

Assessment of the Validity of Queens Step Test for Estimation Maximum Oxygen Uptake (Vo₂ max)

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Abstract

Objectives: The purpose of this study is to assess the suitability of the Queen Step test to predict maximum oxygen in student men.

Subjects and Methods: For this purpose we have randomly selected thirty male university students, with mean age, height, and weight of 22/6 year, 166/4 cm, and 56/9kg, respectively, were randomly sampled from university of Shiraz. Vo₂max of each participant was determined by shuttle run test and also by applying Queen step test with a gap of a seven days between the tests.

Results: The mean of Vo₂ max subjects were 45.53 (ml/kg/min) in Shuttle run (20 m) test and 42.80 (ml/kg/min) in Queen Step test. And also the result of shows that Exhibited significant statistical correlation ($r=0/68$, $p<0.001$) between them.

Conclusion: The result suggest that Queen step test can be applied in the studied population to produce a good estimation of maximum oxygen uptake, especially in the field where large numbers of participants are to be evaluated without a well equipped laboratory.

Keywords: Vo₂max; Queen Step test; university student males; shuttle run test

Introduction

Cardio respiratory fitness is in fact the capacity of heart, lung, and blood vessels to bring the oxygen and food for muscles during Specific time (Rogers et al., 1990). Having physical healthiness is due to Cardiorespiratory fitness which in directly related to efficiency of Cardiorespiratory and the rate of maximum oxygen consumption of person (Asadmanesh, 1997).

Vo₂ max is the maximum amount of oxygen that a person consume during maximal exercise and many expert of sport sciences have an nounced it as a method for evaluating aerobic fitness and as factor for predicting the success of athletes in endurance activities (Sanadgol, 1993).

Maximal oxygen uptake (VO₂max) during exercise test is the objective method to assess cardiorespiratory fitness. Maximal oxygen uptake testing is limited to only a few laboratories as it requires trained personnel and strenuous effort by the subject (Kumar et al., 2012).

In order to assess the maximal aerobic power of large groups of subjects, one has to rely on valid, reliable, safe and inexpensive tests. Assessments of cardiovascular fitness or aerobic power, as the most fundamental element of physical fitness, have specific characteristics (Moradi and jafari, 2012).

Determination of cardiorespiratory fitness in terms of maximum oxygen uptake (VO₂max) is restricted within the laboratory because of its exhausting, laborious, complicated and expensive experimental protocol (Bandyopadhyay, 2011).

Direct estimation of cardiorespiratory fitness in terms of VO₂max is restricted within well equipped laboratory (Bandyopadhyay, 2011).

Various methods have designed for measuring VO_2 max either in laboratory or in field. Although the methods in laboratory has high validity and precision, but because of its high costs it is not suitable for everyone (Haghravan, 1993).

There are a number of limitations to directly measuring VO_2 max. These limitations include logistical issues (e.g., cost, time, staffing), risk and discomfort to the participant of completing a maximum exercise test, and difficulty in motivating the participant to achieve maximal effort (Dean et al., 2011).

In this regard, the presentation of suitable methods- which is easy to perform and which have high credibility in measuring the fitness of Cardiorespiratory—is necessary on the other hand, the field Methods are cheaper and more apply able than those of laboratory (Haghravan, 1993). The precise measurement of VO_2 max requires expensive laboratory equipment, much time and to some extent enough motivation. But instead of direct measurement for VO_2 max, we can use indirect method, so the Queen Step test is useful for this purpose (Patricia et al., 1998). Validity means that weather the test used to measure something, really measures it or not? (Asadmanesh, 1997). Cardiorespiratory fitness and maximum oxygen consumptions are one the important and credible parameter of healthy, physical fitness and endurance capacity (Haghravan, 1993; Zahrayee, 1996). The precise evaluation of this parameter by step test always was uncertain and to some extends with diversion. For this reason, the credibility and capability of the test in evaluating in the subject to more studies.

The 20 meter shuttle run test and Queen step test is the field Tests to measurement of maximum oxygen consumption (VO_2 max). because performing these tests requires less equipments small space and one metronome are required – must of the times and at most circumstances we can use them.

20 meter multi-stage shuttle run test (SRT) is globally very popular one and has been widely used in different studies (Wong et al., 2001; Mota et al., 2002; Guerra et al., 2002; Vicente-Rodriguez et al., 2003; Vicente-Rodriguez et al., 2004).

