Test Items and Standards Related to Muscle Strength and Endurance on the Brockport Physical Fitness Test

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This manuscript provides information on the rationale for the selection of the muscular strength and endurance test items associated with the Brockport Physical Fitness Test for youngsters with mental retardation and mild limitations in fitness, visual impairment (blindness), cerebral palsy, spinal cord injury, or congenital anomalies or amputations. Information on the validity, attainability, and reliability of the 16 tests and their criterion-referenced standards is provided. Suggestions are made for future research.

Muscular strength and endurance (MS/E) is a subcomponent of musculoskeletal functioning in the Brockport Physical Fitness Test (BPFT; Winnick & Short, 1999). MS/E was conceptualized as the subcomponent of health-related physical fitness concerned with the ability to exert force through muscular contraction and the ability to sustain the production of force over a period of time. The BPFT focuses on upper-body MS/E and on trunk and abdominal MS/E. The selection of test items and standards is related to the profile statements associated with the strength and endurance of these two regions of the body. These relationships are depicted in Figures 1 and 2.

There are 16 measures of MS/E included in the BPFT battery. Depending on type of disability, different test items are suggested for different youngsters. Recommended (R) and optional (O) MS/E test items for specific disability groups (as well as for the general population) are discussed in this article. For a description of test items or more specific information on test item selection, readers are referred to the test manual (Winnick & Short, 1999).

Information pertaining to the validity and reliability of the BPFT MS/E test items is discussed under separate headings. The validity section includes a rationale for the selection of each test item, a discussion of the basis for the standards associated with the test, and available data pertaining to the attainability of the standards. Following the reliability section is a brief discussion including recommendations for future research.

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**Musculoskeletal Functioning**

*Upper Body Strength/Endurance*

- Acquire/maintain functional levels of upper body strength/endurance consistent with independent living
  - Grasp and lift object
  - Lift and transfer body
  - Functional mobility
  - Reverse curl
- Seated push-up
- Wheelchair ramp test

*Acquire/maintain levels of upper body strength/endurance for participation in physical activities*

- Push-up
- Modified pull-up
- Dumbbell press
- Isometric pull-up
- Flexed arm hang

*40m walk is used as a general strength/endurance item*


**Musculoskeletal Functioning**

*Trunk/Abdominal Functioning*

- Acquire/maintain levels of trunk extension strength/endurance/flexibility to reduce risk of developing lower back pain
- Trunk lift

*Acquire/maintain levels of abdominal strength/endurance to reduce the risk of developing lower back pain and to participate in physical activities*

- Curl-up
- Curl-up (Modified)

*Minimal Preferred*
Validity

Measures of MS/E traditionally have been prominent in most physical fitness test batteries. The American Alliance for Health, Physical Education, and Recreation (AAHPER) Youth Fitness Test (AAHPER, 1976b), the Special Fitness Test for the Mildly Mentally Retarded (AAHPER, 1976a), and the Motor Fitness Test Manual for the Moderately Mentally Retarded (Johnson & Londeree, 1976) are examples of physical fitness test batteries that included tests of MS/E. More recently published fitness tests that have purported to be health-related also have included MS/E items. The health-related rationale has suggested that the development of abdominal MS/E can reduce the risk of developing low back pain and/or that the development of upper body MS/E can improve the ability to perform daily tasks that require lifting, carrying, pulling, or pushing objects (American Alliance for Health, Physical Education, Recreation and Dance, AAHPERD, 1980; Cooper Institute, 1987; McSwegin, Pemberton, Petray, & Going, 1989). Furthermore, it has been argued that the development of upper body MS/E could be important in escaping from a hazardous or emergency situation (McSwegin et al., 1989). Upper body and abdominal/trunk MS/E test items were included in the FITNESSGRAM “because of their perceived relationship to maintaining functional health and correct posture, thereby reducing possibilities of future low back pain and restrictions in independent living” (Cooper Institute, 1999, p. 21).

Following a literature review on the relationship between musculoskeletal fitness and health status, Warburton, Gledhill, and Quinney (2001) found that muscular strength is positively associated with independence and overall quality of life and negatively associated with morbidity and potentially premature mortality. They also found that muscular endurance is positively related to overall quality of life and concluded that high levels of musculoskeletal fitness are associated with positive health status, and low levels of musculoskeletal fitness are associated with lower health status.

Additional rationale for the inclusion of MS/E items in the BPFT is linked to the health-related concerns typically associated with specific disabilities. The identification of health-related concerns and desired fitness profiles are important steps in the personalized approach espoused in the BPFT (Winnick & Short, 1999), and muscular strength and endurance plays a prominent role in those statements. Although the health-related muscular strength and endurance needs of youngsters with MR or VI are not appreciably different than those of youngsters without disabilities, the MS/E needs of youngsters with physical disabilities sometimes are different or, perhaps, more critical. The development of MS/E in persons with physical disabilities has been shown to prevent orthopedic injuries; increase bone mineral content, which helps to prevent skeletal injury; improve independence; and improve functional skills such as walking, activities of daily living, and sport participation (Lockette, 1995).

Youngsters with SCI characteristically have problems with muscular atrophy, weakness, and imbalance. In many cases osteoporosis occurs as a result of inactivity and lack of weight bearing (Lockette & Keyes, 1994). These conditions create difficulty in wheelchair propulsion, gait training, transferring, and maintaining appropriate postural fitness. Upper body MS/E also is important because the ability to lift the body from the seat of a wheelchair is useful in relieving skin pressure
from the posterior thighs and buttocks, thereby reducing the risk of developing pressure sores (i.e., decubitus ulcers).

