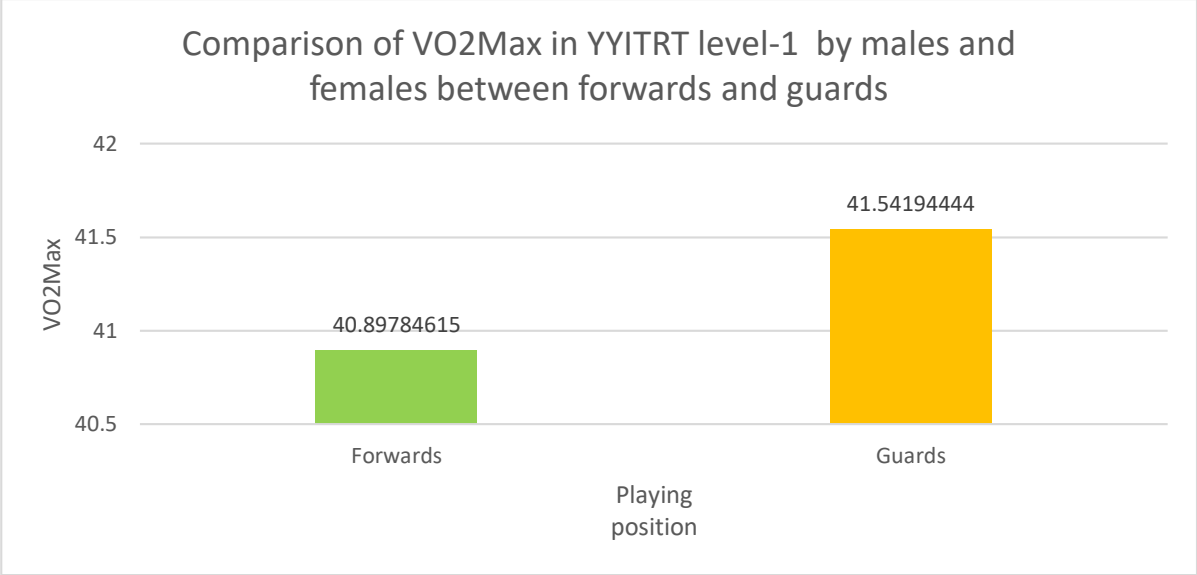
Observation:

Graph 1: Comparison of distance covered in YYITRT level-1 by males and females between forwards and guard.



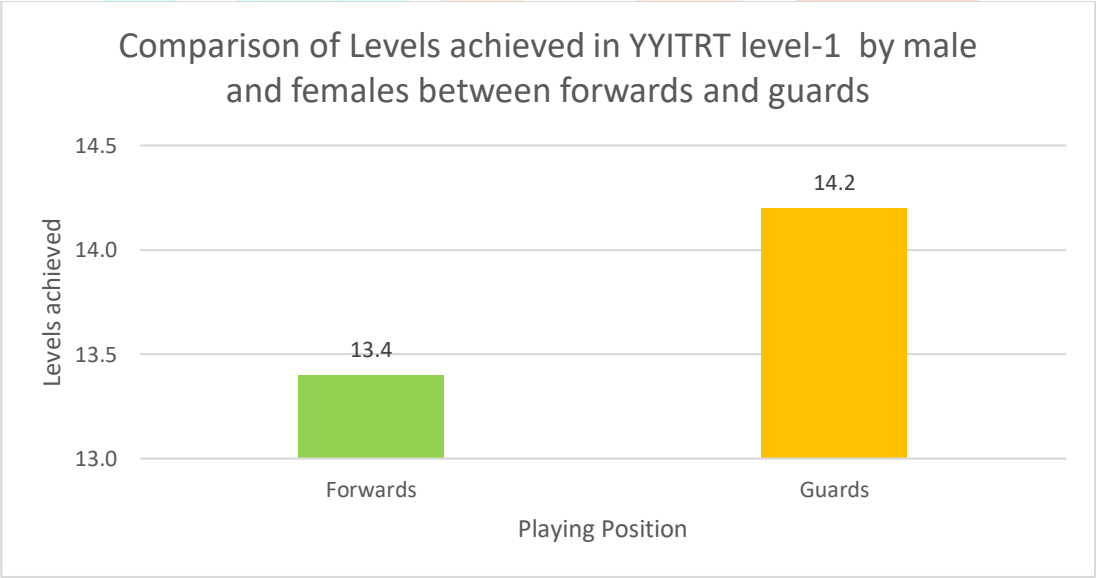
This bar graph shows the comparative result of means of total distance covered between forward and guard positioned basketball players in male and female combine.

Graph 2: Comparison of VO2Max in YYITRT level-1 by males and females between forwards and guards.



