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Analysis of VO₂MAX Differences between Laboratory Test and Field Test in Rowing

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Abstract

The aim of this study was to analyze the results of VO₂max measurement using laboratory test and field test. This research is a descriptive quantitative research with a comparative approach. The samples of this study were 30 male and female athletes of the Indonesian rowing team (male = 17, female = 13) aged 23.5 ± 3.5 years. The anthropometric profile of the athletes included height = 182.2 ± 5.01 cm for male and 171.9 ± 5.73 cm for female, weight = 74.2 ± 5.85 kg for male and 68.6 ± 8.5 kg for female. According to the results of analysis of VO₂max rowing test data gained from both methods, there were low and moderate correlations in the laboratory test and field test in rowing (male $r = 0.425$ and female $r = 0.62$). The results show that VO₂max measured in the laboratory test and field test did not show a significant difference. Therefore, these two parameter tests can be used in Vo₂Max testing.

INTRODUCTION

Rowing performance depends largely on aerobic and anaerobic functional capacities (S. A. Ingham et al., 2002). Rowing is a strength-endurance activity that requires activation of almost all muscles in the body. Therefore, maximal oxygen uptake (VO₂Max) often appears as a strong relationship with rowing performance (Stephen A. Ingham et al., 2013). Maximal oxygen uptake (VO₂Max) is defined as the maximum amount of oxygen taken and used by the body during exercise. This is one of the main variables in sport physiology to determine the cardiorespiratory fitness of an athlete (Bassett & Howley, 2000).

The method employed to measure the VO₂max level of an athlete consists of field and laboratory measurements (Santtila et al., 2013). The laboratory measurement is carried out by increasing the workload gradually and analyzing the absorption of oxygen and release of carbon dioxide integrated with pulse in each period during the test (Matabuena et al., 2018). Meanwhile, the measurement of VO₂max in the field test is conducted by calculating the score based on the specified time or distance (Gönülateş, 2018).

In the field test, the prediction method is used as a calculation consideration based on heart rate, intensity, and volume while moving within a certain period of time (Kavcic et al., 2012). The advantages of this method include the use of simple devices, easy to do, affordable, involve more participants, and time efficient (Paradisis et al., 2014). Meanwhile, VO₂max testing on laboratory test also has several advantages, such as a higher accuracy value, a greater number of measurement analysis component indicators, and maximum test results (Lee et al., 2011). However, laboratory tests require skilled and competent human resources, take longer to process, expensive, and need to be carried out in limited laboratories (Grant et al., 1999).

A number of studies have compared the results of VO₂max values obtained from field tests and laboratory tests in various types of sports (Kavcic et al., 2012) (Gönülateş, 2018). However, comparative analysis of the VO₂max test in rowing with different dominant movements and the use of an ergometer test device that is suitable for the characteristics of the performed movements is still rarely done. In addition, by considering differences in metabolic systems, energy requirements, and limited data related to athletes' physiology

with special movement characteristics; this study was aimed to analyze the VO₂max measurement method by measuring field tests and laboratory tests on rowing by considering the dominant movement mechanism in the sport.

METHODS

The method used was descriptive quantitative research with a comparative approach.

Participants

The samples of this study were 30 athletes of the Indonesian rowing team, consisting of 17 males and 13 females. Anthropometric profiles of the athletes are presented in Table 1.

Table 1. Height and Weight

	Weight (kg)	Height (cm)
Male (n = 17)	74.15 ± 5.85	182 ± 5.01
Female (n = 13)	61.39 ± 5.57	171 ± 5.73

Materials and Apparatus

The instruments used in this study were:

1. Multi-use silicone face mask. The instrument that can be easily use to measure the VO₂max during the sessions. This mask kit is made of silicone to minimize air leakage during the testing.
2. Cosmed Cardiopulmonary Exercise Test (CPET)
3. Calibration Syringe 3L COSMED.
4. Polar H6 Heart Rate Sensor as a digital heart rate sensor device.
5. Treadmill ergometer, paddle ergometer.
6. Screen monitors, projectors, and bleep test software applications.

Procedures

The laboratory test applied in this study was the cardiopulmonary exercise test (CPET) using the Quark PFT Ergo (COSMED® Rome, Italy) on the rowing ergometer (Figure 1). The athletes were asked to warm up on a rowing ergometer with a drag factor of 80 for 10 minutes. Next, a Quark PFT Ergo (COSMED® Rome, Italy) was attached to the athlete to start the test. The protocol of the test was the step test on the rowing ergometer. The athletes performed a row on the ergome-

ter with a drag factor of 115 for women and 130 for men for 5 minutes. The drag factor was increased gradually (20 drag factor in every minute) until the athlete was unable to row.



Figure 1. VO2max Test with COSMED on Rowing Machine

The test protocol for field test measurement used a 20 meters multi stage shuttle run test. This test involved running continuously between two lines with 20 meter distance. The participants stood behind one of the lines facing the second line, then started running when prompted by a beep. The speed at the start was quite slow. The subjects kept running between the two lines, then turn back to the second line once indicated by the ‘beep’ sound. After about a minute, the ‘beep’ sound indicated an increase of speed, and the ‘beep’ got closer and closer. It continued every minute (level). When the line was reached before the beep sounds, the subject had to wait for the beep to sound before continuing. But, when the line was not reached before the beep, the subjects were warned and should continue running to the line, then turn back and try to catch up in two more beeps. Subjects were warned the first time they failed to reach the line within 2 meters and were eliminated after the second warning.

