

Validity and Reliability of Bailey Bridge Test for Hong Kong Secondary School Students 香港中學生拾放豆袋測試的效度及信度

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Abstract

The test most often recommended for measuring upper body strength and endurance is the pull-ups which has often been criticized because of the large number of zero scores. In the last academic school year, twelve secondary schools under the Po Leung Kuk group administered the Bailey Bridge Test for measuring upper body strength and endurance in their own physical fitness test battery. The purpose of this study was to investigate the validity and reliability of the Bailey Bridge Test for secondary school students. A total of 1,906 secondary school students, aged 13-19, from 4 schools, participated in the study. Criterion validity was assessed by correlating Bailey Bridge Test with bent-knee push-up and hand grip strength. A sample of subjects were tested on two different days on Bailey Bridge Test to establish stability reliability. To conclude, the Bailey Bridge test shows unacceptable validity with barely acceptable reliability.

摘要

一般用來測試上肢肌力的引體向上方法，受試者很常會取得零分而影響教師對學生的評估。去年本港保良局屬下十二間中學，製定出一套體適能測試方案，並採用了拾放豆袋測試來量度學生的上肢肌力。本文目的是評審拾放豆袋測試的效度和信度。共有1,906位13至14歲的中學生參與本研究，以屈膝掌上壓及手握力測試的相關系數作為效標關聯效度的指標；再測法則用來計算信度。研究結果顯示拾放豆袋測試的效度未能被接受，信度也偏低。

Introduction

Upper body muscular strength and endurance is considered an important component of health-related physical fitness. Most commonly used test items for measuring upper body strength and endurance are pull-up and flexed-arm hang (AAHPERD, 1988; AAU, 1992; PCPFS, 1987). However, both tests have been criticized because of the observed relatively large percentages of zero scores, particularly among girls and younger boys (AAHPERD, 1988; Jackson & Griffin, 1983; Ross & Gilbert, 1985) and subsequent loss of discrimination among ability levels. Chow (1996) has summarized and described major field tests of upper body strength and endurance. Starting from 1997-98 academic year, 12 secondary schools under the Po Leung Kuk group administered their own physical fitness test battery. The test items were chosen after consultation with the Physical Education Section, Education Department and they mostly adopted the items contained in the "Physical Fitness Award Scheme",

which is jointly promoted by the Education Department and Hong Kong Childhealth Foundation. However, since the Scheme contains no test item for upper body dynamic muscular strength and endurance for secondary students at that time, they decided to adopt the Bailey Bridge test for measuring upper body strength and endurance.

The Bailey Bridge test was one of the items in the physical fitness test of the "Duke of Edinburgh's Award Scheme" (renamed as "The Hong Kong Award for Young People" in 1997) and has been used for over twenty years. The Bailey Bridge Test is purported to measure the upper body strength and endurance and is still used for physical fitness test for the Award Scheme in England. The Bailey Bridge Test involves moving a beanbag up and down from a distance of chair/box height of 45 cm to ground. (see Table 2 for test descriptions). The test itself seems desirable to be used in schools because it requires minimum equipment (beanbags and bench/chairs) and it can be mass testing.

However, the validity and reliability of the Bailey Bridge Test to be used in secondary schools are not known. In a study on 692 primary school children, Chow (1997) found unacceptable criterion validity of the Bailey Bridge test correlated with bent-knee push up and hand grip strength and low test-retest reliability.

Method

The subjects for this study were 1,906 students (782 males, 1,124 females), aged 13-19 years, from 4 co-educational secondary schools which are all located in New Territories regions. Table 1 shows the distribution of subjects by school while Figure 1 shows the distribution of participants by age, sex and by secondary levels. The Bailey Bridge Test was conducted based on the descriptions proposed by PES/ED (see Table 2 for test descriptions). The Bailey Bridge Test score was the number of successful repetitions in 30 seconds. The criterion validity was assessed by correlating the Bailey Bridge Test with 90° straight leg push-up (for male), bent-knee push-up (for female), and hand grip static muscular strength (see also Table 2 for test descriptions). Since both push-up and hand grip tests are also measures of arm strength, it was hypothesized that the children's scores on two should positively correlate with the Bailey Bridge Test. The push-up score was the number of repetitions in 30 seconds. The 90° straight leg push-up test protocol follows the Prudential FITNESSGRAM (1992) except the requirement for 1 push-up every three seconds. The hand grip score was the sum of dominant and non-dominant hand grip static maximal strength with units of kgf. A sample of subjects ($n=881$) from 3 schools (except School D), were also tested on two separate days on Bailey Bridge test to establish stability reliability. Furthermore, data analysis based on younger age group (13-15, 440 males & 697 females) and older age group (16-19, 342 males & 427 females) were conducted. These age divisions correspond closely to junior and senior age secondary students.

