FIELD TESTS OF UPPER BODY STRENGTH AND ENDURANCE

上肢肌力與肌耐力的測試

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摘 要

上肢肌力與肌耐力是健康體適能的主要元素，一般對肌力與肌耐力的測試多注重其可信度和效度。本文目的是探討不同類型的上肢肌力與肌耐力的測試，綜合分析其特點，以提供更有效及可靠的測試方法。

Muscular strength and endurance is one of the component of the health-related physical fitness. Tests of this component normally include abdominal and upper body. Abdominal strength and endurance field tests are bent-knee sit-ups and curl-ups which are easy to administer. Upper body strength and endurance field tests, however, are not as clear cut as those for abdominal and numerous efforts have made in search for a better one which has to be valid, reliable, objective, and mass testable with minimum equipment.

Traditionally, pull-up and flexed-arm hang are the two most commonly used test items for the measurement of upper body strength and endurance (AAHPERD, 1988; AAU, 1992; PCPFS, 1987) (see Table 1 for a comprehensive comparison of various fitness batteries). Both tests require a metal or wooden bar approximately 1-1.5 inches in diameter (Kirkendall, Gruber, & Johnson, 1987). Subject should use an overhand grasp with the palms facing away from the body (see Table 2 for the testing procedures for selected tests introduced in this article). The score for pull-up is the number of completed pull-ups in 30 seconds or 60 seconds while the score for flexed-arm hang is the time a subject holds on the specified position. However, both tests have often 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. Moreover, the test performance of both tests is related to body weight (Cotten, 1990; Pate, Ross, Baumgartner, & Sparks, 1987). The dips is another test for measuring arm and shoulder strength and endurance for male (Johnson & Nelson, 1986), but the test is seldomly included in test batteries, possibly because of the difficulty of the test.

In view of the problems associated with the pull-up and flexed-arm hang (e.g., skewness, poor discrimination, body weight association), various forms of modified pull-up and push-up tests have been developed and are included in some test batteries (see Table 1). The palms-facing chin-up is viewed as less difficult to perform than the palms-forward pull-up (Gabbard, Patterson, & Elledge, 1981), but a large number of zero scores were found in the National Children and Youth Fitness Study [NCYFS], Phase I (1985). The Phase II of the NCYFS adopted the Vermont pull-up (Pate et al., 1987; Vermont Governor's Council on Physical Fitness, 1982) to overcome the zero score problem of pull-up and chin-up, however, the test requires special equipment (see description of the various tests in Table 2). The Baumgartner's modified pull-up test also requires special equipment which can be home-made or obtained through manufacturer. Because of the inclined body position, both Vermont and Baumgartner's modified pull-up tests are easier to perform than pull-up and has been shown to be successful in terms of reliability and score distribution (Baumgartner & Wood, 1984; Baumgartner et al., 1984, Engelman & Morrow, 1991).

The Prudential Fitnessgram's (1992) modified push-up test appears to be reliable for elementary children (McManis & Wuest, 1994). But the problems with maintaining proper form while performing a push-up are not eliminated. Nelson, Yoon, and Nelson (1991) developed a modified push-up test requiring a subject maintaining an "A-shaped" body position both in the "up" and "down" positions following a cadence of 2 seconds per push-up. Construct validity and stability reliability estimates were found to be acceptable for young and college age male and female. Another modified version

of push-up test has been introduced in the Australian Schools Fitness Tests (Pyke, 1985). The modified push-up requires a subject to perform regular push-up from the front edge of the chair placed against a wall. No evidence of validity or reliability for this test was given (Pyke, 1985). Another similar test, called bench push-up, is used for testing primary school children (Kirchner, 1970). The knee push-ups, which is often used for testing female subjects, has also designed as a substitute for the regular push-up test (Johnson & Nelson, 1986; Miller, 1988).

With the plethora of upper body strength and endurance tests, the search for a desirable one continued. Recently the Physical Education Section, Education Department (PES/ED) of Hong Kong, as the local advisory and inspectorial body, proposes the bailey bridge test to be used in schools. The bailey bridge test is one of the items listed in the physical fitness test of the Duke of Edinburgh's Award Scheme. Subjects of the Scheme can either choose push-up or bailey bridge test for measuring the upper body strength and endurance. The PES/ED adapts this test and suggests a bench height of 30 cm for children under age of 9 and keeps the chair height of 45 cm for subjects aged 9 or over (see Table 2 for test description). Since the test requires shifting of body support momentarily to one hand, the ability of dynamic balance seems to confound the test performance. Moreover, the validity and reliability of the bailey bridge test to be used in schools needs to be investigated.

Although most tests of upper body strength and endurance provide norm-referenced standards, scientifically derived criterion-referenced standards (CRS) have not yet been developed. The reason might be because a clear relationship between low strength and endurance and an increased risk of hypokinetic disease has not been established (Rutherford & Corbin, 1994). As stated by Rutherford and Corbin, "research in this area has focused primarily on the positive relationship between bone stress and bone mineral density" (p. 111). In general, research has suggested that resistance exercise may increase bone density and reduce the risk of osteoporosis, particularly in women (Block, Smith, Friedlander, & Genant, 1989). Because the relationship between upper body strength and osteoporosis is unclear, how much strength and endurance necessary for good health or adequate functioning is still unknown.