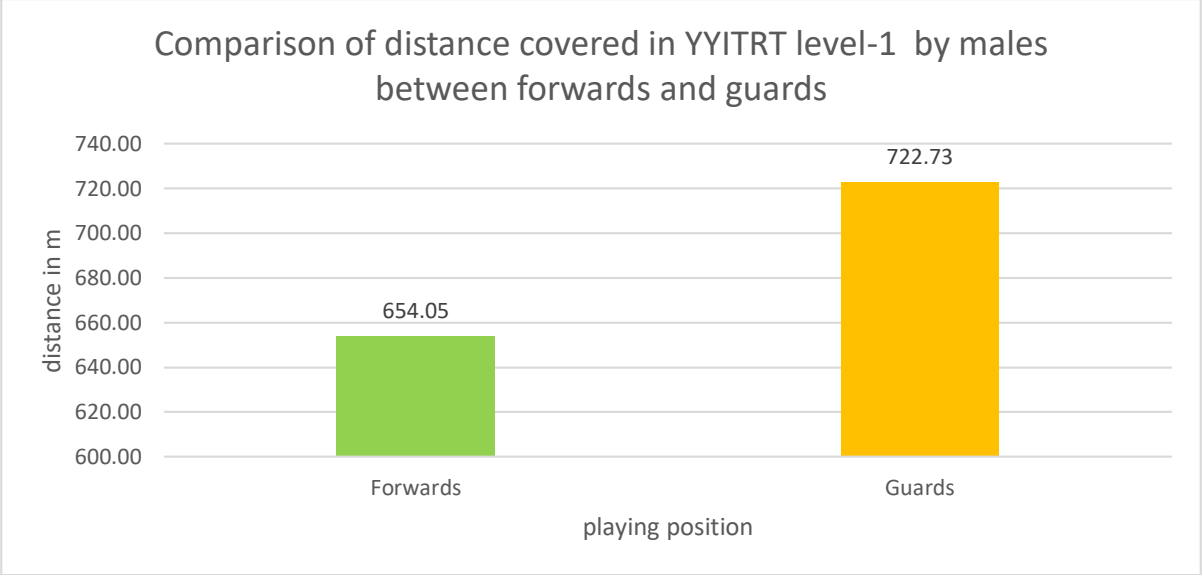
This bar graph shows the comparative result of means of VO2Max between forward and guard positioned basketball players in male and female combine.

Graph 3: Comparison of levels achieved in YYIRT level-1 by Males and Females between Forwards and Guards.



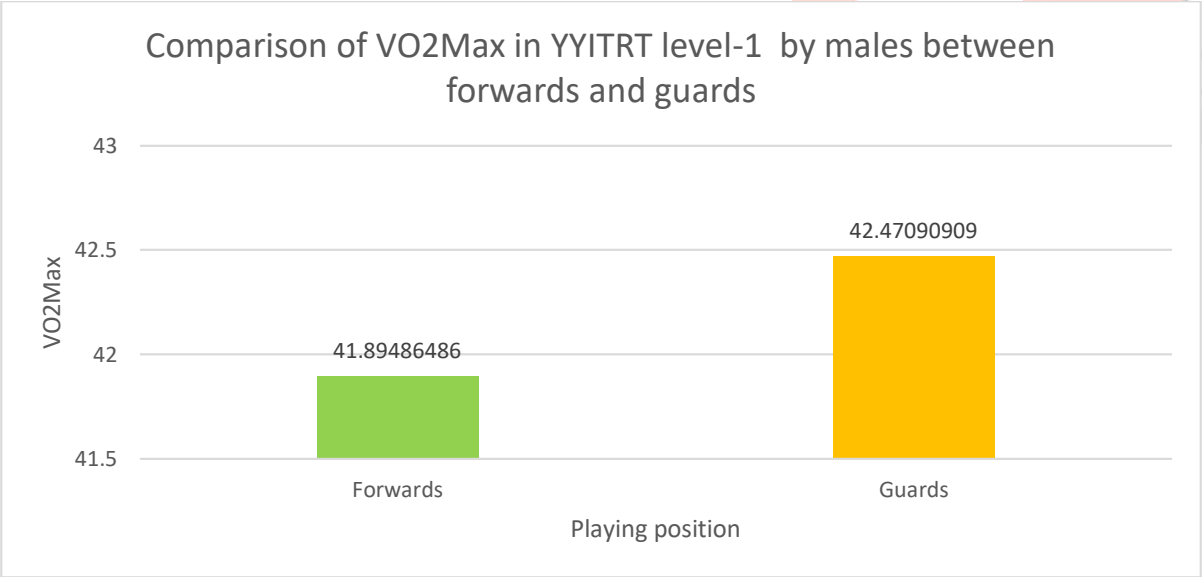
This bar graph shows the comparative result of medians of achieving levels between forward and guard positioned basketball players in male and female combine.

Graph 4: Comparison of distance covered in YYITRT level-1 by males between forwards and guards.