Data Analysis

The data analysis process was carried out using Statistical Product and Service Solution version 25.0 with Pearson's product moment test. The test was performed to determine the degree of correlation between 2 variables, with an interval or ratio scale, by changing this value into a correlation coefficient ranging from -1.0 to 1. A value of -1 means that there is a perfect negative correlation, while 0 means no correlation, whereas 1 indicates a perfect positive correlation.

RESULT

Table 2 presents the mean and standard deviation of the measurement results of VO2max values on laboratory tests, for male (55.72 ± 3.27), and female (50.73 ± 3.27). Meanwhile, the mean and standard deviation of the VO2max testing on the field test were 61.92 ± 3.22 for male and 50.34 ± 4.71 for female.

Table 2. The Result of Vo2max Tests

	Field Tests	Laboratory Tests
Male (n = 17)	61.92 ± 3.22	55.72 ± 3.27
Female (n = 13)	50.34 ± 4.71	50.73 ± 4.17

The mean of both tests presented in Table 2 show a higher result on the field tests than laboratory tests carried out by male subjects but not significant for female.

The data in Figure 2 describes the correlation of the male Vo2Max values between the field test and the laboratory test on Rowing.

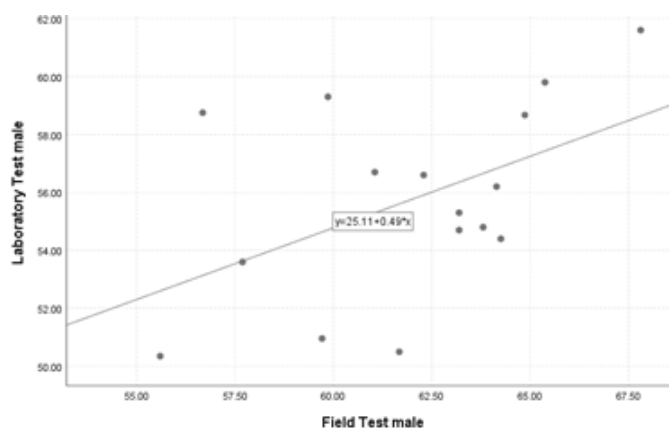


Figure 2. Correlation between Field Tests and Laboratory Test on Male Athletes

The data from Figure 2 illustrates that there is a low positive correlation of the VO₂max measurement results between the field and laboratory test approaches for rowing in male subjects ($r = 0.425$). This relationship shows that the results of the VO₂max test carried out by laboratory tests did not have a significant difference with the results of field tests, yet indicated a low level of correlation, which means that the two test parameters can be used in rowing for male athletes.

The data in Figure 3 describes the correlation results of the female Vo₂Max values from field tests with the laboratory on rowing.

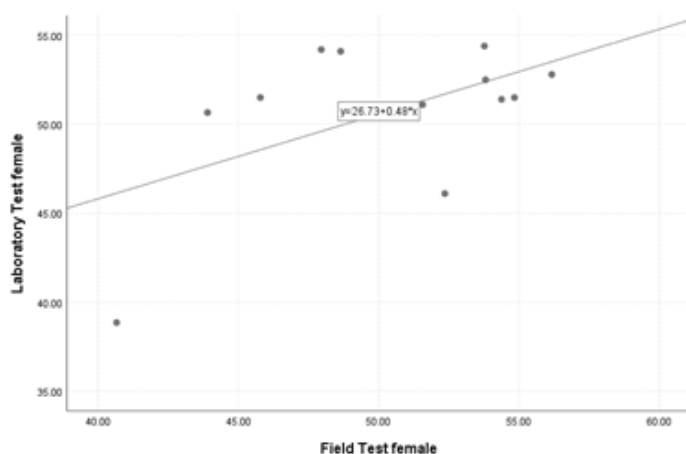


Figure 3. Correlation between Field Tests and Laboratory Test on Female Athletes

The data from Figure 3 shows that there is a significant positive relationship on the VO₂max measurement results of the female subjects between field and laboratory test approaches in rowing ($r = 0.62$). This relationship indicates that the results of the VO₂max obtained from the laboratory tests did not have a significant difference with the results of field measurements with a moderate level of correlation, which means that the two test parameters can be used in rowing for female athletes.

DISCUSSION

This study was aimed to analyze the VO₂max measurement method using field and laboratory VO₂max tests in rowing by considering the dominant movement mechanism that is different from other specific tests. The Vo₂Max results on the field test was

61.92, while for the laboratory test was 55.72 with a correlation value ($r = 0.425$) in male athletes showing that both tests could be used for rowing tests. The low correlation indicates the need to select an objective test for rowing, which is closer to the real condition on the male test considering the dominant characteristics of rowing movements.

Previous studies presented the selection of laboratory tests for better measurement (Lee et al., 2011). While the results of the analysis of VO₂max test data on female athletes concluded that, in the tests using field and laboratory measurements, there was a significant relationship with the moderate category in rowing ($r = 0.62$). Another study conducted by comparing the values of laboratory and field tests in badminton also obtained the same results that the two tests could be used; the study also obtained high correlation results because the dominant characteristic of movements in the two tests used were not much different (Rusdiana, 2020).

CONCLUSION

The correlation results show that the VO₂max test result carried out using the laboratory measurement did not have significant differences with the field measurement. Therefore, these two parameters can be used in the VO₂max rowing test. In addition, the correlation results differ between the male and female athletes. It indicates that physiology gender-specific tests need to be reassessed for male and female athletes.

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