
Test-Retest Reliability of the Digijump Machine

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ABSTRACT

Int J Exerc Sci 1(3): 106-112, 2008. Repetitive jumping has been identified as a possible exercise modality able to provide sufficient stimulus to improve bone health. However, it is necessary to establish whether repetitive jumping can elicit a consistent physiological response with the ability to monitor work rate. The purpose of this investigation was to determine the stability reliability of the Digijump device for the commonly used laboratory measures of oxygen uptake (VO₂), heart rate (HR), and rate of perceived exertion (RPE). College-aged individuals (N = 17) completed two 3-min repetitive jumping bouts on the Digijump machine (120 jumps per minute, jump height = 1.27 cm) at least seven days apart. Stability reliability was calculated using the intraclass correlation coefficient derived from 1-way ANOVA. Absolute VO₂ displayed the highest test-retest reliability (0.95), while the coefficient for relative VO₂ was also acceptable (0.71). The test-retest reliability coefficients for HR (0.89), and RPE (0.75) were determined to be within acceptable limits. Coefficients for all variables compared well with the stability reliability reported for other ergometers such as the Stairmaster, treadmill, and cycle. This data represent an important step in determining the validity of the Digijump machine for physiological testing.

KEY WORDS: Stability reliability testing, repetitive jumping, jump ergometer

INTRODUCTION

Valid physiological tests are important to athletes, coaches, and exercise scientists. Tests that allow an evaluator to draw appropriate interpretations are important for determining baseline measurements, categorizing fitness levels, and prescribing exercise regimens. Because a particular test can not be valid unless it is reliable (2), determining the test-retest reliability of novel ergometers is of importance.

An innovative device, the Digijump machine, has been developed which allows

one to use jumping as an exercise modality without the limitations of "jumping rope." This device allows an individual to jump at a pre-determined rate (jumps per minute) and at a pre-determined height per jump, while not having to "occupy" one's hands and arms, thus potentially reducing localized fatigue and enabling one to continue exercise longer and more consistently. As jumping rate on this device is governed by a series of lights, one may continue to exercise even if the person has an error. In traditional rope jumping, when the rope "catches" the foot, one must stop exercising and then start again.

Bone health and prevention of osteoporosis has been identified as a public health priority by the Department of Health and Human Services. According to the October 2004 Surgeon General's report on bone health and osteoporosis, by 2020 every other American older than 50 years of age will be at risk for fractures either from osteoporosis or low bone mass. One of the recommended measures for targeting this potential problem is encouraging some form of weight-bearing impact exercise. Brief bouts of repetitive jumping are likely an excellent recommendation as it provides both the weight-bearing and impact aspects in addition to an aerobic benefit. Significant increases in bone mineral density and bone mineral content have been reported in participants who jumped rope for 10 min prior to physical education classes (1) and in women who combined 60 min of rope jumping with a super circuit program (7).

It is of importance to examine specific benefits of impact exercise, such as repetitive jumping, on bone health. Prior to engaging in these types of studies however, determining the reliability of an ergometer that allows for repetitive jumping is necessary. Therefore, the purpose of this study was to determine the stability reliability coefficient of commonly measured laboratory variables on the Digijump ergometer.

METHOD

Participants

Participants were 17 college-aged individuals with a mean age of 22±1 (SD), mean height of 170.0±11.7 cm, and mean weight of 79.6±17.6 kg. Subjects provided voluntary written informed consent that

was approved by the institutional committee on the use of human research subjects.

Methodology

Subjects participated in two trials that were separated by at least 7 days. The duration of each trial was three minutes at a constant jump rate of 120 jumps per minute (jpm) and a height of 1.27 cm (0.5 inch). Heart rate (HR), rate of perceived exertion (RPE), and oxygen consumption (VO₂) were monitored at one minute intervals. Heart rate was established using Polar brand telemetric straps and watches (Oy, Finland). The metabolic and measures were generated through Vacumed TurboFit 5.05 software (Ventura, CA). Air cushioned masks were used to analyze expired air rather than the mouthpiece and nose clip method. Subjects reported RPE based on Borg's 6-20 scale (3).