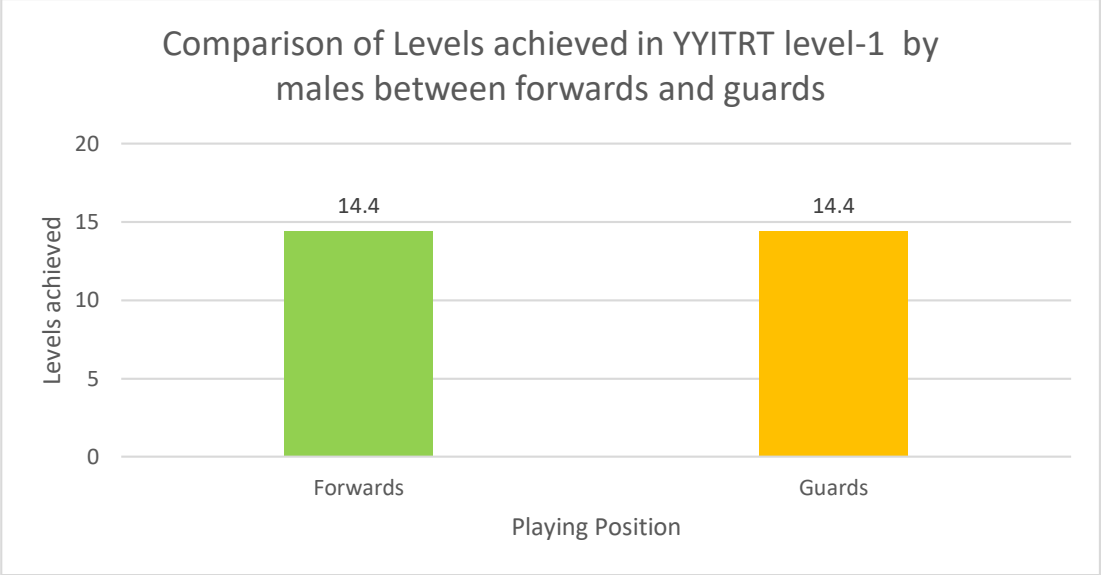
This bar graph shows the comparative result of means of total distance covered between forward and guard positioned basketball players in male.

Graph 5: Comparison of VO2Max in YYITRT level-1 by males between forwards and guards.



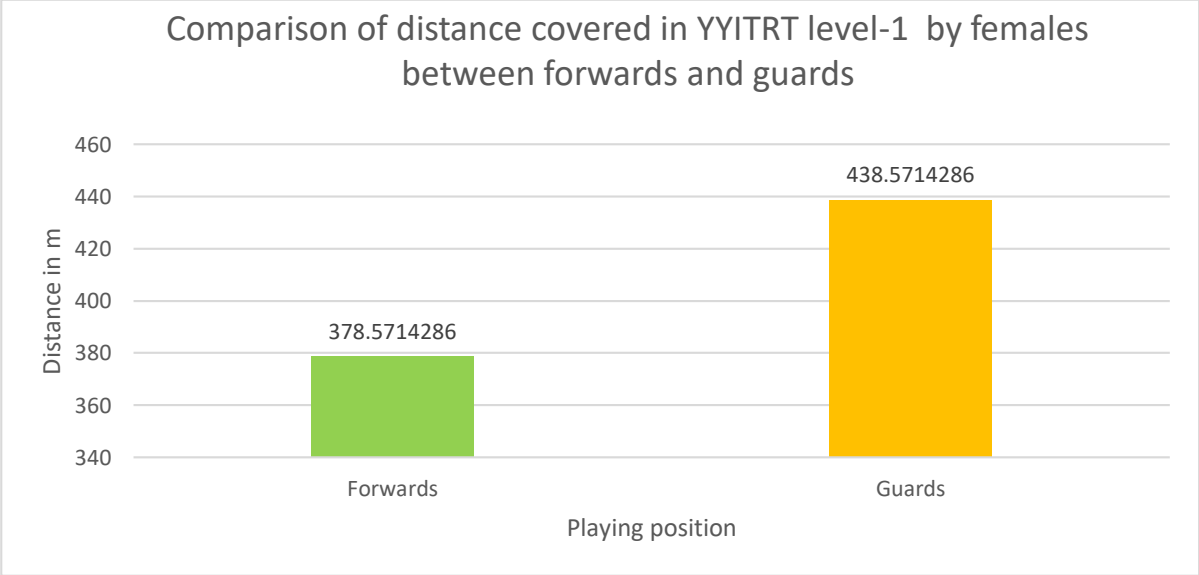
This bar graph shows the comparative result of means of VO2Max between forward and guard positioned basketball players in male.

Graph 6: Comparison of Levels achieved in YYITRT level-1 by males between forwards and guards.