When compared to the general population, MS/E test scores obtained by youngsters with CP tend to be low (Short & Winnick, 1986). The presence of spasticity contributes to reductions in strength and endurance. Persons with spastic CP often exhibit postures characterized by flexion, adduction, internal rotation, and pronation, which are due to muscle imbalances. “Without intervention, and often even despite intervention, this imbalance becomes more pronounced over time; this in turn causes muscle weakness and atrophy, soft-tissue contracture and eventual joint deformity” (Damiano, Vaughan, & Abel, 1995, p. 731). Although the use of direct muscle strengthening techniques as an intervention for muscle imbalance traditionally has been controversial, at least in part due to the notion that resistance training would increase the spasticity of the muscle, there appears to be little support for this concern either clinically or scientifically (Damiano, Vaughan, & Abel, 1995; Richter, Gaebler-Spira, & Mushett, 1996). According to DiRocco (1995), developing and maintaining MS/E is very important to people with CP as a way of improving function “because spastic muscles, although hypertonic, are not necessarily strong—in fact, extensor muscles that oppose spastic flexors are often weak” (p. 17). Development of the triceps muscles is particularly important in improving muscle balance, aiding in wheelchair propulsion, enhancing crutch-assisted walking, and relieving skin pressure from prolonged sitting, transferring, and performing activities of daily living.

In addition to the MS/E needs that any adolescent possesses, youngsters with CA/A, depending on the site of the impairment, must be concerned with the effects of overuse or disuse on muscular balance. Spending prolonged time sitting, pushing a wheelchair, and performing a variety of daily tasks in front of the body may overdevelop anterior upper body muscles. This causes an imbalance and the need to strengthen posterior muscles of the neck and back extensor muscles. These muscles enhance an upright posture, which contributes to the prevention of shoulder and/or back pain.

Although a logical relationship between MS/E and health in a generic sense is easily established, direct links between the two are more difficult to find in the literature. How much MS/E should one possess to meet some index of health status? Unlike aerobic capacity and body composition, which have scientific support for establishing appropriate levels for health-related physical fitness, MS/E does not, at least in part, because the amount of MS/E necessary for a health-related purpose likely will vary from purpose to purpose or task to task. As Looney and Plowman (1990) stated, “it is difficult, if not impossible, to find agreement on criterion tests [of MS/E], let alone criterion values” (p. 221).

In the BPFT, appropriate levels of MS/E for health-related purposes were defined, depending on the test item, in one (or more) of four ways: expert opinion, normative data, logical links to activities of daily living, and values found in the literature. Expert opinion was used most frequently, often in combination with one of the other three approaches. All of the criterion levels of MS/E for the FITNESSGRAM test items included in the BPFT were derived from expert opinion (Plowman & Corbin, 1994).

Although the use of normative data as an index of health may seem antithetical to criterion-referenced testing and somewhat arbitrary, there is a modicum of support for
the selection of the 20th percentile as a critical value. First, analysis of aerobic fitness data has indicated that the greatest difference in disease risk occurs between men and women in the lowest quintile (i.e., bottom 20%) when compared to those in the second quintile (Blair et al., 1989). This suggests, at least with regard to aerobic fitness, that the greatest health benefit can be gained by scoring above the 20th percentile.

Second, MS/E data reported by Malkia (1993) seem to be somewhat consistent with the notion of escaping the 20th percentile as a health-related criterion. He compared the mean scores of healthy men and women and those with diseases on grip strength, sit-ups, and other items. Health status (healthy vs. diseased) was self-reported but dependent on physician diagnosis. Malkia found that the men and women with diseases had mean grip strength scores that were 87% and 88% of those obtained by healthy men and women, respectively. A similar comparison was made for sit-ups for which men and women with diseases obtained means 75% and 76% of those of their respective healthy counterparts.

We applied these percentages to the means of some available data sets for youngsters without disabilities. As part of Project Target, 680 boys and girls aged 10-17 were tested on dominant grip strength. Mean scores for each gender by age combination were adjusted by the percentages reported by Malkia and compared to the respective 20th percentile value (P20). There was an insufficient number of 12- and 13-year-old girls to include in the analysis, but comparisons were made for each of the other 14 gender by age combinations. The adjusted means were identical to or within just one kilogram of P20 for 13 of the 14 comparisons and within two kilograms of P20 for the remaining comparison.

In the case of sit-ups, mean values for data collected on a national sample of participants without disabilities aged 10-17 (n = 1,162: Winnick & Short, 1982) were adjusted by Malkia’s percentages and compared to the P20 values associated with the National Children and Youth Fitness Study (Ross, Dotson, Katz, & Gilbert, 1985). The adjusted mean values were identical to or within one sit-up of P20 in 12 of the 16 gender by age categories. In the four remaining categories, the difference ranged between two and four sit-ups.

It is unlikely that similar analyses with other data sets for grip strength and sit-ups will yield results identical to the analyses described above, namely that Malkia’s percentages, which purport to distinguish between healthy adults and those with disease, provide a remarkably good estimate of the 20th percentile for children and adolescents. Data characteristics such as skewness, for instance, will vary from sample to sample and will influence the ability of Malkia’s percentages to coincide with P20. Still, when these results are considered along with Blair et al.’s (1989) findings pertaining to aerobic fitness, the utilization of the 20th percentile as a tentative health-related criterion-referenced standard seems reasonable, especially in the absence of a better index.

For some of the items in the BPFT battery, criterion levels of MS/E were linked to activities of daily living. To answer the question, “Does a youngster possess a necessary level of MS/E to perform a particular ADL?” one might simply test the ADL. This approach was taken for four test items, including, for example, the wheelchair ramp test, which requires youngsters to push their wheelchairs up a standard ramp.

Finally, in some cases, values recommended in the literature were used to help establish criterion levels of MS/E. Examples include a recommendation by
Waters (1992) with regard to a functional walking speed that was utilized in the 
40m push/walk test and one by Kosiak and Kottke (1990) pertaining to skin pres-
sure relief that was incorporated into the seated push-up.

Sixteen measures of MS/E are included in the BPFT. Six of the tests (flexed arm 
hang, push-ups, pull-ups, modified pull-ups, trunk lift, and curl-ups) are included 
in the FITNESSGRAM (Cooper Institute, 1992, 2004) test battery. Effort was 
made in the development of the BPFT to establish an association with the FIT-
NESSGRAM so that test users could switch back and forth between the two tests 
as necessary. The FITNESSGRAM items are discussed below as a group. Six other 
tests (modified curl-ups, grip strength, isometric push-up, bench press, extended 
arm hang, and dumbbell press) were included to be used as alternative measures 
of MS/E for youngsters with selected disabilities for specific reasons discussed 
later in this manuscript. Each of these items is discussed separately (or in pairs). 
The final four items (seated push-up, 40-meter push/walk, wheelchair ramp test, 
and reverse curl) also are alternative measures but were designed specifically for 
youngsters with physical disabilities. Each of these four items is discussed sepa-
rately later in the article.