Statistical Analysis

The intraclass correlation coefficient from one-way analysis of variance was used to determine the stability coefficient for each variable (SPSS version 14.0, Chicago, IL). This coefficient was calculated according to the following equation:

$$R = \frac{MS_A - MS_W}{MS_A}$$

RESULTS

VO₂ (L·min⁻¹)

Absolute oxygen uptake following three minutes of jumping on the Digijump device resulted in above average acceptability (R = 0.951, see table 1). The group VO₂ for trial 1 was 2.46±0.61 L·min⁻¹ and 2.32±0.58 L·min⁻¹ for trial 2 respectively. A scatter plot of the

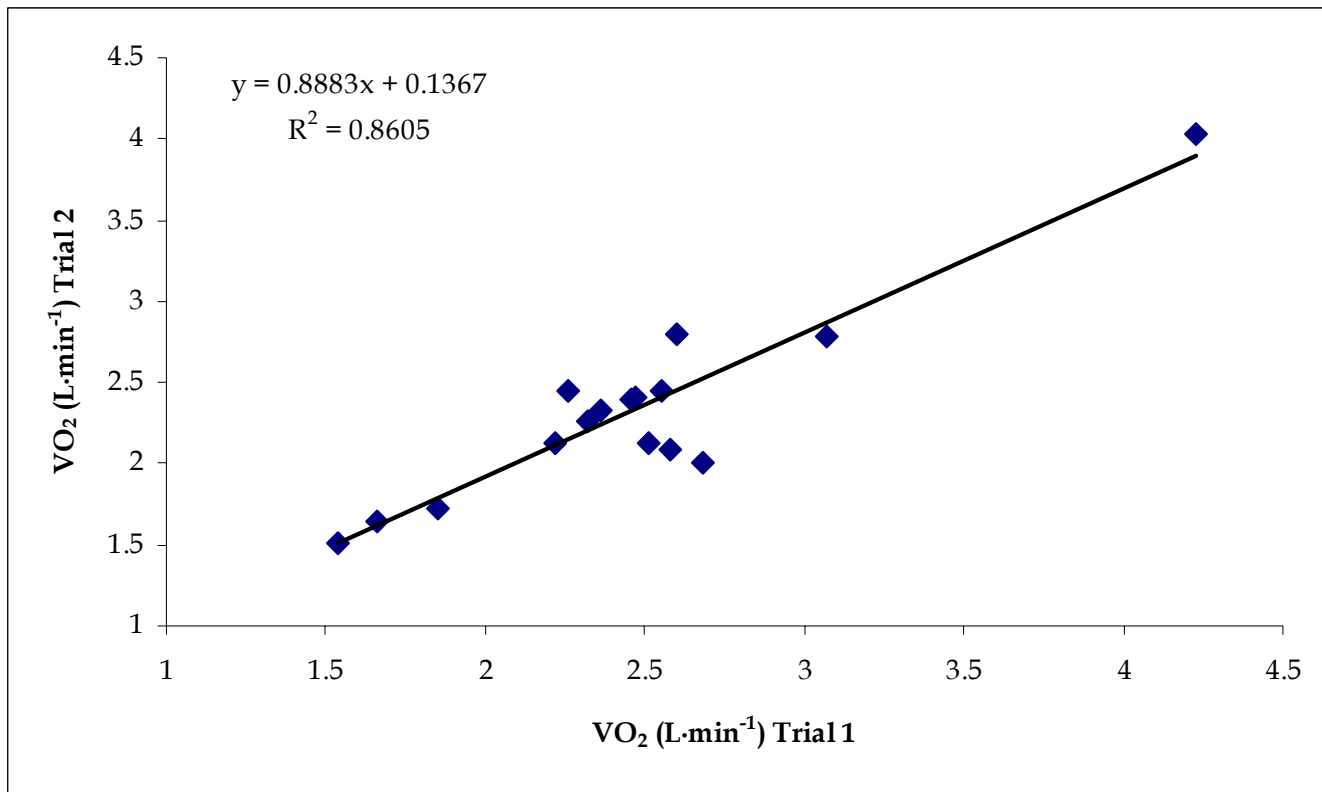


Figure 1. Test-retest oxygen uptake (L·min⁻¹) for participants who completed 3-min bouts of jumping on the Digijump device at a height of 0.5 inches and 120 jumps per minute.

individual measures are displayed in figure 1.