Several researchers have studied the validity of SRT in different populations, but authentic validity of SRT with population-specific simple (Suminski et al., 2004; Cooper et al., 2005; Chatterjee et al., 2008)

According to the fact that each of these tests in performed in different procedure and each of them requires specific instruments and equipment which can be not at access. So, this research is pursuing top show to which extent, these two tests in determining VO_2 max have correlation.

In other words, the most accurate assessment of aerobic capacity is the direct measurement of maximum oxygen uptake (VO_2 max) during a graded exercise test. However, despite its level of accuracy, direct measurement of VO_2 max is primarily reserved for the laboratory setting because of the cost of the equipment, the need for trained technicians, and the inability to test large numbers of people at one time (Jana et al., 1996).

It is therefore desirable to find simple procedure for evaluation of VO_2 max in large number of population, especially in the field and in absence of well equipped laboratory

For these reasons, the aim of this research is to compare and show the different of the result of VO_2 max of male students of Shiraz University by these two tests (20 meter shuttle run test and Queen Step test).

Material and Methods

The static society composed of all male students of shiraz university who were passing general physical education .Thirtieth (30) healthy sedentary male students of same socioeconomic background having mean age, body height and body mass of 22/6 year, 166/4 cm, and 56/9kg, respectively were selected as a static sample for the study by random sampling from the University of Shiraz.

VO_2 max of each participant was determined by shuttle run test and also by applying Queen step test with a gap of a seven days between the tests.

Shuttle run (20 m) test: Subjects ran back and forth on a 20 meter course and must touched the line marked as “20 meter” at an initial speed of 8.5 km.hr⁻¹. The speed of the shuttle runs progressively increased at the rate of 0.5 km.hr⁻¹ every minute, as dictated by the frequency of adjusted “beep” sound signal from a pre-recorded audio tape. Several shuttle runs made up each stage, and subjects were instructed to keep running pace with the sound signal for as long as possible. The last stage of the running pace was determined when subjects could no longer follow the pace (Bandyopadhyay, 2011).

Scoring: The athletes score is the level and number of shuttles (20m) reached before they were unable to keep up with the recording. This score can be converted to a Vo_2 max equivalent score using calculator and also an estimation of Vo_2 max can be calculated from the test results, using the formula below (Ramsbottom et al., 1988):

$$Vo_2max_{(ml/kg/min)} = 31/025 + 3/238 \times speed - 3/248 \times age + 0/1536 \times speed \times age.$$

Estimation of VO_2 max by Queen’s College Step

The step test was performed on a step of 41.3 cm height a rate of 22 steps per minute for females and at 24 steps per minute for males, for a total of 3 minutes. For a total duration of 3 minutes. Immediately after stepping for a period of 3 minutes, the recovery pulse rate was determined for a 15-second period starting 5 seconds into recovery and the maximum oxygen uptake (VO_2 max I) was calculated. (KRISHNA KUMAR et al, 2012)

Scoring: an estimation of Vo_2 max can be calculated from the test results, using the formula below (McArdle et al. 1972):

$$Vo_2max_{(ml/kg/min)} = 111/33 - 0/42 \times \text{heart rate}$$

It should be noted that of tests were performed separately in two weeks and subjects performed the tests at a same day in each week and at the same time.

Statistical analysis:

The data were analyzed using SPSS11/5 with Pearson’s coefficient of correlation and statically significance was set at $P \leq 0/001$.

Results

The Mean and standard variation of Maximum oxygen uptake ,resulted from two tests -20 meter shuttle run test and Queen step test- is presented at table1.

The mean of Vo_2 max subjects were 45.53 (ml/kg/min) in Shuttle run (20 m) test and 42.80 (ml/kg/min) in Queen Step test.

Also the Variance of Vo_2 max estimation between Queen Step test and shuttle run (20m) is represented by figure 1.

Research findings with regard to spearman assumptions indicated that there is a significant relationship between the estimated oxygen uptake by shuttle run test and Queen Step test.

The results of analysis of data represented significant correlation ($r=0.68$, $p<0.001$) between 20 meter shuttle run test and Queen step test in assessing maximum oxygen uptake.

As table 2 shows, correlation coefficient is ($r=0.68$, $p<0.001$) and there is significant correlation between 20 meter shuttle run test and Queen step test.

