



## The Yo-Yo test and its application in assessing endurance in basketball athletes

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### Abstract

There does not exist a single compiled source which matches the different populations of basketball athletes to the corresponding and most suitable variant of the yo-yo test. Overcoming this shortcoming and providing the reader of the article with a concise source of information and provide a complete understanding of which yo-yo test is the most suitable for the basketball athlete, is the main objective of this study. Furthermore, the study also provides a clear understanding of all the quoted studies and also elucidates the drawbacks of them. This study is the first of its kind literature review to put together such a reader friendly representation of data of the yo-yo test and its application in endurance assessment of basketball athletes. The method of study includes intensive scouring of scholarly platforms, and a search algorithm based on Boolean Algebra, and stringent inclusion criteria in order to refine the search to the most relevant and empirical research articles for reviewing. The results of the study provide conclusive data on the matching of the yo-yo test to the basketball population, and this data is provided as the conclusion in the form of a table. Furthermore, data regarding the shortcomings of the reviewed studies are also provided in a comprehensive way, so that the reader is informed of the potential fallbacks. All in all, this one-of-a-kind meta-analysis, is probably the first of its kind to compile and present data in such a complete and cohesive manner.

**Keywords:** Yo-yo endurance test, Yo-yo endurance test, compilation, compendium, literature review, meta-analysis

### Introduction

The sport of basketball has ventured beyond leisure and entertainment and has taken a step into the scientific world. As we delve further into understanding and quantifying every aspect of athleticism, we also have a greater need for accurate and relevant tools of quantification. This has given rise to the formulation of numerous field tests for measuring various attributes of athleticism.

Endurance is an attribute which poses a challenge to quantify and compare. Understanding the endurance of an athlete gives us a complete understanding of their aerobic capacity

One of the most crucial attributes of a basketball athlete is endurance, and one of the universally used tests is the yo-yo endurance test. The Yo-Yo IR tests have shown to be a more sensitive measure of changes in performance than maximum oxygen uptake. The Yo-Yo IR tests provide a simple and valid way to obtain important information of an individual's capacity to perform repeated intense exercise and to examine changes in performance [1].

The yo-yo test is a tool for measurement of endurance which is an important attribute of an athlete, and the test is widely applied in sports of football, volleyball, and track sports. Over the years the applicability of the test in the sport of basketball has been tested, but there does not exist a single source of information for knowing which yo-yo test is applicable to a specific demographic.

Hence, we can say that the need of the study arises due to the increased desire to quantify attributes of basketball athletes and secondly due to the lack of a single source of compiled information regarding endurance testing of various basketball athletes. Furthermore, the study also enumerates the drawbacks of the studies which are being analysed. This will allow the article consumer to differentiate the factors which deem the study under consideration an appropriate fit for the athlete they want to test, hence acting like a diagnostic tool that enables test selection.

### Materials and Methods

#### Materials and Methods used

- Available literature on scholarly platforms: Google Scholar, and PubMed
- Boolean Algebra- a basic understanding and implementation in the search process
- PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) technique adopted for article review and reporting.
- Implementation of stringent inclusion and exclusion criteria in order to attain studies of highest quality and maximum relevance

### Implementation of PRISMA and It's four steps

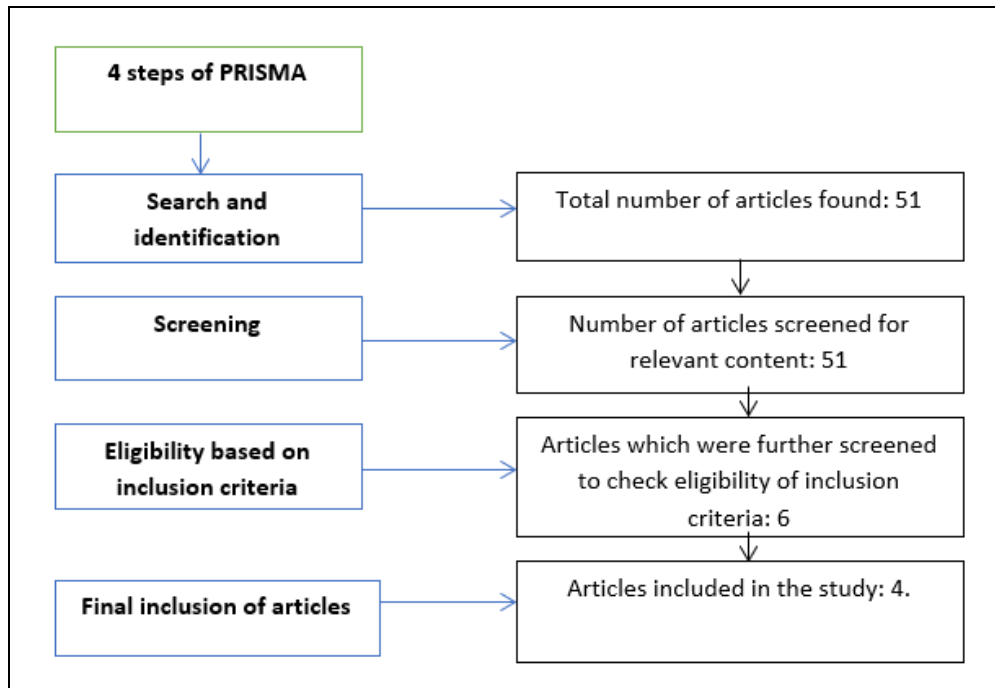


Fig 1

#### Criteria for inclusion

- The study population were basketball players exclusively and the yo-yo test was being used.
- The study included a different demographic
- Articles were relevant and relatively modern
- English articles

#### Criteria for exclusion

- The study population was not basketball players exclusively and yo-yo test not being used.
- The articles were irrelevant.
- Articles were not in English.