VO₂ (mL·kg·min⁻¹)

Relative oxygen uptake following three minutes of jumping on the Digijump device resulted in acceptable reliability (R = 0.708, see table 1). At the end of three minutes of jumping, the mean VO₂ for trial 1 was 30.6±4.1 mL·kg·min⁻¹ and 28.8±3.0 mL·kg·min⁻¹ for trial 2 respectively. A scatter plot of the individual measures are

displayed in figure 2.

Heart Rate (bpm)

Heart rate measured after three minutes of jumping on the Digijump device resulted in acceptable reliability (R = 0.888, see table 1). At the end of three minutes of jumping, the mean HR following trial 1 was 155±18 beats·min⁻¹, and 159±17 beats·min⁻¹ following trial 2 respectively. A scatter plot of the individual measures are displayed in figure 3.

Table 1. Stability reliability for measures from two 3-min Digijump bouts with reported confidence interval estimates.

Variable	Stability Reliability	95% Confidence Interval
VO ₂ (L·min ⁻¹)	0.951	0.863-0.983
VO ₂ (mL·kg·min ⁻¹)	0.708	0.186-0.897
Heart Rate	0.888	0.628-0.967
RPE	0.745	0.312-0.907

STABILITY RELIABILITY OF THE DIGIJUMP DEVICE

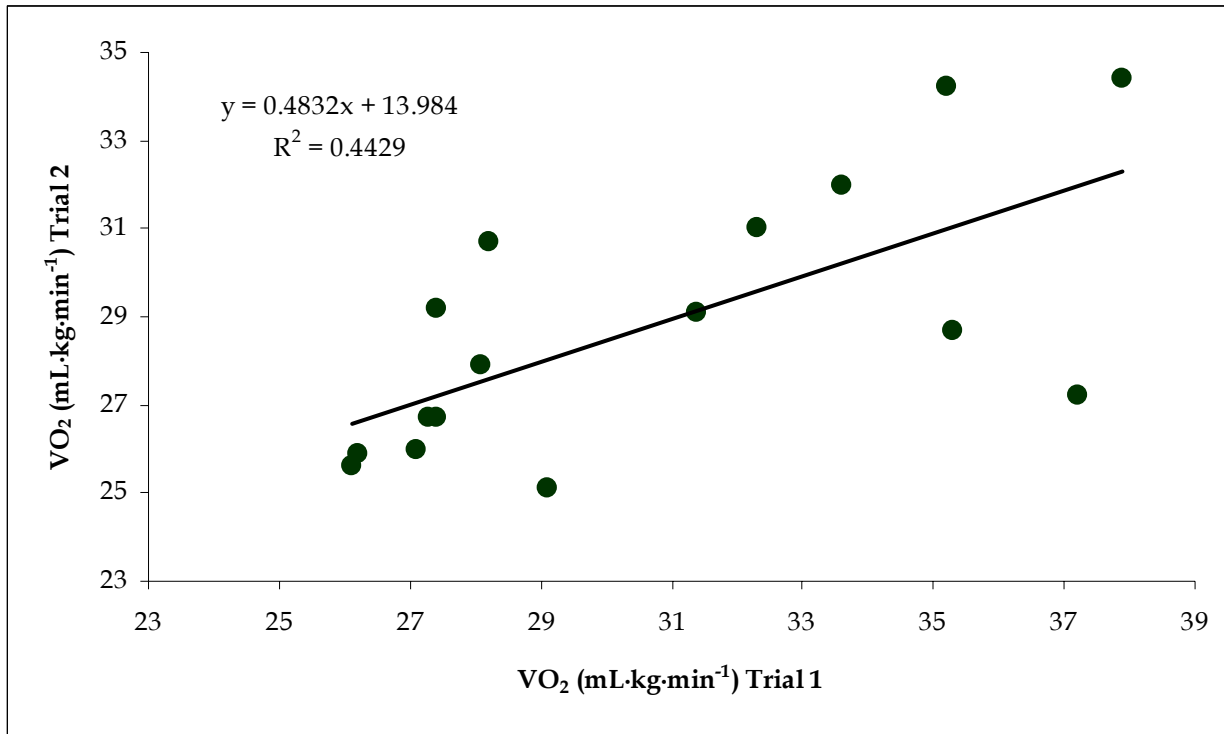


Figure 2. Test-retest oxygen uptake (mL.kg.min⁻¹) for participants who completed 3-min bouts of jumping on the Digijump device at a height of 0.5 inches and 120 jumps per minute.

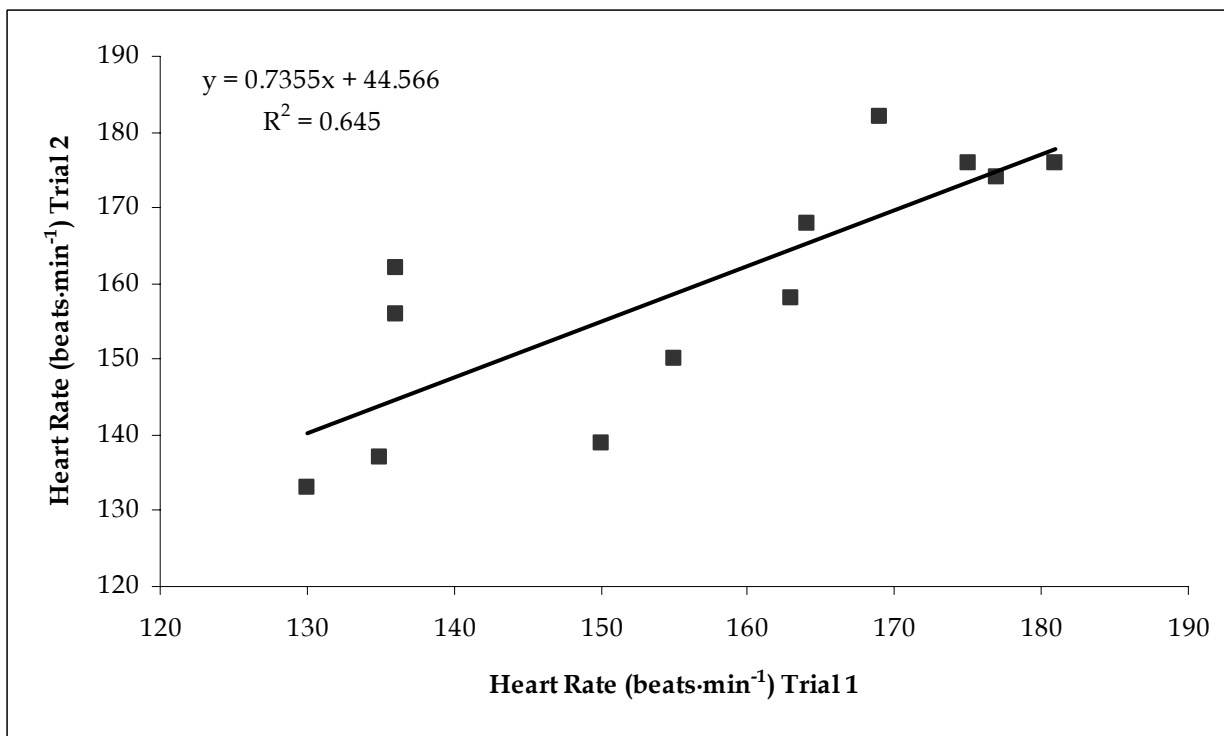


Figure 3. Heart rate test-retest measures for participants who completed 3-min bouts of jumping on the Digijump device at a height of 0.5 inches and 120 jumps per minute.

