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Original Article

Objectivity, Reliability, and Validity of the 90º Push-Ups Test Protocol Among Male and Female Students of Sports Science Program

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Abstracts
This study was conducted to determine the objectivity, reliability and validity of the 90º push-ups test protocol among male and female students of Sports Science Program, Faculty of Sports Science and Coaching Sultan Idris University of Education. Samples (n = 300), consisted of males (n = 168) and females (n = 132) students were randomly selected for this study. Researchers tested the 90º push-ups on the sample twice in a single trial, test and re-test protocol in the bench press test. Pearson-Product Moment Correlation method's was used to determine the value of objectivity, reliability and validity testing. The findings showed that the 90^0 push-ups test protocol showed high consistency between the two testers with a value of r = .99. Likewise, The reliability value between test and re-test for the 90º push-ups test for the male (r=.93) and female (r=.93) students was also high. The results showed a correlation between 90º push-ups test and bench press test for boys was r = .64 and girls was r = .28. This finding indicates that the use of the 90º push-ups to test muscular strength and endurance in the upper body of males has a higher validity values than female students.
Key words: arm and shoulder girdle strength and endurance, 90^0 push-ups, bench press

Introduction

The 90° Push-ups test are used as a measure of arm and shoulder girdle strength and endurance. Several different forms of 90º push-ups test s are used in physical fitness tests. In the past, 90º push-ups test s for males were executed with the toes and hands on the ground (full-body push-ups test), whereas females performed modified versions, including those with the knees and hands on the ground (bent-knee push-up). These modified versions were used because females tend to score lower than males on a full-body push-ups test. Also, the bent-knee push-up test was used with boys and girls who could not execute a full-body push-ups test. Presently, however, fitness tests like FITNESSGRAM® ® (Cooper Institute for Aerobics Research, 2007) have a 90° push-ups test for both boys and girls in which the toes and hands are on the ground while the participant lowers the body to the ground until the arms are at a 90° angle. Although the FITNESSGRAM® ® are mainly designed for testing children and youth, they are used for testing young healthy adults such as college students in fitness programs. Many fitness tests include versions of the push-ups test for females that appear to be easier and more discriminating among levels of arm and shoulder girdle strength and endurance for females than the male 90º push-ups test version. For example, in the past the Physical Fitness Index test required females to perform push-ups test s with the feet on the floor and the hands on a bench 13 in. high, touching the chest to the bench (Clarke, 1967; Mathews, 1978). The California Physical Performance test (Clarke, 1967), the Indiana Physical Fitness test (Clarke, 1967), and the Division for Girls' and Women's Sports test (Mathews, 1978) were several tests that included the bent-knee push-up for females. Safrit and Wood (1995) suggested using the bent-knee push-up for females examinees, stating that the full-body 90º push-ups test may not be a discriminating measure for some groups because some examinees cannot execute one execution. Tritschler (2000) suggested that girls and women perform a bent-knee push-up, whereas boys and men perform a full-body 90º push-ups test . The University of Massachusetts (2002) also includes a bent-knee push-up for women participants in the school's health and fitness assessments.

Recently, some programs like FITNESSGRAM® (Cooper Institute for Aerobics Research, 2007) required the 90° push-up for both males and females. Based on the FITNESSGRAM® standards, most females performing this 90º push-ups test could complete at least one. In the FITNESSGRAM®, intraclass reliability coefficients ranging from r = .64 to .96 were reported for 90º push-ups test scores of females (Cooper Institute for Aerobics Research, 2007); however, the reliability coefficient of r = .96 was obtained using bent-knee push-up scores. McManis, Baumgartner, and Wuest (2000) found low objectivity and reliability for both males and females in the ages from elementary school to college for 90° push-up scores. They also found that it was difficult to discern correct and incorrect forms with this 90º push-ups test, and low strength college-age women had difficulties performing the 90° push-up correctly. Based on these findings, they stated that a modified version of the 90° push-up might be needed for adequate measurement of low strength individuals.

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In light of these findings, Baumgartner, Oh, Chung, and Hales (2002) developed a 90° push-up test, defining the down position as the body from the chest to the knees contacts the floor. This 90º push-ups test protocol is a full-body push-ups test . Strong validity evidence was also found with correlations between revised 90º push-ups test and bench press scores of .80 for women and .87 for men. Despite this strong evidence, many women had scores of zero on this 90º push-ups test.

The developers of the FITNESSGRAM® (Cooper Institute for Aerobics Research, 2007) reported in their literature review that the push-ups test scores for college-aged women had good reliability but the push-ups test were done with the knees on the floor. The developers also found that, for youth taking the 90° push-up test in the FITNESSGRAM® , 5% of both boys and girls over 8 years of age and 10% of both boys and girls ages 6 to 8 years completed zero 90° push-ups. These zero scores on the 90º push-ups test may indicate that the 90º push-ups test on the hands and toes is too difficult for females to perform.