**Flexed Arm Hang, Push-Ups, Pull-Ups, Modified Pull-Ups, 
Trunk Lift, and Curl-Ups**

These six test items are included in the FITNESSGRAM (Cooper Institute, 1992, 
2004). Some (or all) of these items are either recommended or optional tests for 
youngsters with VI, MR, or, depending upon the site of the impairment, CA/A.

Information on the rationale and validity (as well as reliability) of these test 
items is already available (Plowman & Corbin, 1994) and will not be reiterated 
here in any great detail. In essence, the claim for the validity of all of these test 
items is largely logical (i.e., domain-referenced). The trunk lift and curl-up tests 
have been linked to the incidence of low back pain, but those relationships are 
not yet completely understood. Skinner and Oja (1994) recommended that both 
trunk flexion and trunk extension strength/endurance be tested when attempting 
to assess the muscular fitness of the trunk. “Strong fatigue resistant trunk muscles 
(both abdominal flexors and trunk extensors) maintain spinal and pelvic alignment, 
provide stability, and allow for controlled movement” (Plowman & Corbin, 1994, 
p. 92). Jackson, Morrow, Jensen, Jones and Schultes (1996) called for future research 
on the concurrent, predictive, and construct validity of the trunk lift. Subsequently, 
Hannibal (2003) reported Pearson product moment correlation coefficients between 
the trunk lift and three laboratory tests of low back strength and endurance as an 
indication of concurrent validity. Unfortunately, these coefficients were low and 
none were significant at the .05 level.

A “criterion health condition” has not been identified for the four upper body 
measures although “it has been speculated that strong muscles of the upper body 
region are necessary as a protection against osteoporosis at advanced ages” (Plow-
man & Corbin, 1994, p. 93). In the BPFT, the logical validity for the inclusion of 
all of these items is extended to the notion that sufficient strength and endurance 
of the trunk, shoulders, arms, and hands is necessary to “perform and sustain daily 
activities,” a component of the BPFT definition of health-related physical fitness. 
Previous factor analytic work using participants with disabilities established that
flexed arm hang and pull-ups generally are associated with factors labeled “power-strength,” suggesting that either could be used to measure a unique aspect of fitness (Winnick & Short, 1982).

**Standards** The general standards of the BPFT for flexed arm hang, push-ups, pull-ups, modified pull-ups, trunk lift, and curl-ups were adopted from the FITNESSGRAM and appear in Table I. The FITNESSGRAM (Cooper Institute, 1992) CR standards for each of these items were based on expert opinion derived, in part, from an analysis of normative data collected in the United States and Canada (Plowman & Corbin, 1994). Where appropriate, FITNESSGRAM standards that define the lower end of the “healthy fitness zone” are considered to be “minimal general standards” in the parlance of the BPFT; standards at the higher end of the zone are called “preferred general standards.”

When these tests are either recommended or optional for youngsters with VI, MR, or CA/A, general standards are used to assess performance, with one exception. Flexed arm hang is a recommended item for youngsters with MR (aged 13-17) for which specific standards are provided in addition to general standards.

Specific standards are provided for some MS/E items in the BPFT battery for youngsters with MR when an adjustment to the general standards appeared to be warranted (see Table 2). There is a consistent trend in the literature that documents a performance discrepancy between youngsters without disabilities and those with mental retardation on many measures of MS/E. Factors such as motivation, fewer opportunities to train, fewer opportunities to participate in physical activities, poor instruction, and/or physiological factors have been cited by researchers attempting to explain the performance gap.

Where specific standards are provided for youngsters with MR in the BPFT, they are derived by lowering the minimal general standards by a percentage that ranges from 25-50%. The particular percentage utilized is an estimate of the performance discrepancy identified for a specific item in previous research. In selecting a particular percentage for a specific item, available data collected on participants with both mild and moderate MR were considered. Depending on the test item in question, and in addition to comparative data collected as part of Project Target, data sources consulted included Eichstaedt, Wang, Polacek, and Dohrmann (1991); Findlay (1981); Francis and Rarick (1959); Hayden (1964); Johnson and Londereee (1976); Montgomery, Reid, and Seidl (1988); Pizzaro (1990); Rarick, Dobbins, and Broadhead (1976); Rarick and McQuillan (1977); Reid, Montgomery, and Seidl (1985); Roswal, Roswal, and Dunleavy (1986); Sengstock (1966); and Vodola (1978). The 25-50% adjustment range serves to operationalize the notion of “mild limitations in fitness.” Many youngsters with MR, especially those with milder forms, essentially have no limitations in fitness (i.e., require less than a 25% adjustment to scores typically obtained by the general population) and are able to, and should, pursue the general standards. Youngsters with MR who require more than a 50% adjustment to general population scores (or who cannot learn to perform a particular test item) are considered to have severe limitations in fitness. Testers may have to develop individualized standards for youngsters in this latter group. (Other options include assessing physical activity rather than fitness or using task analytic strategies for measuring fitness.)

In the case of flexed arm hang, an analysis of relevant data (AAHPER, 1976a; Eichstaedt et al., 1991; Johnson & Londereee, 1976) suggested that a 50% adjustment
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L = lower boundary of acceptable range; U = upper boundary of acceptable range; M = minimal; P = preferred.

Adapted, with permission, from the Cooper Institute, 2004, *FITNESSGRAM/ACTIVITYGRAM test administration manual*, 3rd edition (Champaign, IL: Human Kinetics), 61, 62.

<table>
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<tr>
<th>Age</th>
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**Females**

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M = minimal; P = preferred.
Table 2  Specific MS/E Standards for Youngsters With MR and Mild Limitations in Physical Fitness

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<td>8</td>
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<td>14</td>
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</table>

Females

<table>
<thead>
<tr>
<th>Age</th>
<th>Isometric Push-up (sec.)</th>
<th>Bench Press (# completed)</th>
<th>Extended Arm Hang (sec.)</th>
<th>Flexed Arm Hang (sec.)</th>
<th>Dominant Grip Strength (kg.)</th>
<th>Modified Curl-ups (# completed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>13</td>
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<td>15</td>
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</table>


to the minimal general standards was warranted. The 50% adjustment is the maximum adjustment allowed under the concept of "mild limitations in fitness" described above and appears to be necessary based on the data reviewed. Testers also may choose to use general standards when assessing the performance of youngsters with MR. In this way it is hoped that youngsters and teachers will be encouraged to pursue levels of fitness consistent with those recommended for youngsters without disabilities.