### Results and discussions

#### Discussions

##### Yo-yo test in professional/elite basketball players

**Study by:** Gürses, Sakir Akgül, Ceylan, Baydil, *et al*<sup>2</sup>. The original aim of the study was to investigate the relationship of the direct and indirect methods of endurance testing. The participants of the study include 14 adult males, who were professional basketball athletes of with the height  $192.36 \pm 5.90$  cm, weight  $89.21 \pm 7.6$  kg, body fat percentage  $11.07 \pm 1.82$  %. Standardization of data was ensured. Measurements were carried out at the end of the season. The participants were familiarized with the test procedure. 3 days prior to testing the players were not allowed to perform any strenuous activity. All measurements were carried out on the hardwood floor in a sport hall. Yo-yo IR2 was performed in accordance to the methods mentioned before. The study also analyzed blood lactate levels, heart rate and  $VO_2$  max in a standardized manner. The study finds a significant correlation between the yo-yo IR2 test results and the  $VO_2$  max findings. Therefore, the yo-yo IR2 test, which is a simple, easy to perform, cost-effective field test as opposed to the calculation of  $VO_2$  max, can be used to determine the endurance levels of the players. From this we can deduce that the findings of a yo-yo test are consistent with and have a significant relation to the findings of the  $VO_2$  max laboratory test. Therefore, yo-yo IR2 can be used to estimate the  $VO_2$  max of basketball players with a time-saving and cost-effective manner and hence be able to assess the aerobic performance of an athlete satisfactorily

##### Yo-yo test applicability in junior basketball players

**Study conducted by:** Vernillo, Gianluca, Silvestri, Adriano, Torre, Antonio La<sup>3</sup>. Participants of the study were categorized as Under 14 to Under 17. 119 male adolescents were taken for this test. Distribution - Elite (n=46), Sub-elite (n=42) and healthy age matched non-athletic male (n=31). The study was conducted for 5 weeks. The first 2 weeks were utilized for a familiarization trial of the yo-yo IR1, once per week, so the athletes have 2 chances to get familiar with the test. The actual test sessions were performed over 3 weeks (once per week) to determine the reliability of the yo-yo IR1. Standardization was ensured as tests for all groups were carried in an indoor basketball court. The tests were carried out at the same time of the day. For athletic groups there were

gaps of 3 days between competition and testing. Statistical methods employed were a 2-way analysis of variance (ANOVA) was used to evaluate between-performance levels differences in the anthropometric characteristics. A 2-way analysis of covariance (ANCOVA) was used to compare the yo-yo IR1 performances for the 3 performance levels (elite, sub-elite, and nonathletic) across the 3 age groups (U-14, U-15, and U-17). The body mass of the athletes was found as a confounding factor in the analysis, influencing the dependent variable which is the total distance covered. To the best of the researcher's knowledge, this is the first study to thoroughly investigate the evolution of the ability to perform the yo-yo IR1 in male basketball adolescents. The result of the study suggests that yo-yo IR1 may accurately distinguish the aerobic performance abilities between elite junior basketball players compared with their sub-elite counterparts and nonathletic groups. The analysis evaluating the homogeneity-of-regression assumption indicated that the relationship between the body mass, which was identified as a confounding factor and the test results, which are the dependent variable, did not differ significantly as a function of performance levels and age groups, which were demonstrated as independent variables by the ANCOVA. Finally, study suggests that yo-yo IR1 is a valid, reliable and easily available method of testing endurance of junior basketball athletes. From these tests we may arrive upon a conclusion of the "elite" status of the player. Suggestion for future studies is to take into account the biological maturity and lean muscle mass of the individuals to be tested.

### Yo-yo test applicability in wheelchair basketball players

**Study by:** Yanci J, Granados C, Otero M, *et al*<sup>4</sup>. Participants of the study were sixteen players, 14 males and 2 females, belonging to the Spanish national WB third division league. The yo-yo IR1 test was performed as previously described. Modifications were made to compensate for the difference between wheelchair pushing versus running. The original distance of 20 meters was reduced to 10 meters. The test was considered to have ended when the participant failed twice to reach the front line in time or felt they were unable to attain the speed. Standardization of the tests was done by ensuring that they were performed on a synthetic indoor court, and at the same time, before the season started. Participants were familiarized with the tests. The players were instructed to perform all tests at maximum intensity. No strenuous exercises were performed 2 days prior to the tests and the study was supervised at all times. Heart rate and blood lactate were measured in a standardized way. Data analysis was performed using the Statistical Package for Social Sciences. Standard statistical methods were used for the calculation of the mean and standard deviations. The authors mention that there is no such study conducted previously examining the reproducibility of the results of the yo-yo IR1. The authors mention there is an inverse relation between the heart rate and blood lactate levels and the level of spinal cord lesion. The interprets from the data that Yo-yo IR1 (modified 10m) is a reliable test for evaluation programmes in WB athletes. Suggestions for future studies include evaluation of WB players in different categories according to level of spinal cord injury, especially if the level of injury directly involves the autonomic innervation of the heart. The results of the study must also be expanded to test reliability of yo-yo IR1 in athletic performances and not just in evaluation programmes.