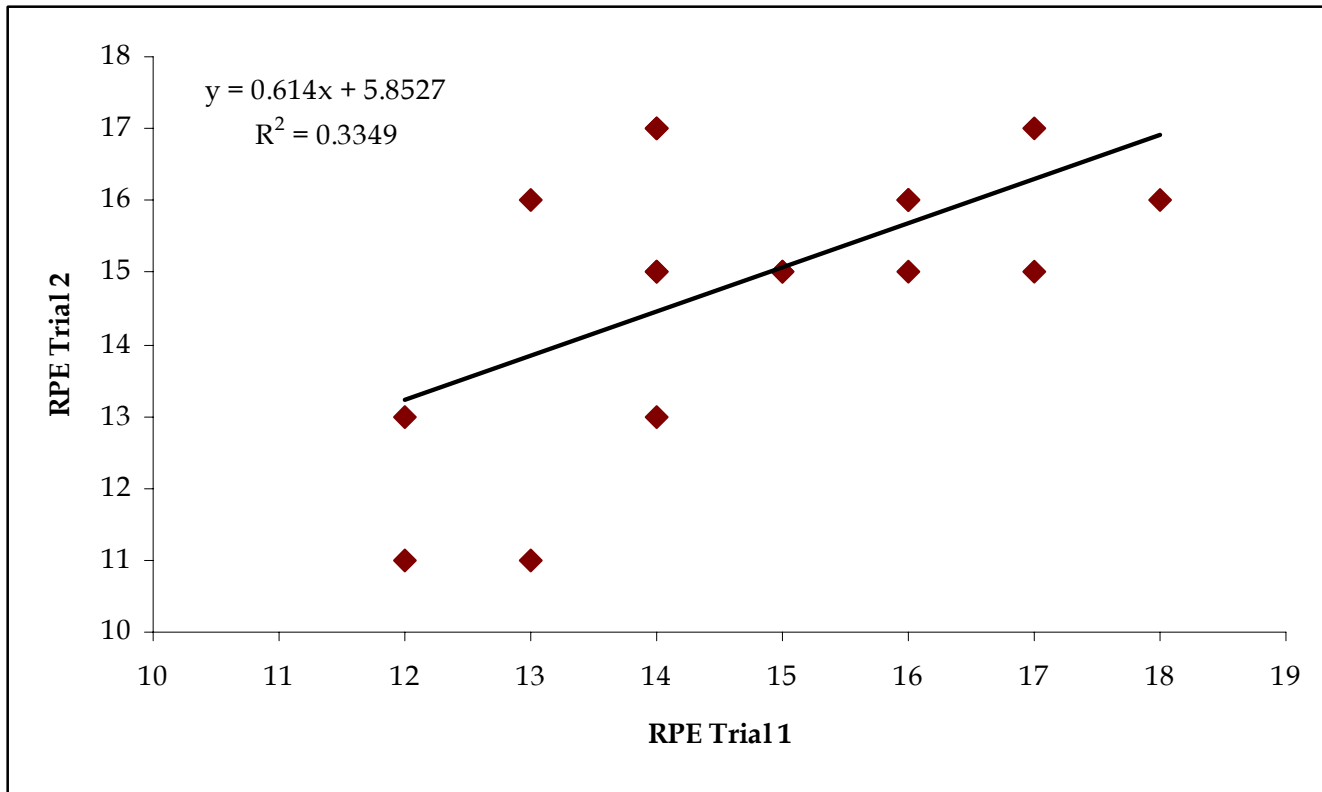


Figure 4. Rate of Perceived Exertion test-retest measures for participants who completed 3-min bouts of jumping on the Digijump device at a height of 0.5 inches and 120 jumps per minute.

Rate of Perceived Exertion

Rate of Perceived Exertion recorded at three minutes of jumping on the Digijump device resulted in acceptable reliability ($R = 0.745$, see table 1). Following three minutes of jumping, the mean RPE at the end of trial 1 was 14.7 ± 1.8 , and 14.9 ± 1.9 following trial 2 respectively. A scatter plot of the individual measures are displayed in figure 4.