**Attainability**  A number of youngsters with MR or VI were tested on five of the six FITNESSGRAM items in conjunction with Project Target (Winnick & Short, 1998). Youngsters with MR were tested in the New York City public schools, the Houston Independent School District, and the School of the Holy Childhood in Rochester, NY. Youngsters with VI were tested in the New York City public schools and at sport campsites in East Lansing and Kalamazoo, Michigan. Number of participants tested and passing rates for various standards are presented for these and other MS/E items in Table 3.

The passing rates shown in Table 3 suggest that most youngsters with VI should find the minimal general standards associated with the trunk items (trunk lift and
Table 3  Passing Rates for Participants With MR and VI for Relevant Tests of MS/E and Available Standards

<table>
<thead>
<tr>
<th>Items</th>
<th>Group</th>
<th>N</th>
<th>Specific</th>
<th>Minimal General</th>
<th>Preferred General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexed Arm Hang</td>
<td>MR</td>
<td>25</td>
<td>24%</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>57</td>
<td>NR</td>
<td>25%</td>
<td>14%</td>
</tr>
<tr>
<td>Push-ups</td>
<td>VI</td>
<td>99</td>
<td>NR</td>
<td>31%</td>
<td>10%</td>
</tr>
<tr>
<td>Pull-UPS</td>
<td>VI</td>
<td>53</td>
<td>NR</td>
<td>23%</td>
<td>8%</td>
</tr>
<tr>
<td>Trunk Lift</td>
<td>MR</td>
<td>113</td>
<td>NR</td>
<td>61%</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>102</td>
<td>NR</td>
<td>85%</td>
<td>NR</td>
</tr>
<tr>
<td>Curl-ups</td>
<td>VI</td>
<td>104</td>
<td>NR</td>
<td>55%</td>
<td>30%</td>
</tr>
<tr>
<td>Modified Curl-ups</td>
<td>MR</td>
<td>36</td>
<td>50%</td>
<td>39%</td>
<td>11%</td>
</tr>
<tr>
<td>Grip Strength</td>
<td>MR</td>
<td>154</td>
<td>55%</td>
<td>8%</td>
<td>5%</td>
</tr>
<tr>
<td>Isometric Push-up</td>
<td>MR**</td>
<td>40</td>
<td>43%</td>
<td>30%</td>
<td>28%</td>
</tr>
<tr>
<td>Bench Press</td>
<td>MR*</td>
<td>76</td>
<td>40%</td>
<td>15%</td>
<td>1%</td>
</tr>
<tr>
<td>Extended Arm Hang</td>
<td>MR**</td>
<td>36</td>
<td>39%</td>
<td>31%</td>
<td>14%</td>
</tr>
</tbody>
</table>

* Ages 13-17  **Ages 10-12  MR = mental retardation  VI = visually impaired  NR = standard is not recommended for that item for specific youngsters

curl-ups) to be within their reach. The standards for the arm and shoulder items (flexed arm hang, push-ups, and pull-ups), however, will be more challenging for youngsters with VI. More recently, Lieberman and McHugh (2001) administered curl-ups, trunk lift, and push-ups to youngsters with visual impairments and reported the following pass rates for youngsters who were blind: curl-ups (44%), trunk lift (76%), and push-ups (29%). Again it appears that the arm and shoulder items (represented by push-ups here) will be challenging for youngsters who are blind. Most youngsters with MR and mild limitations in fitness will find the minimal general standards for the trunk lift to be attainable, but the standards for the flexed arm hang apparently are more difficult. Even with a 50% reduction to the minimal general standards, only 24% of the participants tested could achieve the specific standards (Winnick & Short, 1998).

Modified Curl-Up

The modified curl-up was added to the BPFT battery after it was determined that many youngsters with MR who were participating in a Project Target training study were unable to efficiently learn the curl-up test using FITNESSGRAM procedures. Youngsters had difficulty dealing with the four-inch strip that is placed on the ground and upon which participants slid their hands while curling up. Reaching the end of the strip signaled completion of a single curl-up. Perhaps the use of the strip conflicted with how they had previously learned to perform sit-ups, or perhaps because the strip is not easily seen, it did not provide a concrete target to sufficiently
provide motivation. The use of the modified curl-up (hands slide up the thighs rather than across the strip) appeared to improve student learning significantly. The BPFT modified curl-up is similar to the partial curl-up described by Jette, Sidney, and Cicutti (1984), who pointed out that EMG analysis suggested that the endurance of the abdominal muscles (rectus abdominis and obliques) likely was the limiting factor in test performance.

**Standards** The standards associated with the FITNESSGRAM curl-up were adopted as the general standards for the BPFT modified curl-up (Table 1). It was felt that the two items were sufficiently similar so that different standards for curl-ups and modified curl-ups would not be necessary. There is some evidence among adults, however, that the curl-up test may yield somewhat higher scores than the modified curl-up test (Faulkner, Sprigings, McQuarrie, & Bell, 1989).

Specific standards for youngsters with MR are available for the modified curl-ups (see Table 2). Specific standards were developed following an analysis of previously published data (Eichstaedt et al., 1991; Pizzaro, 1990; Rarick et al., 1976; Reid et al., 1985; Roswal et al., 1986; Sengstock, 1966; Vodola, 1978) for various forms of the sit-up or curl-up tests. The specific standards reflect a 40% reduction to the minimal general standards, consequently the specific standards are 60% of the minimal general standards.

**Attainability** The pass rates for 36 youngsters with MR from Rochester, NY tested on the modified curl-up are presented in Table 3 (Winnick & Short, 1998). With almost 40% achieving the minimal general standards, this is an item with standards that are readily within reach for youngsters with MR.