The CRS for muscular fitness have established mostly from normative data and expert opinion (Safrit & Wood, 1990). For example, the CRS for pull-up test of the Prudential Fitnessgram (1992) is one pull-up for children aged five through thirteen. Figure 1 shows the comparison of CRS for the pull-up test across several national test batteries in USA (Baumgartner & Jackson, 1995). However, Rutherford and Corbin (1994) used the contrasting groups method for trained and untrained subjects and found the cutoff scores of .5 repetitions, 14 repetitions, and 5 seconds for the pull-up, push-up and flexed-arm hang, respectively for college-age females. The researchers recommended more research on establishing CRS for muscular fitness.

To summarize, the pull-up and flexed-arm hang tests seem undesirable to be used in the local schools. Young children, especially the heavy ones, may be discouraged from active strength training if they cannot even get a test score of one. Tests like the knee push-up, "A-shaped" modified push-up or possible the bailey bridge test may be better since they do not require special equipment and have no zero score problems. More research are needed for evidence of validity and reliability of these tests when used in schools.

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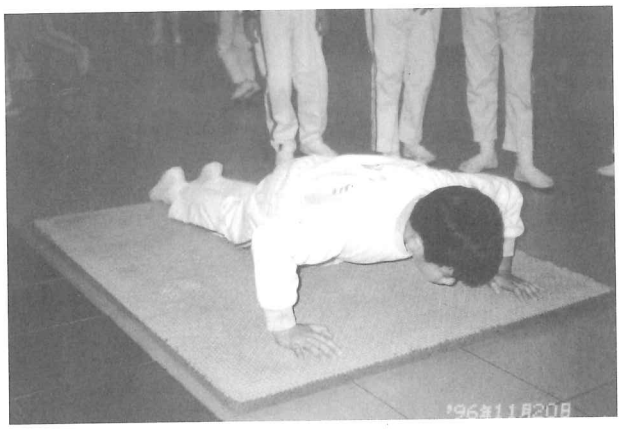

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Table 1 Upper Body Strength and Endurance Measures Across Major Test Batteries

Tests	AAHPERD '88	AAU '92	Fitnessgram '92	PCPFS '87	Asian*	Eurofit*	CAHPER* (Canada)	ICHPER.SD* Asia	PRC* (China)
Pull-Up	Y	Y	Y	Y	Y			Y	Y
Flexed-Arm Hang	Y	Y	Y		Y	Y	Y		
Mod. Pull-Up			Y					Y	Y
Iso-metric Push-Up		Y							

Note: "Y" means Yes; the battery contains this test item.
The first four test batteries without * are major US test batteries.
* Tests were listed by Fu (1994).

Table 2 Descriptions of Major Field Tests of Upper Body Strength and Endurance Measures

Pull-Up (AAHPERD, 1988)	Overhand grip (palms forward); body hanging position; pull up until chin rests over bar; lower body till arms are straight; no kick, jerk allowed; record total number performed.
Flexed-Arm Hang (AAHPERD, 1988)	Overhand grip; raise body off floor till chin is above bar; elbows flexed; chest close to bar; record total time to keep this position.
Vermont Modified Pull-Up	Supine position; bar adjusted just out of reach of fully extended arms; elastic band positioned about 6 in. below bar; grasp bar by overhand grip; start position: buttock off floor, arms and legs straight; feet together with only heels touching floor; pull body up with arms till chin clears elastic band; lower to start position; record total number performed.
Baumgartner's Modified Pull-Up	need special equipment; supine inclined position; lie on scooter board with top of board at bottom of sternum; push to top of pull-up board; grasp pull-up bar at top end of pull-up board by overhand grip; hands about shoulder-width apart; assume a straight-arm hanging position; pull up inclined board till chin is over bar; return to a straight-arm hanging position; record number of completed repetitions.
Modified Push-Up[a]	hands and feet on floor; arms extended; feet about shoulder-width apart; "up" position as an "A-shaped" with hips in air; "down position": bend elbows till forehead touches partner's hands placed on floor; return back to "up" position; follow a cadence of 2 seconds per push-up; stop test if missing 2 counts of cadence; record number push-ups completed in a maximum of 2 minutes.
Modified Push-Up	46 cm chair against wall; mark position for feet: lie, face up, with soles of both feet in Chair line with front of chair seat, mark a line on floor at level of elbows; stand behind line and reach forward to place both hands, shoulder-width apart, on front edge of chair; with body and legs in a straight line with arms extended at an angle of about 90^0 to the body; "down" position: lower body till chest touches front edge of chair; "up" position: raise body till arms extended. Count number of push-ups in 30 seconds.
Bailey Bridge Test	start with front support position with shoulders near to and facing a box/chair; top of box/chair of 45 cm from floor for age 9 or over; 30 cm (bench height) for age under 9; take the bean bag from top of box with 1 hand; place bean bag on floor; pick up bean bag with another hand; place it back to top of box; count number of times bean bag is placed on the box in 30 seconds.

[a]Nelson, Yoon, Nelson (1991).

Figure 1. Comparison of Criterion-referenced Standards of Pull-up Test Across Major US Test Batteries.