Results and Discussions

Means and standard deviations of various tests by age and sex level were reported in Table 3. As expected, the mean values for older age groups were greater than the younger age groups and means for males were greater than females. The means for the Bailey Bridge Test in 30 second ranged from 15 to 19 for various age groups. Table 4 showed the correlations between Bailey Bridge test with the grip strength (sum of dominant and non-dominant hands) and the 30 second push-up test. Correlation between Bailey Bridge and grip strength tests (total: dominant + nondominant score; unit: kgf) was found to be $r = .36$ for all subjects and r ranged from .13 to .27 for younger and older age groups and by sex. On the other hand, correlation between Bailey Bridge and push-up tests was found to be higher than

hand grip strength with $r = .38$ for all subjects and r ranged from .25 to .44 for younger and older age groups and by sex.

The test-retest stability reliability for the Bailey Bridge test was calculated by the one-way ANOVA model. The intraclass reliability coefficient was found to be $R=0.77$ for all subjects ($n=881$). The R for 13-15 age group were found to be .84 and .65 for males ($n=180$) and females ($n=452$), respectively while R for 16-19 age group males ($n=106$) was .73 and females ($n=143$) was .67. Therefore, reliability coefficients for males were found to be higher than females. A possible explanation is that females tend to perform inconsistently than males.

According to Safrit (1990), values of validity coefficient exceeding .80 are acceptable if a test is being used as a substitute for a more sophisticated test. The findings in this study showed the highest Pearson correlation as a criterion validity coefficient for Bailey Bridge test with grip strength was .36. This particular correlation coefficient can only reflect 13% of explained variance for their relationship. Similarly, the relationship between the Bailey Bridge test and the 30-sec push up test was found to be weak with the highest coefficient being .44 indicating 19% of explained variance for their association. Therefore, the Bailey Bridge test is invalid for secondary school students when tested by correlation with two similar arm strength tests.

By kinesiological viewpoint, the Bailey Bridge Test itself mostly requires static muscular support by one hand, which seems to involve different muscle groups as push up test. Moreover, since the Bailey Bridge test requires manipulative skill of moving the beanbag and balancing skill by one arm, test results might be confounded by abilities other than the upper body strength and endurance of which the test is purported to measure. Abilities affecting the test performance might include manipulative skill and dynamic balance that may explain for the low criterion validity found in this study. Another possibility for such a weak correlation might be due to the difficulty of getting true reflection of upper body strength and endurance ability for the push up test since both the straight leg and bent-knee push up tests are hard to be detected for incorrect form. On the other hand, finding for the low correlation between the Bailey Bridge and grip strength is unexpected. Again, such a result may reflect that the Bailey Bridge test is measuring different components of physical abilities as compared with the grip strength test. The present author suggests further tests for criterion validity correlated with some other upper body strength and endurance measures should be conducted. For example, laboratory tests such as dynamic arm muscular strength tested by cable tensiometer or by bench press, shoulder press machines can be used as criterion measures for the Bailey Bridge test.

In terms of test-retest reliability, Baumgartner and Jackson (1995) stated that most physical measures exhibit coefficients between .80 and .95. The findings in this study showed intraclass coefficients for the Bailey Bridge test ranged from .65 to .84 for different age groups. Thus, the reliability for the Bailey Bridge test is found to be just barely acceptable when the test is conducted on secondary school students.

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Acknowledgement

The author would like to acknowledge the following physical education teachers in the data collection for this study: Ms. May Chan, Mr. Chan Kwong Hei, Mr. Lee Tung Wah, Mr. Pun Tai Wai, and Mr. Tai Chung Ko.