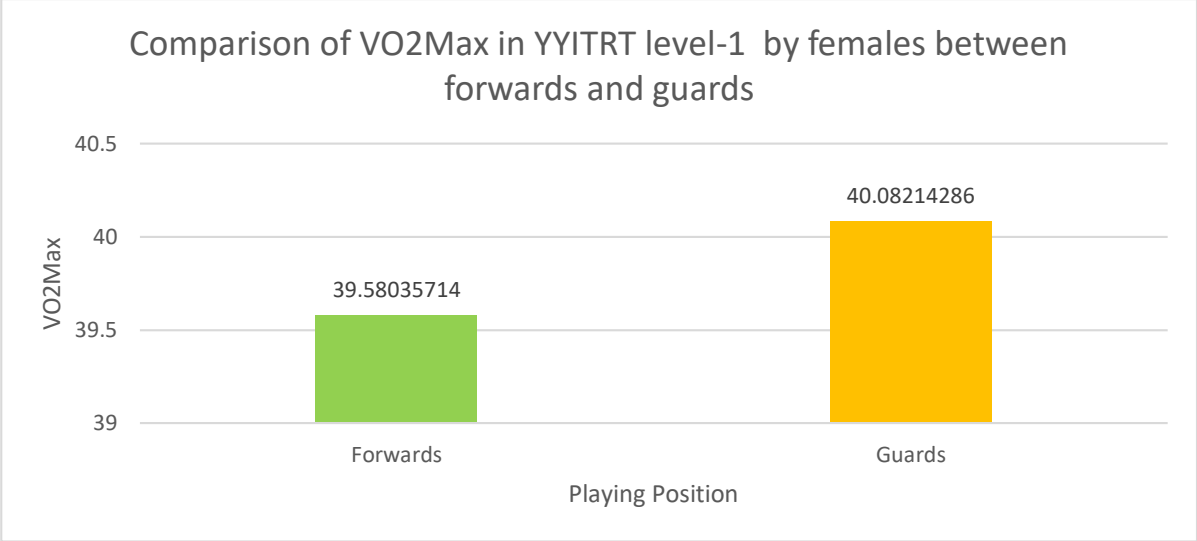
This bar graph shows the comparative result of medians of achieving levels between forward and guard positioned basketball players in male.

Graph 7: Comparison of distance covered in YYITRT level-1 by females between forwards and guards.



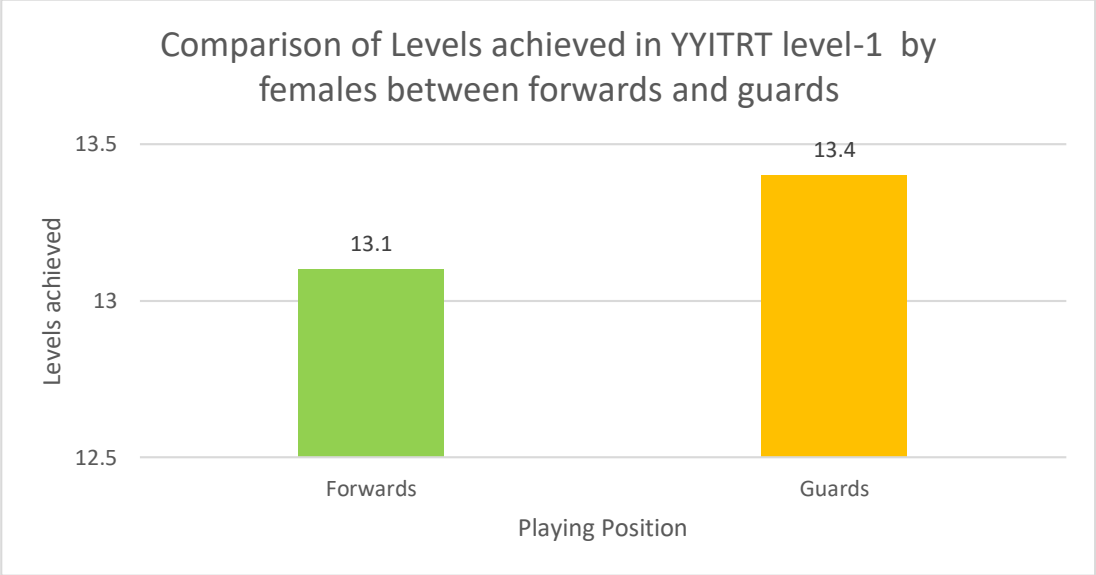
This bar graph shows the comparative result of means of total distance covered between forward and guard positioned basketball players in female.

Graph 8: Comparison of VO2Max in YYITRT level-1 by females between forwards and guards.



This bar graph shows the comparative result of means of VO2Max between forward and guard positioned basketball players in female.

Graph 9: Comparison of Levels achieved in YYITRT level-1 by females between forwards and guards.



This bar graph shows the comparative result of medians of achieving levels between forward and guard positioned basketball players in female.

Table 1: Comparison of the mean and standard deviation in distance covered, VO_{2Max} achieved between the Forwards and Guards basketball players.

Ranks

	Groups	N	Mean	Standard Deviation (SD)
Distance	1 (Forwards)	65	535.38	278.72
	2 (Guards)	72	612.22	325.70
	Total	137		
VO2Max(mL/min/kg)	1(Forwards)	65	40.90	2.34
	2(Guards)	72	41.54	2.74
	Total	137		

Group 1 suggest the forward position male and female basketball players and group 2 suggest the guard male and female basketball players in Table 1.

The Mean ± SD of distance covered by forward position players were 535.38 ± 278.72 and by guard position players were 612.22 ± 325.70.

The Mean ± SD of VO_{2Max} by forward position players were 40.90 ± 2.34 and by guard position players were 41.54 ± 2.74.