**Dominant Grip Strength**

Dominant grip strength is a recommended item for youngsters with either SCI or CA/A and an optional item for youngsters with CP and MR. Grip strength has been used with good success with youngsters who have physical disabilities (Winnick & Short, 1985) as well as with youngsters who have MR (Rarick et al., 1976; Rarick & McQuillan, 1977). Factor analyses of data collected on participants with disabilities suggested that grip strength measures generally are associated with factors labeled “strength,” a term used to convey activities requiring maximum (or near maximum) muscle contractions over a brief period of time (up to about 1 second) (Winnick & Short, 1982). Although the item is optional for youngsters with MR, it is included in the battery primarily for youngsters with physical disabilities as a measure of upper body M/E.

In summarizing literature related to handgrip force, Shephard (1990) indicated that static grip strength is a good predictor of total upper body isokinetic strength and that a substantial relationship exists between grip strength and habitual physical activity for individuals with SCI. Project Target research on participants without disabilities yielded Pearson correlations of .77 ($n = 381$) and .76 ($n = 501$) between dominant grip strength and 35-lb bench press and 15-lb dumbbell press respectively (Winnick & Short, 1998). The inclusion of a grip strength test for youngsters who propel their wheelchairs with their arms or who use crutches for mobility also can be justified on logical grounds; independent locomotion would seem to be dependent, at least in part, on grip strength.
There may also be a positive association between grip strength and physiological health. Rantanen (2003) examined longitudinal data on over 8,000 men (aged 45-68) and reported that men who were in the lowest third of the distribution on grip strength at the start of the study (1965) were at two to three times greater risk of developing disabilities assessed 25 years later when compared to the highest third. He also reported that those with poorer grip strength at baseline were more likely to die over the 30-year follow-up period.

**Standards** The general CR standards for grip strength are given in Table 1. The minimal general standards for grip strength, as well as for some of the other MS/E items in the BPFT, are based on expert opinion and are derived from normative data (Advisory Committee, 1995); specifically, the minimal general standard for grip strength approximates the 20th percentile for data normed on youngsters without disabilities (n = 680) tested during Project Target (Winnick & Short, 1998).

The preferred general standards for grip strength also are based on expert opinion (Advisory Committee, 1995). In this case, the 60th percentile of the same data set serves as the preferred CR standard and is meant to represent a "good" level of health-related fitness. The performance of youngsters with SCI, CA/A, and CP on grip strength is compared to the general standards (Advisory Committee, 1995). Specific standards for grip strength, however, were developed for youngsters with MR (see Table 2). An analysis of previously published comparative data (Montgomery et al., 1988; Rarick et al., 1976) as well as data collected as part of Project Target (115 participants with MR contrasted with 680 participants without MR) suggested that a 35% reduction to the minimal general standards would be an appropriate estimate of the performance discrepancy existing between youngsters with and without MR on grip strength (Winnick & Short, 1998). The specific standards, therefore, are 65% of the minimal general standards.

**Attainability** Pass rates for grip strength (dominant hand) collected as part of Project Target (Winnick & Short, 1998) are summarized in Table 3 for participants with MR. The availability of specific standards for this group would seem to be important in providing an obtainable goal; the pass rates for the general standards are less than 10% for youngsters with MR. Available data for youngsters with physical disabilities is limited. Eleven youngsters with CP (appropriate classes only) and four with SCI (paraplegia) were tested on grip strength during Project Target. Six of 11 (55%) of the youngsters with CP met the minimal general standards, while four of the 11 (36%) were able to reach the preferred general standards. Of the four youngsters with SCI, all four (100%) attained the minimal general standards and one of the four (25%) met the preferred general standard. No data were collected for youngsters with CA/A.

**Isometric Push-Up and Bench Press**

The primary rationale for the inclusion of the isometric push-up and the bench press (35 lb) was to provide alternative measures of triceps-related strength and endurance for youngsters with MR; both items are optional for this group. (Project Target field-testing revealed that many youngsters with MR had difficulty learning to perform the traditional push-up correctly.) The bench press also is appropriate for youngsters with lower limb disabilities (i.e., SCI, CA/A) and is an optional test.
for these groups in the BPFT. Both the isometric push-up and the bench press have been used successfully with special populations and are the measures of upper body strength and endurance included in the *Kansas Adapted/Special Physical Education Test Manual* (Johnson & Lavay, 1988). During the development of the Kansas test, pilot testing revealed that the bench press was not particularly appropriate for youngsters under the age of 13. Younger children were fearful of the equipment, 35 lbs proved to be too heavy to lift, and equipment requirements were inconvenient for itinerant teachers (Eichstaedt & Lavay, 1992); consequently, this test is recommended only for youngsters aged 13-17 in the BPFT. The isometric push-up serves more as a lead-up test item to the bench press (or possibly the traditional push-up) and therefore is recommended only for youngsters aged 10-12. No correlational data between isometric push-up and bench press are available, but Project Target research (Winnick & Short, 1998) found a Pearson r of .55 between the isometric push-up and traditional push-ups for a group of participants without disabilities \(n = 120\) aged 13-15.

**Standards** In the BPFT, general standards are provided for youngsters aged 10-12 for the isometric push-up and 13-17 for the bench press (see Table 1). Both minimal and preferred standards were established using normative data; minimal standards approximate the 20th percentile and preferred standards approximate the 60th percentile of data collected on participants without disabilities during Project Target. A total of 177 10-12-year-old participants and 322 13-17-year-old participants were tested on the isometric push-up and bench press, respectively. Test protocol for the isometric push-up limits the maximum score to 40 s, which explains why the minimal and preferred standards sometimes overlap. Similarly, the bench press is limited to a maximum of 50 repetitions for boys and 30 for girls, which also creates some overlapping of standards (i.e., 17-year-old boys). General standards are appropriate for youngsters with SCI and CA/A (lower limb disabilities) for the bench press.

Specific standards are available on these two items for youngsters with MR (see Table 2). The specific standards reflect a 50% adjustment to the minimal general standard. The basis for this adjustment comes primarily from limited comparative data collected during Project Target (Winnick & Short, 1998). The mean bench press scores of 31 participants with MR were contrasted to the mean scores of 322 participants without disabilities by gender and age (13-17). A similar comparison was made between 13 participants with MR and 177 participants without disabilities (aged 10-12) on the isometric pushup. For both items, the group with MR generally had means less than 50% of the means of the group without disabilities. A 50% adjustment was selected as the basis for specific standards for both items to represent the maximum adjustment allowed for the Project Target notion of "mild limitations in fitness" (Advisory Committee, 1996).