Table 1. Distribution of Subjects by School, Secondary Levels and Sex.

| School | Location | Secondary Levels | Sex | n |
|--------|------------|------------------|------|------|
| A | Fanling | S1-4 & S6 | F | 595 |
| B | Ma On Shan | S1-2 & S6 | M | 134 |
| C | Tsuen Wan | S1, 3 & S4 | M, F | 152 |
| D | Tsuen Wan | S1-S7 | M, F | 1052 |

Table 2. Test Descriptions for Bailey Bridge Test, Bent-knee Push-up and Hand Grip Strength.

| | |
|---|---|
| Bailey Bridge Test | |
| • | is used for measuring the dynamic strength of the arms. |
| • | The subject starts the test in the front support position with shoulders near to and facing a box/chair. |
| • | The top of the box/chair should be 45 cm from the floor. |
| • | Take the bean bag from the top of the box with one hand. |
| • | Place the bean bag on the floor. |
| • | Pick up the bean bag with another hand and place it on the top of the box/chair. |
| • | The number of times that the bean bag is successfully placed on the box/chair in 30 seconds will be recorded. |
| 90° Straight Leg Push-up | |
| • | Subject in a prone position on the mat with hands placed under the shoulders. |
| • | Fingers stretched out, legs straight, parallel & slightly apart, toes tucked under. |
| • | Subject pushes off mat with arms until arms are straight, keeping legs & back straight. |
| • | Then lowers body using arms until the elbows bend at 90° angle and the upper arms are parallel to the floor. |
| • | Repeat movement as many times as possible in 30 seconds. |
| Bent-knee Push-up | |
| • | Body position: on a mat, arms straight, hand shoulder width apart and slightly forward of the subjects. |
| • | Knees on the floor with a straight line from shoulders to knees. |
| • | Maintain this straight body position, lower the chin to the mat and return to the starting position. This counts as one repetition. |
| • | The score is the number of repetitions in 30 seconds. |
| Hand Grip Strength (Use of Grip Dynamometer) | |
| • | Keep the straight arm hanging on the side of body. |
| • | Adjust grip handle width. |
| • | Return the dial back to zero. |
| • | Squeeze with straight arm as hard as possible without moving the hand. |
| • | Three trials are given separately for dominant hand and nondominant hand. |
| • | Record the best score for each hand. |
| • | The total score is the sum of dominant hand score and nondominant hand score. |

Table 3. Descriptive Statistics of Test Performances.

| Tests | Values | Male All (n=782) | Female All (n=1124) | Male 13-15 yrs (n=440) | Female 13-15 yrs (n=697) | Male 16-19 yrs (n=342) | Female 16-19 yrs (n=427) |
|---|--------|------------------------|---------------------------|------------------------------|--------------------------------|------------------------------|--------------------------------|
| Bailey Bridge (#) | M (SD) | 17.9 (3.3) | 15.9 (3.0) | 17.2 (3.4) | 15.3 (2.9) | 18.8 (2.9) | 17.0 (2.9) |
| | Min | 5 | 6 | 5 | 6 | 8 | 8 |
| | Max | 36 | 28 | 36 | 23 | 28 | 28 |
| Grip (tot) ^a (kgf) | M (SD) | 61.8 (18.4) | 47.7 (8.8) | 52.7 (15.4) | 46.1 (8.6) | 73.6 (14.7) | 50.4 (8.5) |
| | Min | 22 | 21 | 22 | 21 | 28 | 26 |
| | Max | 124 | 78 | 102 | 77 | 124 | 78 |
| Grip (dom) ^b (kgf) | M (SD) | 31.6 (9.4) | 24.5 (4.1) | 27.2 (8.0) | 23.8 (4.6) | 37.2 (7.9) | 25.7 (4.6) |
| | Min | 11 | 10 | 11 | 10 | 18 | 13 |
| | Max | 63 | 39 | 54 | 38 | 64 | 39 |
| Grip (non) ^c (kgf) | M (SD) | 30.3 (9.5) | 23.2 (4.6) | 25.5 (7.8) | 22.3 (4.4) | 36.4 (7.7) | 24.7 (4.5) |
| | Min | 6 | 10 | 10 | 10 | 6 | 11 |
| | Max | 61 | 40 | 50 | 39 | 61 | 40 |
| 30 sec. Push- Up ^d (#) | M (SD) | 21.2 (9.1) | 21.6 (10.2) | 18.6 (8.5) | 18.7 (9.5) | 24.5 (8.9) | 27.8 (8.7) |
| | Min | 0 | 5 | 0 | 5 | 0 | 6 |
| | Max | 49 (n=776) | 57 (n=995) | 46 (n=437) | 50 (n=678) | 49 (n=339) | 57 (n=317) |