Table1: Mean and Standard deviation of Vo_2 max Queen Step test and shuttle run (20m)

	mean	Standard deviation	Sample number
Shuttle run(20 m) test	45.53	6.20	30
Queen step test	42.80	2.97	30

Table2: correlation between Vo_2 max estimation between Queen Step test and shuttle run (20m)

result	P-Value	correlation coefficient
significant	0/000	0. 68

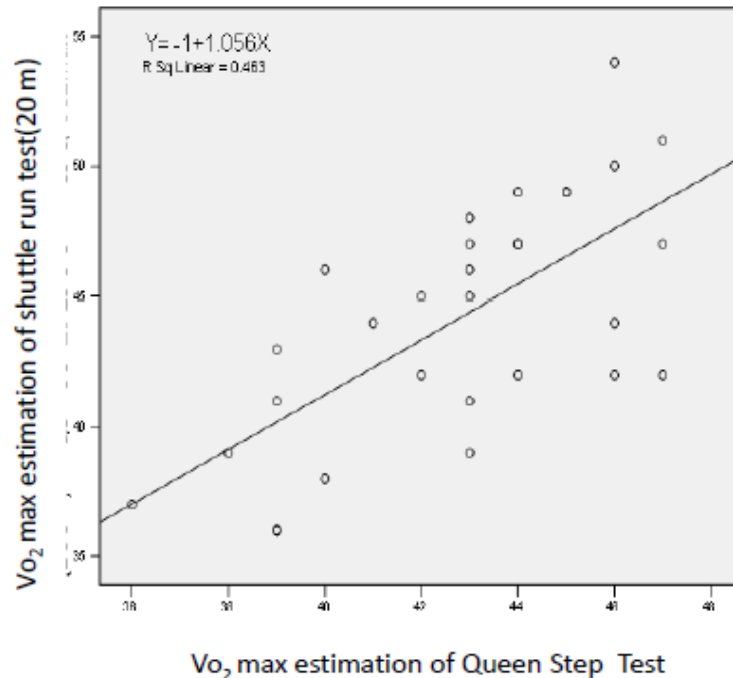


Figure 1: variance of Vo₂ max estimation between Queen Step test and shuttle run (20m)

Discussion and Conclusions

Finding of present study regarding Queen Step test represent a significant correlation ($r=0/68$) between this test and that of 20 meter shuttle run test.

Rodgers et al., reported significant relation between the result of (Vo₂ max) of step test and running on treadmill and shuttle run test (Rogers et al., 1990).

In study by Bandyopadhyay (2011), demonstrated that there are significant difference ($P<0.001$) with VO₂max (39.80 ± 4.06 ml.kg⁻¹min⁻¹) in the study group (Bandyopadhyay, 2011).

Earlier studies in the relevant field, also found significant difference between the directly measured and indirectly predicted values of VO₂max as also depicted in the current investigation (Chatterjee et al., 2008; Chatterjee et al., 2004).

In the one study, VO₂max was directly measured by maximal exercise test using a bicycle ergometer and was compared with VO₂max derived by recovery heart rate in Queens College step test (QCST). The values of directly measured VO₂max showed no significant correlation either with the estimated VO₂max with QCST or with VO₂max predicted by Wasserman equation. (Krishna Kumar et al., 2012). And also, results of one study show that Rockport and Queen Exercise tests were valid for estimation of VO₂max in male elite karate competitors. Although, estimated VO₂max in Queen Step test was slightly underestimated from two other tests. However, estimation of VO₂max could predict using provided linear regression equations (Moradi et al., 2012).

Aerobic capacity of sedentary female university students of same socio-economic background was also determined by both direct method, using bicycle ergometer, and indirect method, using Queen's College Step Test by Chhaterjee et al (2006) at Kolkatta. They found significant difference on aerobic capacity obtained by both methods and based on their study (Chhaterjee et al., 2006).

The finding of current study show significant correlation with that of other studies. Although there is a difference between correlation coefficient of this study and that of others in some cases, but these differences are not high and significant. The main reasons for these differences are related to age, gender and the differences of characteristics of subjects.

The 20-m multistage shuttle run(20-m MST, Leger et al., 1988; Leger et al., 1989) is often used worldwide (Wong et al., 2001; Mota et al., 2002; Guerra et al., 2002; Vicente-Rodriguez et al., 2003; Vicente-Rodriguez et al., 2004) for measurement of aerobic capacity.

Among various indirect protocols the Queen's College step test is the simplest one and uses the prediction equations to calculate the VO₂max from recovery heart rate (Chatterjee et al., 2006).

In conclusion , the finding of current study reported a significant and direct correlation between two tests- Queen Step test and 20 meters shuttle run test – for estimating the maximum oxygen uptake (VO_2 max). accordingly ,it can be suggested that these two tests can be used substituted . Whenever it is impossible to perform 20 meter shuttle run test we can substitute other tests such as Queen Step test.

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