Due to the difficulty of the 90° push-up and modified push-up tests for some participants, especially females, the tests may lack the discrimination needed in a fitness test. The bent-knee push-up may be easier than the full-body push-ups test for females to perform. McManis et al. (2000) found that low strength females had difficulties performing the 90° push-up correctly, but were more successful performing bent-knee push-ups as an exercise in their class.

Objectivity, reliability, and validity must be acceptable for a test to be considered a good test. Baumgartner, Jackson, Mahar, and Rowe (2003) stated that, to have validity, a test must have reliability; however, to have reliability a test must first have objectivity. Validity exists if the interpretation of the test scores is correct (Baumgartner, Strong, Hensley, 2002). Validity evidence can be obtained by the criterion approach, determining the correlation between test scores and scores for a criterion or standard measure of the attribute being studied (Baumgartner et al., 2003). Baumgartner et al. (2003) defined reliability as the consistency of test scores; a test has objectivity if the scores are not dependent on who administered the test. At least two scores for each person being tested must be gathered to provide evidence of reliability or objectivity. These two scores can be collected from two different scorers, on two different trials in one day, or on two different days (Baumgartner et al., 2003).

For the measurement of arm and shoulder girdle strength and endurance, a standard measure or criterion is the bench press. Baumgartner, Oh, et al. (2002) used the bench press as the criterion to estimate the validity for the 90º push-ups test. Jackson, Fromme, Plitt, and Mercer (1994) and Pate, Burgess, Woods, Ross, and Baumgartner (1993) also used the bench press to provide evidence of criterion validity for the 90º push-ups test . Because the 90º push-ups test requires moving a person's body weight up and down, the bench press should also require moving a percentage of a person's body weight. Baumgartner, Oh, et al. (2002) used 70% of body weight for men and 40% of body weight for women for the bench press test. Each person executed as many repetitions as possible for the bench press. The score of a participant was the number of bench presses continuously executed correctly before the participant stopped due to fatigue or before body position was changed.

Based on the findings of Baumgartner, Oh, et al. (2002) there is good objectivity, reliability, and validity for the 90º push-ups test ; however, some women could not execute one 90º push-ups test . Possibly the bent-knee push-up test should be the alternative to the 90º push-ups test for college-age women. The purpose of this study was to determine the objectivity, reliability, and validity the 90º push-ups test protocol among male and female students of Sports Science Program and to determine the relationship between 90º push-ups test and bent press scores.

Method

Participants

Data were collected from samples (n = 300), consisted of males (n = 168) and females (n = 132) students of Sports Science Program. Students were randomly selected for this study. Students volunteered to participate in the research study. They were accustomed to executing 90° push-ups and bench press. Most of the data were collected before classes began each day.

Procedures

During the initial meeting with the participants, all of the participants signed an informed consent form, were told the purpose of the study, and were familiarized with tests they would be performing. The participants were tested a total of 2 days. The first day, all participants were weighed and performed 90° push-ups. The 90° push-up required the person being tested to lie face down on the floor with the hands placed under the shoulders, fingers pointed forward, and elbows pointed backward along the sides of the body. The person pushed up to full arm extension so the body weight was resting on the hands and toes; this was the up position. Then, keeping the body straight, the participant lowered herself until all of the body from the chest to the thighs touched the floor. The participant then pushed up to full arm extension, back to the up position. These down and up steps counted as one 90º push-ups test . The person being tested continued these steps at a comfortable rate with no rest until fatigued. One 90º push-ups test was counted when the participant started at the up position, went to the down position, and then returned to the up position. The score was the number of 90º push-ups test s executed correctly

before stopping or before body position was changed (Clarke, 1967). Two raters, trained in the methods to be used, tested the participants for objectivity purposes. Both raters independently scored the number of 90º push-ups test s performed correctly. The two raters were used in only half of the classes. These classes were randomly selected. On the 2nd day of testing, all the participants performed a bench press test. The bench press test protocol was based on lifting used 70% of body weight for men and 40% of body weight for women for the maximum number of repetitions possible (Baumgartner, Oh, et al., 2002). The participant's hands were placed on the bar approximately shoulder length apart. The participant pushed the bar up to full arm extension. This was the starting position. The bar was then lowered with a controlled motion to the chest. One press was counted once the bar was raised back up to the starting position. The score of a participant was the number of full presses continuously executed with correct form before the participant stopped due to fatigue or body position was changed. An attempt to make up for a missed test was made after each testing day.

Data Analysis

Objectivity for the 90°push-ups test scores was estimated for the score of one rater (in the future, one rater scored the test) using an intra class correlation coefficient (R) based on Pearson Product Moment model as presented by Baumgartner et al. (2003). Reliability for the 90° push-ups test scores was estimated for a score collected on one day by one rater (in the future, one rater scored the test on one day) using on intra class correlation coefficient (R) based on Pearson Product Moment model as presented by Baumgartner et al. (2003). For criterion validity, a Pearson correlation coefficient was calculated to determine the relationship between the 90° push-ups and bench press scores. Also, a Pearson correlation coefficient was calculated to determine the relationship between 90° push-up and bench press. The SPSS version 14.5 package of statistical computer programs was used to do all the calculations.