DISCUSSION

The significant findings of the current study are that the common laboratory measurements of relative and absolute oxygen uptake, heart rate, and rate of perceived exertion each displayed acceptable stability reliability coefficients. These results indicate that a young college-aged individual would be expected to

produce similar values on the Digijump machine if two tests of similar intensity were completed on different days. The findings of the present study become an important first step in being able to determine the validity of using the Digijump device for physiological testing and its efficacy in potential training programs.

The stability reliability coefficients for oxygen uptake in the present study compare well with those reported in investigations on other ergometers. The reliability of relative oxygen uptake in participants who completed incremental tests on the Stairmaster 4000PT 6-8 days apart was reported to be 0.92 in men and 0.95 in women (5). The reliability of

absolute VO_2 during cycle ergometry has been reported to be between 0.85 and 0.95 in men, and between 0.80 and 0.99 in women for intensity ranges of ~60% to 100% $\text{VO}_{2\text{max}}$ (6). Using the same intensity ranges, treadmill running has been found to be reliable in men (0.93-0.98) and women (0.97-0.99) (6). While the stability reliability of absolute VO_2 in the present study was of above average acceptability (0.951), the reliability for relative VO_2 was found to be just acceptable (0.708). This may indicate increased variability in metabolic pathways utilized, muscle fiber types recruited, or mechanical efficiency involved in repetitive jumping on the Digijump device compared to other types of ergometers when body weight is accounted for.

For the measurement of heart rate, test-retest reliability on the Stairmaster 4000PT was reported to be 0.92 in women, and 0.91 in men (5). Stability reliability during cycle ergometry exercise was found to be between 0.83-0.91 in men and 0.84-0.90 in women (intensity ranges between ~60% to 100% $\text{VO}_{2\text{max}}$) (6). Similarly, stability reliability during treadmill running was reported to range between 0.90-0.95 in men and 0.91-0.96 in women (~60% to 100% $\text{VO}_{2\text{max}}$ range) (6). When compared to the reliability coefficients reported on other ergometers, the intraclass correlation coefficient for heart rate in the current study was similar (0.888). This indicates that the cardiovascular measure of heart rate is relatively constant from one exercise bout to the next, and provides the possibility that training programs on the Digijump device may use heart rate to accurately track progression.

The stability reliability for rate of perceived exertion in the present study is similar to what has been reported for treadmill exercise. Lamb et al. asked subjects to complete two incremental treadmill tests between two and five days apart (4). The reliability for RPE during the various stages are as follows: stage 1 (8 mph 2.5% grade) = 0.82, stage 2 (8 mph 5% grade) = 0.80, stage 3 (8 mph 7.5% grade) = 0.77, and stage 4 (8 mph 10% grade) = 0.75 (4). According to this data, the stability reliability coefficient decreased as exercise intensity increased. The reliability coefficient in the present study (0.745) corresponds most closely with those reported during the final stage of treadmill running. While the average RPE for both bouts was near 15, corresponding to "Hard" on the Borg scale (3), it is possible that repetitive jumping has a fatiguing effect on the lower leg muscles similar to the final stages of treadmill running. A comparative investigation of the Digijump to other types of ergometers is warranted.

The present study found that measures of oxygen uptake, heart rate, and rate of perceived exertion are reliable when repetitive jumping is completed on the Digijump device. As this study only included college-aged individuals, caution should be used with the interpretation of these findings until a wider age range of participants can be investigated. In addition to the measures of oxygen uptake and heart rate reported in the present study, it is recommended that the stability reliability of other cardiovascular and metabolic measures be determined while using the Digijump machine. Finally, as the current study only determined reliability at the end of exercise, various physiological responses

during the course of exercise should be compared. Given the findings of the present study, the Digijump machine, which has been developed with the express purpose of using repetitive jumping as a mode of exercise, shows promise as an ergometer that can be used to perform valid physiological testing.

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