Table 2: Comparison of the median and standard deviation in Levels achieved between the Forwards and Guards basketball players.

Ranks

	Groups	N	Median	Standard Deviation
Levels Achieved	1 (Forwards)	65	13.4	1.20
	2 (Guards)	72	14.2	1.30
	Total	137		

Group 1 suggest the forward position male and female basketball players and group 2 suggest the guard male and female basketball players in Table 1

The Median ± SD of Levels achieved by forward position players were 13.4 ± 1.20 and by guard position players were 14.2 ± 1.30.

Table 3: Statistical analysis of distance covered, VO_{2Max} and levels achieved in Forwards and Guards basketball players.

Mann-Whitney U-Test:

Test Statistics[a]

	Distance	VO2Max(mL/min/kg)	Levels Achieved
Mann-Whitney U	1991.500	1991.500	1991.500
Wilcoxon W	4136.500	4136.500	4136.500
Z	-1.505	-1.505	-1.505
Asymp. Sig. (2-tailed)	.132	.132	.132

a. Grouping Variable: Groups

Mann-Whitney U test was used to compare Distance covered (0.132), VO_{2Max} (0.132) and Levels achieved (0.132) between the basketball players in Forward positioned both male and female players and Guard positioned both male and female players.

There were No significant differences ($p>0.05$) observed.

Table 4: Comparison of the mean and standard deviation in distance covered, VO_{2Max} achieved between the Forwards and Guards male basketball players.

Ranks

	Groups	N	Mean	Standard Deviation (SD)
Distance	1 (Forwards)	37	654.05	294.58
	2 (Guards)	44	722.73	350.03
	Total	81		
VO2Max(mL/min/kg)	1 (Forwards)	37	41.89	2.47
	2 (Guards)	44	42.47	2.94
	Total	81		

Group 1 suggest the forward position male basketball players and group 2 suggest the guard male basketball players in Table 4.

The Mean ± SD of distance covered by forward position players were 654.05 ± 294.58 and by guard position players were 722.73 ± 350.03.

The Mean ± SD of VO_{2Max} by forward position players were 41.89 ± 2.47 and by guard position players were 42.47 ± 2.94.

Table 5: Comparison of the median and standard deviation in levels achieved between the Forwards and Guards male basketball players.

Ranks

	Groups	N	Median	Standard Deviation (SD)
Levels Achieved	1 (Forwards)	37	14.4	1.11
	2 (Guards)	44	14.4	1.25
	Total	81		

Group 1 suggest the forward position male basketball players and group 2 suggest the guard male basketball players in Table 5.

The Median ± SD of levels achieved by guard position players were 14.4 ± 1.11 and by forward position players were 14.4 ± 1.25.

Table 6: Statistical analysis of distance covered, VO_{2Max} and levels achieved in male Forwards and Guards basketball players.

Test Statistics[a]

	Distance	VO2Max(mL/min/kg)	Levels_Achieved
Mann-Whitney U	722.500	722.500	722.500
Wilcoxon W	1425.500	1425.500	1425.500
Z	-.869	-.869	-.869
Asymp. Sig. (2-tailed)	.385	.385	.385

a. Grouping Variable: Groups

Mann-Whitney U test was used to compare Distance covered (0.385), VO_{2Max} (0.385) and Levels achieved (0.385) between the basketball players in Forward positioned male players and Guard positioned male players.

There were No significant differences ($p>0.05$) observed.

Table 7: Comparison of the mean and standard deviation in distance covered, VO_{2Max} achieved between the Forwards and Guards female basketball players.

Ranks

	Groups	N	Mean	Standard Deviation (SD)
Distance	1 (Forwards)	28	378.57	153.76
	2 (Guards)	28	438.57	180.69
	Total	56		
VO2Max(mL/min/kg)	1 (Forwards)	28	39.58	1.29
	2 (Guards)	28	40.08	1.51
	Total	56		

Group 1 suggest the forward position female basketball players and group 2 suggest the guard female basketball players in Table 7.

The Mean ± SD of distance covered by forward position players were 378.57 ± 153.76 and by guard position players were 438.57 ± 180.69.

The Mean ± SD of VO_{2Max} by forward position players were 39.58 ± 1.29 and by guard position players were 40.08 ± 1.51.

Table 8: Comparison of the median and standard deviation in Levels achieved between the Forwards and Guards female basketball players.

Ranks

	Groups	N	Median Rank	Standard Deviation (SD)
Levels_Achieved	1 (Forwards)	28	13.1	0.90
	2 (Guards)	28	13.4	1.01
	Total	56		

Group 1 suggest the forward position female basketball players and group 2 suggest the guard female basketball players in Table 8.

The Median ± SD of levels achieved by guard position players were 13.1 ± 0.90 and by forward position players were 13.4 ± 1.01.

Table 9: Statistical analysis of distance covered, VO_{2Max} and levels achieved in female Forwards and Guards basketball players.