**Attainability** Pass rates for participants with MR tested during Project Target (Winnick & Short, 1998) on isometric push-up and bench press are provided in Table 3. It is apparent that many youngsters with MR will need to train to reach these standards; the pass rates for even the specific standards are less than 50%. (Very limited data were collected on youngsters with either SCI or CA/A, but there is a logical expectation that individuals with lower limb disabilities can, and should, attain the general standards.)
Extended Arm Hang

As with the isometric push-up, the extended arm hang is included as a lead-up test item for youngsters with MR aged 10-12. In this case the “parent” test item is the flexed arm hang. Youngsters with MR typically do not do well on the flexed arm hang with many making zero scores (Johnson & Lavay, 1988). Both items require participants to support their body weight off the floor by grasping a bar with their hands. A moderate relationship \( r = .54 \) was found between the extended arm hang and flexed arm hang among 111 participants without disabilities (aged 14-17) tested during Project Target (Winnick & Short, 1998). The extended arm hang has been previously recommended as a fitness test item for youngsters with MR (Hayden, 1964) and is meant to provide younger students with some bar hang experience and yield test scores that can discriminate among ability levels.

**Standards**

The general standards for extended arm hang (see Table 1) were developed by testing youngsters without disabilities. The minimal standards approximate the 20th percentile of a distribution of scores obtained by 403 10-12-year-old participants. The preferred standards are equivalent to the maximum score allowed by the test protocol (40 s) and represent a value that is less than the 60th percentile. During data collection for Project Target, the maximum score was set at 120 s. P60 values ranged from 49-60 s for girls and 62-88 s for boys. The preferred standard was limited to 40 s, however, in part because many participants reported discomfort in the hands (apparently due to bar friction) during more lengthy hangs.

Specific standards are available for youngsters with MR (Table 2). The specific standards reflect a 25% adjustment to the minimal general standards; the specific standards, therefore, are 75% of the minimal general standards. In arriving at the 25% adjustment, P50 values obtained for the participants without disabilities were contrasted with P50 values obtained by Hayden (1964) on a sample of participants with severe retardation. Scores obtained by Hayden’s participants ranged from 82-93% of the Project Target scores using participants without disabilities. To create the specific standards, 75% of the minimal general standards was used in keeping with the operational definition of “mild limitations in fitness” (25-50% adjustments).

**Attainability**

Thirty-six participants (aged 10-12) with MR from Rochester, NY and New York City were tested on the extended arm hang as a part of Project Target (Winnick & Short, 1998). Pass rates for the available standards are provided in Table 3. The pass rates for most of the MS/E items for youngsters with MR for the specific standards range from about 40-50%. The extended arm hang value of 39% is close to the low end of that range.

Dumbbell Press

The dumbbell press (15 lb) is either a recommended or optional test item for youngsters aged 13-17 in subclassifications associated with CP, SCI, or CA/A. Its inclusion in the BPFT battery stems primarily from the desire to offer an elbow extension item for participants with CP. The bench press is a BPFT item that requires elbow extension; however, the dumbbell press has an advantage over the bench press in that it can be taken by persons with hemiplegia, which makes it appropriate not only for some youngsters with CP but also for those with other single-arm impairments (e.g., CA/A). The dumbbell press has the added advantage of increased feasibility...
over the bench press since it does not require wheelchair users to transfer prior to administration nor does it require as much equipment. Project Target research (Winnick & Short, 1998) with 490 participants without disabilities aged 11-17 found a good relationship \( r = .81 \) between the two items.

**Standards** Only general standards are provided for the dumbbell press (see Table 1) for youngsters 13-17. Expert opinion was used to determine that the general standards are appropriate for the classes of participants for whom the test was designed (Advisory Committee, 1996). Participants need only to reach the standards on one side of the body (i.e., preferred hand). As with some of the other MS/E items, the basis for the minimal and preferred standards is an approximation of the 20th and 60th percentiles, respectively, of data collected on adolescents without disabilities \( n = 447 \).

**Attainability** Attainability data is limited for the dumbbell press (preferred hand). Nine youngsters with CP and just two with SCI took this test item during Project Target testing in Brockport, New York (Winnick & Short, 1998). Only one of the nine participants with CP met the minimal general standard for dumbbell press. This youngster also attained the preferred standard. Of the two participants with SCI, both reached the minimal standard and one met the preferred.

**Seated Push-Up**

The seated push-up is the first of the four tests specifically designed for youngsters with physical disabilities. It is included in the BPFT battery primarily for wheelchair users (i.e., selected subclassifications of CP, SCI, and CA/A). (The seated push-up also is recommended for ambulatory CP class C6.) The test measures upper body strength and endurance, particularly of the elbow extensors. The ability to lift the body from the seat of a wheelchair by placing the hands on the arm rests and extending the elbows is believed to be important for lifting the body and providing relief of skin pressure and as a prerequisite to transferring (Advisory Committee, 1995). (Testers should recognize that performance may be affected by wheelchair size or fit to the youngster.) As a measure of elbow extension, the seated push-up also has some significance for improving muscle balance around the elbow joint, especially for youngsters with spastic CP who tend to have flexor dominance in the upper extremity.

**Standards** Two specific standards, 5 s and 20 s, are provided for the seated push-up and are the same for all gender and age categories. The 5 s standard is linked to the recommendation by Kosiak and Kottke (1990) that a “regimen in which there is complete relief of pressure for approximately 5 sec every 15 min” is the best advice for reducing the risk of acquiring pressure-induced skin ulcers (p. 977). The 20 s standard is derived solely from expert opinion (Advisory Committee, 1995). Based on clinical experience and informal observations, it was felt that the ability to lift and support the body for a period of 20 s would be sufficient for most transferring situations.

**Attainability** Pass/fail information is limited for the seated push-up. Of eight youngsters with SCI (paraplegia) tested during Project Target (Winnick & Short, 1998), six (75%) were able to exceed 10 s; in fact, five of eight (63%) were able to
hold themselves up for 30 s or more. Eight of 11 youngsters (73%) with CP (classes C2-C4 and C6) were able to achieve or surpass 10 s on the seated push-up. All 19 of these participants with either SCI or CP were within the 10-17 age range. The test was also administered, however, to five adult Paralympians with CP, and all five were able to score at least 30 s on the seated push-up.