Note:

a: grip strength total by dominant hand & non-dominant hand

b: grip strength (dom) as dominant hand

c: grip strength (non) as non-dominant hand

d: male- 90° straight legs push-up; female-bent-knee push-up; different n for push-up

Table 4. Correlations of Criterion Measures with the Bailey Bridge Test.

| Tests | Bailey Bridge Test | | | | | |
|--------------------------------------|--------------------|-----------------|----------------------|----------------------|----------------------|----------------------|
| | Male | Female | Male | Female | Male | Female |
| | All (n=782) | All (n=1124) | 13-15 yrs (n=440) | 13-15 yrs (n=697) | 16-19 yrs (n=342) | 16-19 yrs (n=427) |
| Grip (tot) ^a (kgf) | .31 | .22 | .18 | .19 | .27 | .13 |
| Grip (dom) ^b (kgf) | .31 | .22 | .18 | .19 | .29 | .14 |
| Grip (non) ^c (kgf) | .29 | .20 | .17 | .16 | .21 | .11 |
| 30 sec. Push- Up ^d (#) | .44 (n=776) | .39 (n=995) | .38 (n=437) | .35 (n=678) | .44 (n=339) | .25 (n=317) |

Note:

a: grip strength total by dominant hand & non-dominant hand

b: grip strength (dom) as dominant hand

c: grip strength (non) as non-dominant hand

d: male- 90° straight legs push-up; female-bent-knee push-up; different n for push-up

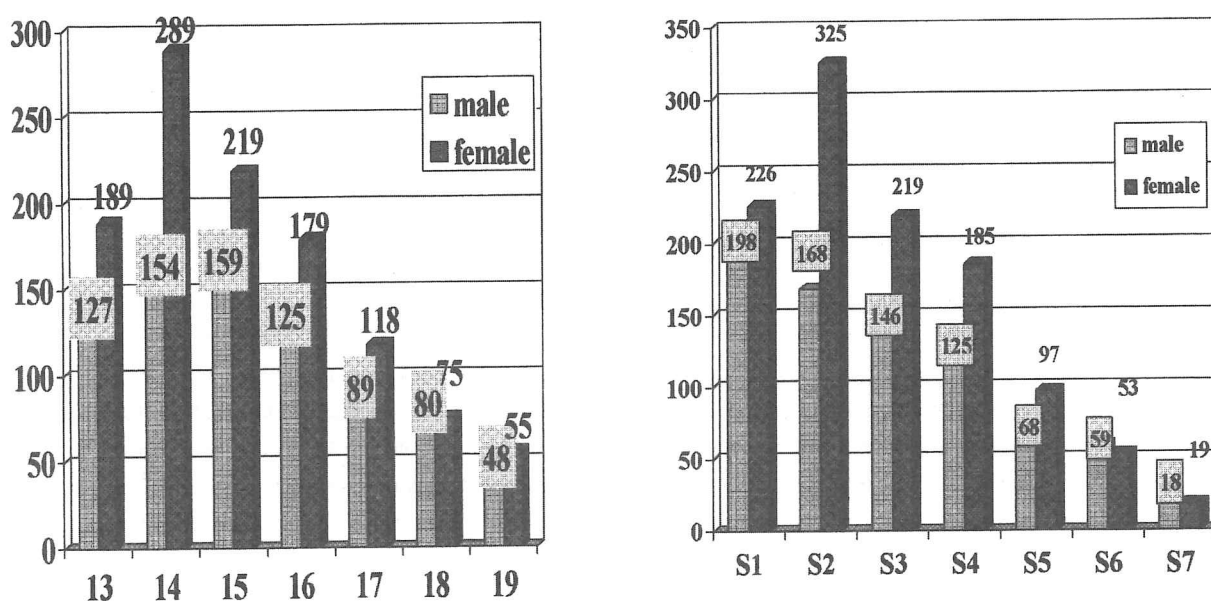


Figure 1. Number of subjects by age & sex & secondary school levels.