Test Statistics[a]

	Distance	VO2Max(mL/min/kg)	Levels_Achieved
Mann-Whitney U	317.500	317.500	317.500
Wilcoxon W	723.500	723.500	723.500
Z	-1.227	-1.227	-1.227
Asymp. Sig. (2-tailed)	.220	.220	.220

a. Grouping Variable: Groups

Mann-Whitney U test was used to compare Distance covered (0.220), VO_{2Max} (0.220) and Levels achieved (0.220) between the basketball players in Forward positioned female players and Guard positioned female players.

There were No significant differences ($p>0.05$) observed.

Table 10: Comparison of the mean and standard deviation in distance covered, VO_{2Max} achieved between the female and male Forward basketball players.

Ranks

	Gender group	N	Mean	Standard Deviation (SD)
Distance	3(Forwards Female)	28	378.57	153.76
	4(Forwards male)	37	654.05	294.58
	Total	65		
VO2Max(mL/min/kg)	3(Forwards Female)	28	39.58	1.29
	4(Forwards male)	37	41.89	2.47
	Total	65		

Group 3 suggest the forward position female basketball players and group 4 suggest the forward male basketball players in Table 7.

The Mean ± SD of distance covered by forward position female players were 378.57 ± 153.76 and by forward position male players were 654.05 ± 294.58.

The Mean ± SD of VO_{2Max} by forward position players were 39.58 ± 1.29 and by forward position players were 41.89 ± 2.47.

Table 11: Comparison of the median and standard deviation in Levels achieved between the female and male Forward basketball players.

Ranks

	Gender group	N	Mean	Standard Deviation (SD)
Levels_Achieved	3(Forwards Female)	28	13.1	0.90
	4(Forwards male)	37	14.4	1.11
	Total	65		

Group 3 suggest the forward position female basketball players and group 4 suggest the forward male basketball players in Table 11.

The Median ± SD of levels achieved by forward position female players were 13.1 ± 0.90 and by forward position male players were 14.4 ± 1.11.

Table 12: Statistical analysis of distance covered, VO_{2Max} and levels achieved in female and male Forward basketball players.

Test Statistics[a]

	Distance	VO2Max(mL/min/kg)	Levels_Achieved
Mann-Whitney U	200.000	200.000	200.000
Wilcoxon W	606.000	606.000	606.000
Z	-4.224	-4.224	-4.224
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Grouping Variable: Gender group

Mann-Whitney U test was used to compare Distance covered (0.000), VO_{2Max} (0.000) and Levels achieved (0.000) between the basketball players in Forward positioned female players and male players.

There were significant differences ($p<0.05$) observed.

Table 13: Comparison of the mean and standard deviation in distance covered, VO_{2Max} achieved between the female and male Guard basketball players.

Ranks

	Gender group	N	Mean	Standard Deviation (SD)
Distance	3(Guards Female)	28	438.57	180.69
	4(Guards male)	44	722.73	350.03
	Total	72		
VO2Max(mL/min/kg)	3(Guards Female)	28	40.08	1.51
	4(Guards male)	44	42.47	2.94
	Total	72		

Group 3 suggest the guard position female basketball players and group 4 suggest the guard male basketball players in Table 13.

The Mean ± SD of distance covered by guard position female players were 438.57 ± 180.69 and by guard position male players were 722.73 ± 350.03.

The Mean ± SD of VO_{2Max} by guard position players were 40.08 ± 1.51 and by guard position players were 42.47 ± 2.94.

Table 14: Comparison of the median and standard deviation in Levels achieved between the female and male Guard basketball players.

Ranks

	Gender group	N	Mean Rank	Sum of Ranks
Levels_Achieved	3(Guards Female)	28	13.4	1.01
	4(Guards male)	44	14.4	1.25
	Total	72		

Group 3 suggest the guard position female basketball players and group 4 suggest the guard male basketball players in Table 11.

The Median ± SD of levels achieved by guard position female players were 13.4 ± 1.01 and by guard position male players were 14.4 ± 1.25.

Table 15: Statistical analysis of distance covered, VO_{2Max} and levels achieved in female and male Guard basketball players.

Test Statistics[a]

	Distance	VO2Max(mL/min/kg)	Levels_Achieved
Mann-Whitney U	300.000	299.500	300.000
Wilcoxon W	706.000	705.500	706.000
Z	-3.657	-3.663	-3.657
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Grouping Variable: Gender group

Mann-Whitney U test was used to compare Distance covered (0.000), VO_{2Max} (0.000) and Levels achieved (0.000) between the basketball players in guard positioned female players and male players.

There were significant differences ($p<0.05$) observed.

Discussion:

The Yo-Yo test is developed to check and to increase the individual's ability in their related sports. Yo-Yo test is more focused and directional towards the fitness of the players who are in the intermittent sports like football, basketball, etc. Yo-Yo test is able to evaluate the fitness, recovery in between the test shuttles and even the endurance according how much they covered the distance in test, their estimated VO2Max and speed levels which are achieved by players also indicated by these tests.[15]

Yo-Yo intermittent recovery test level 1 is one of the types of The Yo-Yo tests. The Yo-Yo intermittent recovery test level 1 helps to evaluate the physical fitness of the players who are into this specific shuttle test.[15]

Yo-Yo Intermittent recovery test leve-1 test consisted of 20-m shuttle runs performed at increasing velocities with 10s of active recovery between runs until exhaustion. The end of the test was considered when the participant twice failed to reach the front line in time (objective evaluation) or he/she felt not able to cover another shuttle at the dictated speed (subjective evaluation).[15] The total distance covered during the YYIR test level-1 was primary performance measure and the speed attained during the last 2 m × 20 m bout was considered as VO2Max. Testing session was performed on the same basketball court where players usually play.