40-Meter Push/Walk

The 40-meter push/walk is included primarily for youngsters who have a need to either develop or maintain independent forms of locomotion. It was specifically designed for CP youngsters in classes C2, C3, and C6. The test purports to be a measure of the strength and endurance necessary for functional mobility, defined as the ability to maintain a certain speed at a low level of exercise intensity. Functional mobility is considered critical to the independence of persons with physical disabilities. For the BPFT, mobility includes both ambulation and wheelchair propulsion. It is not unusual for ambulatory youngsters with physical disabilities, including CP, to increasingly rely on wheelchairs for locomotion as they get older (Waters, 1992). Youngsters who walk, therefore, should strive to continue to walk rather than to begin to rely on a wheelchair for their mobility. Similarly, those who use a wheelchair need to continue to propel the chair independently rather than to begin to rely on others (or motors) for propulsion.

Standards

A single specific standard (i.e., “pass”) is recommended for all gender and age categories. The standard represents the ability to travel at a rate of at least 40 m per min. This value is based on the observation by Waters (1992) that “the functional range of walking speeds in adults ranges from approximately 40 meters/min to 100 meters/min” (p. 454). In the BPFT, 40 m/min has been adopted as the minimal speed necessary for functional mobility (ambulatory or wheelchair).

Some consideration was given to adjusting the standard downward for children and adolescents since the 40 m/min value was for adults. Energy expenditure for walking tends to decrease as children get older (Waters, 1992); this, combined with the fact that increased body size generally will result in increased stride length, suggested that a downward adjustment of the standard might be warranted for younger participants. Waters (1992), however, found that the energy expenditure for youngsters with CP increased between ages five and 17 and is “consistent with the increased body weight and size in older children and the greater difficulty of the child with impaired motor control and spasticity carrying the added weight” (p. 487). It appears that if youngsters cannot attain the 40 m/min speed in childhood/adolescence, it is unlikely that they will be able to do so as adults.

Although 40 m/min is the CR standard for functional mobility, there is another very important condition that has to be met. Youngsters must be able to meet the speed standard while maintaining a heart rate indicative of light exercise intensity. Lerner-Frankiel, Vargas, Brown, Krusell, and Schoneberger (1986) estimated that community ambulation required their participants to cover an average of approximately 330 m to complete their task. At a speed of 40 m/min, it would take an individual over eight min to reach and negotiate the destination. Consequently, it is necessary that the functional speed be maintained without undue fatigue. If 40 m/min is a “wind sprint” for youngsters, it would not be considered functional because it could not be sustained in the community.
Heart rate is used as an indicator of “comfortable” exercise intensity for the 40-meter push/walk. For the purposes of the BPFT, 60% of maximum predicted heart rate was used as a demarcation between light and moderate intensity (American College of Sports Medicine, 1995; the American College of Sports Medicine 2005 demarcation subsequently has been set at 63%); youngsters have to travel at 40 m/min at a heart rate below 60% max to pass the test. Although maximum heart rate varies as a function of age, 125 beats per min is the criterion used in the test as an estimate of the upper limit of light exercise intensity for participants who walk or propel their wheelchairs with their legs. For those who propel their wheelchairs with their arms, the criterion is 115 beats per min, adjusted to reflect differences in the demands of arms-only forms of exercise (Rimmer, 1994). It is assumed that youngsters who can travel at a speed of at least 40 m/min at a light or comfortable exercise intensity possess functional mobility for community use (Advisory Committee, 1997).

**Attainability** The 40-meter push/walk was field tested on only a few participants as part of Project Target (Winnick & Short, 1998). Useable data were collected on just five participants with CP, two from class C3 and three from class C6. All five participants were able to pass the test.

### Wheelchair Ramp Test

Like the 40-meter push/walk, the wheelchair ramp test is a measure of functional mobility. It is included specifically for CP class C3 only and purports to assess the MS/E of the upper body to propel a wheelchair up a standard ramp.

**Standards** The CR standards for the ramp test are either eight feet or 15 or more feet for all participants, regardless of age or gender. The conditions for attaining the first standard require youngsters to move a wheelchair up a ramp that has eight feet of run and a rise of eight inches. These dimensions coincide with those recommended by the American National Standards Institute (ANSI, 1987), which call for ramps to be constructed with 12 inches of run for every inch of rise. Eight inches of rise was selected for use with the wheelchair ramp test to measure the youngster’s ability to negotiate a “one-step” elevation. Curb-cuts, for instance, have a recommended maximum rise of eight inches and steps for stairs have a uniform height of seven inches (ANSI, 1987).

The second standard is based on the notion that youngsters should be able to negotiate ramps they encounter on a daily basis, such as at school. While it is assumed that such a ramp would conform to the 12:1 ANSI standard, the length of the ramp will vary with location. It is also assumed that no ramp will be longer than 30 feet without a level platform for rest (ANSI, 1987). The preferred standard of at least 15 feet reflects half the distance of the longest ramp a youngster may encounter and provides testers with the latitude to increase the standard as necessary. Youngsters in different locations, therefore, will face different standards, but the ability to negotiate a frequently-encountered ramp reflects a degree of functional independence for each. Both standards were adopted by a panel of experts (Advisory Committee, 1997).

**Attainability** Pass rate information for the ramp test is extremely limited. Two CP class C3 participants attempted the test during Project Target testing (Winnick...
& Short, 1998) and both met the minimal standard; no other attainability data are available.

**Reverse Curl**

The reverse curl is recommended only for youngsters with SCI quadriplegia as a measure of upper body strength. It requires the participant to lift a one-pound dumbbell off the lap using a pronated grasp and elbow flexion. The ability to lift a light weight (one pound) was believed to have functional significance for the performance of some ADLs for youngsters with injuries in the lower cervical region (C6-C8; Advisory Committee, 1996). The reverse curl (palm down) was selected as the test so that youngsters (especially those with a C6 injury) might make use of the tenodesis grip. Tenodesis causes fingers to flex passively when the wrist is hyperextended and aids in grasping when the finger flexors are paralyzed (Surburg, 1995).