### The yo-yo test in female basketball players

**Study by:** Nabli, M. A., Chamari, K.*et al*<sup>5</sup>. The aims of the study were defined as to define the relationship between the Yo-Yo-IR1 and in game physical-activity. The yo-yo IR1 was performed as per methods mentioned before. Heart-rate and blood lactate concentration was measured in 30 female U-19 players during eight games at the playoff stage. Standardization was done by defining the RS value (repeated sprint) as a minimum of 3-sprints, with recovery of less than 21-sec in-between any of sprints' set. It is essential to define the RS value because the results were based on a comparison of in game performances and yo-yo IR1 test. While measuring blood lactate and heart rate, the standardized methods were adopted. The study found a statistically significant correlation between yo-yo IR1 performance and the percentage of in-game time spent in RS bouts. This further helps us conclude that the Yo-yo IR1 test is an indispensable tool of measuring endurance performance in female U-19 basketball players. Furthermore, there is a significant correlation between the blood lactate levels and the time spent in high-intensity activity. A similar correlation was found to be present between the yo-yo test results and the time spent in high-intensity activity. The study concludes that the yo-yo test is a reliable, easily performed and cost-effective field-testing method to assess the aerobic functionality of the athlete with results correlatable to the findings of blood lactate levels.

## Results

Table 1

Slot no.	Demographic of basketball athletes	Yo-yo test applicable	Limitations	Interpretation
6.2.1	Professional basketball players	Yo-yo intermittent test level 2	<ul style="list-style-type: none"> <li>▪ The study does not include female players, however the title of the study does not specify the study is for male athletes only.</li> </ul>	The study establishes a definite correlation between laboratory measurements and the yo-yo IR2 test results,

			<ul style="list-style-type: none"> <li>▪ In the study the athletes only take the test once, but multiple testing and familiarization drills can prove the results obtained</li> <li>▪ The author also identifies a limitation in the size of the study, which is just 14 men, and suggests that in further studies the sample size be larger.</li> </ul>	indicating its accuracy in assessing aerobic performance in professional basketball players.
6.2.2	Junior basketball players (U-14& U-17)	Yo-yo intermittent test level 1	<ul style="list-style-type: none"> <li>▪ The athletes were grouped according to their age groups, but we must note that not all children attain biological maturity at the same chronological age. Therefore, physiological changes that occur during puberty, which notably enhance athletic performance were unaccounted for.</li> <li>▪ The body composition and the lean muscle mass, which is known to potentially enhance functional of the athletes were also not taken into consideration.</li> <li>▪ There is also a limitation that lies in correlating the age of the athlete to their aerobic performance.</li> </ul>	The study does not attempt to draw a parallel in the results of laboratory methods and the yo-yo field test. The study identifies yo-yo test as an effective way to assess the endurance of junior basketball players and identify the “elite” status of the athletes.
6.2.3	Wheelchair basketball athletes	Modified 10 meter yo-yo intermittent level 1 test	<ul style="list-style-type: none"> <li>▪ The study factors in the heart rate of the athletes to comment on their endurance, however, it does not factor in the level of spinal cord injuries of the athlete. Autonomic innervation of the heart is directly affected in injuries above T5 level which is a possible confounding factor.</li> <li>▪ •There exists a categorization system for WB athletes based on level of disability. The study is unable to differentiate significantly between these categories.</li> </ul>	The study identifies the modified version of the yo-yo test as an effective method to employ in evaluation programmes for the assessment of endurance in WB players.
6.2.4	Female basketball players	Yo-yo intermittent test level 1	<ul style="list-style-type: none"> <li>▪ The testing was only done for female populations under 19 years of age. However, there are physiological differences in adult females and under-19 females which directly affect the aerobic performance.</li> <li>▪ The authors also state that there has been no extensive research into this, and the ecological validity of the Yo-yo IR1 in female athletes has not been tested previously.</li> </ul>	The study utilizes data collected both from athletes’ in-game performance as well as from a field test set up. The study finds that the yo-yo test is a good indicator of the athletes’ aerobic performance.

### Conclusion

The yo-yo test consistently shows that it bears significant resemblance with the results obtained by laboratory tests. It shows the capability of measuring the endurance performance of basketball players, in the various populations that participate in the sport. Finally, it is an easily executed, time-efficient, cost-effective method to determine the endurance of all demographics of basketball players.

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