This study is done to observe and compare the fitness level between guards and forwards positions of the basketball players in males and females as well. Generally, Fitness of the players is by far depended on the distance which they covered in their shuttle runs of the Yo-Yo intermittent recovery test level 1 and also depended on a VO2Max as well. Secondarily, speed level achieved also taken with kilometer per hour measurement in this study.

In this study, basketball players were compared who were trained to play proper playing positions which were forward position and guard position. As mentioned in statistical analysis, for checking the significant difference of total covered Distance and VO2Max as well as for checking the significant difference in levels achieved measurements, Mann-Whitney U test as non-parametric test was used.

As per result, Mann-Whitney U test at 95% of confidence interval, there was statistically no significant difference ($p>0.05$) found as per Total covered Distance (sig. difference = 0.142) between Forward positioned Male and Female basketball players and Guard positioned Male and Female basketball players respectively and also for VO2Max, there was no significant difference found (sig. difference = 0.143) between Forward positioned Male and Female basketball players and Guard positioned Male and Female basketball players respectively.

In analysis with non-parametric test, Mann-Whitney U test noted statistically no significant differences ($p>0.05$) found as per Distance (sig. difference = 0.385) and VO2Max (sig. difference = 0.385) between Forward positioned Male basketball players and Guard positioned Male basketball players and there were also statistically no significant difference ($p>0.05$) found as per Distance (sig. difference = 0.220) and VO2Max (sig. difference = 0.220) between Forward positioned Female basketball players and Guard positioned Female basketball players as per analysis.

As per Non-Parametric test results, Mann-Whitney U Test showed no significant difference 0.132 ($p>0.05$) in measuring the Levels achieved by the basketball players in both males and females as Forward positioned male and female players and Guard positioned male and female players counted and No significant difference 0.220 ($p>0.05$) found in Levels achieved by the basketball players in females as Forward positioned female players and Guard positioned female players counted. Also, it suggested No significant difference 0.385 ($p>0.05$) in Levels achieved by the basketball players males as Forward positioned male players and Guard positioned male players counted.

At the other side, as per Mann-Whitney U-test at 95% of confidence interval, there were statistically significant difference ($p<0.05$) found as per Distance (sig. difference = 0.000), VO2Max (sig. difference = 0.000) and Levels achieved (sig. difference = 0.000) between guard positioned Female basketball players and Guard positioned Male basketball players respectively as well as significant differences found between forward positioned Female basketball players and forward positioned Male basketball players.

There was one discriminative study of Yo-Yo intermittent recovery test level 1 had been done on prospective young football players who are under the age of 19. Discrimination in the study had been done regarding their playing position (forward position, forward-back position, mid-field position, wide mid-field position, defense position) in the game of football. Study concluded that forward position players had significantly better fitness than the other playing positions in football.[16]

As compared to above mentioned study, there was no significant changes observed in the fitness level regardless of players playing positions in this study. As above given pie charts suggested that the Guard playing position players results of total covered distance were slightly better than forward playing position players in males and

females both combined but in achieving VO2Max and in Achieving the Levels of the test had equalized results between guard and forward playing position players in males and females both combined respectively.

Yo-Yo intermittent recovery test level 1 had been done by participants at their highest physical limit. It showed their physical fitness that push themselves to the next limit and showed more capability. Even in Yo-Yo tests other than Yo-Yo intermittent recovery test level 1, there is another recovery also which shows the fitness ability at the maximum physical limit and that test is Yo-Yo intermittent recovery test level 2. Level 2 is preferred more in measuring the fitness ability on elite and well-trained intermittent sports players. The Yo-Yo IR2 test was shown to be a sensitive tool to differentiate between intermittent exercise performance of soccer players in different seasonal periods and at different competitive levels and playing positions.[17]

YYIR test level 1 is helpful to evaluate the fitness ability like YYIR test level 2. But, the main difference between both test is the starting speeds, so that at any given time the athlete would be running at a faster speed if they are doing the level 2 test compared to the level 1 test. The different levels were originally designed for testing athletes at different playing levels (and therefore it was assumed different fitness levels). If the test was too easy then the athlete would continue for a long time, if too hard, the test would be over too quickly. Different levels were required so athletes of different fitness levels could complete the test in a similar time frame, and consequently similar energy systems would be stressed. Just as the level 1 and level 2 tests are used to test groups of different fitness level, similarly it can be used to test males and females. The levels level one test can be used for women, as women generally have a slower maximum running speed and VO2max level, while men do the level 2 test.[18]