Results

A total of 300 participants were included in this study were tested with both the 90º push-ups test and bench press test. All participants were used in the objectivity of the 90º push-ups test scores, reliability of the 90º push-ups test scores, and criterion validity of the 90º push-ups test portions of the study. Descriptive information for the scores on the 90º push-ups test and bench press tests are presented in Table 1.

There were 132 women and 168 male who completed 90º push-ups tests on the 1st day when two raters were present. Presented in Table 1 is descriptive information concerning the scores for raters A and B. The score for a person varied only by one 90º push-ups test when variations occurred between the two raters. Participants (male = 84, female = 66) had 90º push-ups test s scores for both Day 1 and Day 2. The same rater tested the participants both days. One hundred and sixty eight male and one hundred and thirty two female performed the 90º push-ups test and bench press tests. For descriptive information on this group, see Table 1 and 2. The same rater administered both tests.

Table 1 Descriptive Statistics for the 90º push-ups test and Bench Press Scores of the Participants in the Study (Male)

Variable	n	M	SD	Minimum	Maximum
90º push-ups test Rater A	84	36.42	4.05	26	45
90º push-ups test Rater B	84	36.50	3.96	28	44
Overall 90º push-ups test	168	36.93	3.469	26	45
Bench Press	168	7.75	1.87	1	11

Table 2 Descriptive Statistics for the 90º push-ups test and Bench Press Scores of the Participants in the Study (Female)

Variable	n	M	SD	Minimum	Maximum
90º push-ups test Rater A	66	22.14	2.76	17	32
90º push-ups test Rater B	66	21.70	3.34	16	34
Overall 90º push-ups test	132	22.58	2.58	18	34
Bench Press	132	3.85	0.85	1	6

The intra class correlation coefficient using the scores of the two raters and estimating the objectivity for the score of one rater (Baumgartner et al., 2003) was r = .99 (male) and r = 0.98 (female). This correlation coefficient suggests high objectivity between raters. Ninety percent confidence limits for the correlation coefficient are presented in Table 3. The confidence limits values are high and quite close together.

Table 3 Ninety Percent Confidence Limits for the Intra class and Pearson Correlation Coefficients Calculated as Objectivity, Reliability, and Validity Evidence

Evidence Use	R (Male)	R (Female)	r (Male)	r (Female)	n (Male)	n (Female)
Objectivity	0.99	0.98	-	-	84	66
Reliability	0.93	0.93	-	-	84	66
Validity (90º push-ups test)	-	-	0.64	0.28	168	132

The intra class correlation coefficient using the scores from two days and estimating the stability reliability for 1 day was r = .93 (male) and r = .93 (female). This is an acceptable value for the stability reliability

evidence (Baumgartner et al., 2003). The Pearson correlation coefficient between the 90º push-ups test and bench press scores was r = .64 (male) and r = .28 (female). This value is moderate criterion validity for the 90º push-ups test scores.

Discussion

The objectivity coefficient (.98 - .99) for the 90º push-ups scores was very good. Baumgartner et al. (2003) stated that the inter scorer objectivity coefficient should be at least .80. The 90º push-ups test appears to be easily administered by different raters without the raters having different scores. The protocol for the 90º push-ups seems to be simple enough for the raters and the participants to follow easily. The stability reliability coefficient obtained (.93) was moderate for the 90º push-ups scores. Baumgartner et al. (2003) suggested that the stability reliability coefficient should be at least .80. Baumgartner, Oh, et al. (2002) found higher stability reliability (.90–.95) than was found in this study for the 90º push-ups test. The moderate stability reliability suggests that the scores may change slightly between days for each participant even if the scorer remains the same. The confidence limits for a correlation coefficient are the degree of confidence the researcher has that the population value of the correlation coefficient is between the lower and upper values of the confidence limits.

The criterion validity evidence, a correlation coefficient between the 90º push-ups scores and the bench press scores, of r = .64 (male) was moderate and r = .28 (female) was below moderate. The correlation between the 90º push-ups test scores and bench press scores was .64. Baumgartner, Oh, et al. (2002) found a higher correlation (r = .80) than was found in this research study between the 90º push-up scores and the bench press scores for women. Differences in the correlation coefficients between their study and this study could be due to sample differences or size of the samples. Notice in Table 2 the upper limit value of the confidence limits for the validity of the 90º push-ups test is .80, the value found by Baumgartner, Oh, et al. (2002). Scores of zero were not found in this study on the 90º push-ups test. The 90º push-ups test seem appropriate for use in fitness testing test protocol among male and female students of Sports Science Program, Faculty of Sports Science and Coaching.

In conclusion, the inter scorer objectivity for the 90º push-ups test scores in this study is very good for male students. The stability reliability of these scores is acceptable. The validity obtained in this study for the 90º push-ups test is acceptable. Baumgartner, Oh, et al. (2002) developed the 90º push-ups test because he found good objectivity, reliability, and validity for the 90º push-ups test. The use of the bent-knee push-up test rather than the 90º push-ups test would allow for better measurement of the lower strength female because the bent-knee push-up is easier for the college-age female population.

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