Generally, the intermittent nature of the yo-yo tests taxes both the aerobic and anaerobic energy system, but the relative contribution of each system will depend on many factors, such as the duration and intensity of the test. Depending on the starting speed and the fitness level and running speed of the athletes being tested, the relative contribution from each energy system will vary. The Yo-Yo intermittent recovery test level 1 has a high-discriminative ability to distinguish between elite and non-elite young football players.[19]

Professional and Semi-professional rugby players were examined with Yo-Yo intermittent recovery test level 1. Total covered distance was taken as the performance index and physiological variables. The performance of the professional rugby players had been measured higher than the semi-professional rugby players. But comparing to the physiological variables with their performance values, there was no significant difference found by Atkins S.J. in their study.[20]

Aerobic fitness (VO2max, lactate thresholds, and running economy) can be accurately evaluated using a variety of laboratory protocols. Although the values obtained with laboratory testing are considered the ‘‘gold standard’’ for the measurement of aerobic fitness, the procedures involved are time consuming and require trained personnel and expensive equipment. For these reasons, some continuous field-tests involving shuttle running over 20 m (approximately court length) have been proposed as practical alternatives to laboratory assessments in basketball. The validity of these tests is based on their correlations with VO2max (criterion validity) and displacement specificity (logical validity). However, due to the intermittent nature of basketball, the exercise continuity considered in this test may considered as a potential threat to the logical validity and content validity.[15]

Yo-Yo is related with the ability to repeatedly perform aerobic high-intensity work, as previously shown by Krustrup et al. where the Yo-Yo test performance was significantly correlated ($r = 0.71$) with the high-intensity running covered by the players during games.[21]

The distance improvements on the Yo-Yo may be linked to the other factors such as anaerobic capacity, the ability to recover between the runs and the technical ability to do the test: reaction time at the sound signal, acceleration, stop and shift of direction. According to these latter results, it does not appear consistent to estimate VO2max from the distance covered during the Yo-Yo or from the VYo-Yo even if this criterion is less sensitive than the distance.[16]

An activation of energy processes during a basketball game is mainly based on aerobic sources. However, it can be said that there are some differences between basketball being played around the world. Basketball being played in some region is mostly aerobic, while in some region the basketball, which is different based on its rules and

dynamics, is mostly anaerobic. It is assumed that anaerobic metabolism is crucial for a basketball game. Many studies point to the fact that the success of the basketball game to a large extent depends on the anaerobic capabilities of basketball players themselves and that they are the most important in the game. The aerobic system is indispensable in building anaerobic systems during the game or training process for basketball players.[14]

Therefore, aerobic metabolism is significant, but more in terms of the process of recovery from intense anaerobic activity than the direct effects in the game. Aerobic capacity is especially important in the stages of recovery. It represents the ability to perform work over a longer period of time in conditions of aerobic metabolism.[14]

The aerobic capacity indicates the general magnitude of aerobic metabolic processes in the human body and an athlete, and represents VO2Max which refers to best indicator of cardiorespiratory endurance and aerobic fitness. So, their study differed values of maximum oxygen consumption in players to players and playing positions which, they are trained for.[14]

Regarding this study, Non-gender specific formula for VO2Max is taken to check the aerobic fitness which is depended upon the total covered distance and time-decremented levels achieved. So, if player is able to cover the distance more so, the test time is increasing with time-decremented levels are achieved more and higher value VO2Max can be achieved which will show the better fitness level of that player.

Also, as above-mentioned study their study based on the smaller sample size as compared to this study. Estimated sample size was around 190 calculated for this study but regarding the covid-19 situations, there were not much basketball academies started their training and practise on a full-fledged level as compared to before covid-19 situations.

In summary, present study showed that there has no significant differences found between guard and forward positioned players by testing the Yo-Yo intermittent recovery test Level-1.

4. Conclusion

- This study showed similar aerobic capacity between Guards and Forwards playing position with of Yo-Yo Intermittent Recovery Test Level-1.
- This study also found that there were significant differences between both the genders in total covered distance, VO2Max and Levels achieved of YYIRT Level-1

5. Clinical implications

During the test, both aerobic and anaerobic energy systems are highly taxed, and the test evaluates an individual's ability to recover from intense exercise. Thus, it can be used to examine seasonal changes in the physical capacity of athletes in intermittent sports.

There are many factors that predispose toward a successful career in professional intermittent sports, one of them being player's aerobic and endurance capacity, particularly intermittent specific endurance. Thus, during the process of selection, development and professional guidance of players, coaches, and sports physiotherapist, physical conditioning specialists should systematically monitor players, aerobic endurance performance.

Currently, a number of laboratory and field tests are available for the evaluation of athlete's endurance performance. However, most of these tests are not intermittent sports specific, and their practical utility in any age in any intermittent sports is poorly understood.

Thus, coaches and physical conditioning specialists may find this simple and easily available sports specific recovery test useful in the process of selection and training of players. Also, as the results in this study were

obtained on a sample of prospective players, coaches and scientists may use the reported Yo-Yo IR1 test results as reference values for categorized the players.

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