**Standards** The CR standard for the reverse curl is simply tied to the functional ability of lifting a 1-pound weight one time. Only a single standard is recommended and it was determined solely by expert opinion (Advisory Committee, 1996).

**Attainability** No attainability data were collected for the reverse curl as a part of Project Target.

**Reliability**

Considerable reliability data have been collected on most of the measures (or related tests) of MS/E contained in the BPFT. Plowman and Corbin (1994) summarized 17 reliability studies of tests of abdominal strength and endurance using participants without disabilities. Most of the studies investigated various forms of the sit-up. Most of the reliability coefficients reported (both interclass and intraclass) in these studies were in the .80 – .89 range. Of the 17 studies reviewed, one addressed the reliability of the curl-up procedures and one employed the modified curl-up protocol. Intraclass coefficients (R) for the curl-up ranged from .93 – .97 (Robertson & Magnusdottir, 1987) and the interclass coefficient (r) reported for the modified curl-up was .88 (Jette et al., 1984).

Additional reliability studies have been conducted on tests of abdominal strength and endurance using participants with MR. Some of these studies are summarized in Table 4. Although it is necessary to collect additional data for both curl-ups and modified curl-ups, it appears that a generally acceptable level of reliability can be claimed for measures of abdominal strength and endurance.

Considerable reliability data also exist for upper arm and shoulder strength and endurance tests. Winnick and Short (1998) tested 64 youngsters without disabilities aged 11-13 on the 35-lb bench press and found an alpha coefficient of .92. Plowman and Corbin (1994) summarized nine studies investigating the reliability of various forms of the pull-up, modified pull-up, flexed arm hang, and push-up. Of the numerous reliability coefficients reported, most were in the .80 and .90 range leading Plowman and Corbin to conclude that “field tests of upper arm and shoulder girdle strength-endurance have been found to be generally acceptable” (p. 82). This also appears to be the case when individuals with disabilities serve as
Table 4  Reliability of Field Tests for Abdominal Strength/Endurance for Individuals With MR

<table>
<thead>
<tr>
<th>Author</th>
<th>Disability</th>
<th>N</th>
<th>Gender</th>
<th>Age</th>
<th>Field Test</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Londeree &amp; Johnson (1974)</td>
<td>Moderately MR</td>
<td>1105</td>
<td>M/F</td>
<td>6-21</td>
<td>30-s sit-ups</td>
<td>spring and fall test-retest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>r = .78 -.99</td>
</tr>
<tr>
<td>Reid, Montgomery, &amp; Seidl (1985)</td>
<td>MR</td>
<td>20</td>
<td>M/F</td>
<td>20-39</td>
<td>60-s sit-ups</td>
<td>test-retest R = .63</td>
</tr>
<tr>
<td>Pizzaro (1990)</td>
<td>EMR</td>
<td>44</td>
<td>M/F</td>
<td>12-15</td>
<td>modified sit-ups</td>
<td>test-retest r = .83</td>
</tr>
<tr>
<td></td>
<td>TMR</td>
<td>37</td>
<td>M/F</td>
<td>12-15</td>
<td>modified sit-ups</td>
<td>test-retest r = .94</td>
</tr>
<tr>
<td>Eichstaedt &amp; Lavay (1992)</td>
<td>Unclassified</td>
<td>209</td>
<td>M/F</td>
<td>unspecified</td>
<td>modified sit-ups</td>
<td>R = .92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>school-aged</td>
<td></td>
<td>one week test-retest r = .96</td>
</tr>
<tr>
<td>Winnick &amp; Short (1998)</td>
<td>MR</td>
<td>25</td>
<td>M/F</td>
<td>11-17</td>
<td>modified curl-ups</td>
<td>one week test-retest a = .82</td>
</tr>
</tbody>
</table>

Note. r = interclass coefficient; R = intraclass coefficient; a = alpha coefficient; EMR = educable mentally retarded; TMR = trainable mentally retarded.
participants. A number of reliability studies employing participants with disabilities are summarized in Table 5. Although some of the studies have small sample sizes, the coefficients reported in Table 5 for a variety of upper arm and shoulder tests suggest good test-retest score consistency. Data reported more recently by Romain and Mahar (2001) support this contention. They reported intraclass Rs of .98 for push-ups and .97 for modified pull-ups (one trial for each item with 5th and 6th grade youngsters). Furthermore, they also reported good criterion-referenced reliability for both items. The push-up test yielded a proportion of agreement of .97 and a modified kappa of .94. For the modified pull-up, the proportion of agreement was .95 and the modified kappa was .90. (Modified kappa is the proportion of agreement adjusted for chance.)

Grip strength tests traditionally have enjoyed a reputation of good reliability. Fleishman (1964), for instance, reported a test-retest r of .91 on a sample of some 20,000 12-18-year-old boys and girls. Keogh (1965) found coefficients ranging from .70-.85 among first and third graders. Reliability research on the grip strength of youngsters with mental retardation also has resulted in acceptable coefficients as shown in Table 6. These coefficients suggest a high degree of score consistency for the grip strength test.

Less reliability data are available for the trunk lift. Plowman and Corbin (1994) summarized two trunk extension studies which employed different procedures than the FITNESSGRAM and reported interclass r's ranging from .74-.96. Rarick et al. (1976) reported test-retest coefficients for a spinal extension test given to participants with an educable form of MR. The spinal extension test was done in a side-lying position and did not require the subject to perform against the pull of gravity. The interclass r's for the spinal extension test ranged from .90-.96 for the participants with MR. In the Project Target study (Winnick & Short, 1998), a proportion of agreement of .89 was calculated for the trunk lift across two administrations (14 days apart) using youngsters with MR (n = 36). Jackson et al. (1996) reported a proportion of agreement of .98 for college-aged participants on the trunk lift and a modified kappa of .96. More recently, Hannibal (2003) reported test-retest intraclass coefficients of .99. While more reliability data is needed for the trunk lift, available data are encouraging.

Reliability data also are needed for the seated push-up, 40-meter push/walk, wheelchair ramp test, and reverse curl. Since these items are appropriate only for youngsters with very specific types of physical disabilities, obtaining adequate sample sizes to conduct meaningful studies will be a challenge to researchers. Inasmuch as each of these items is objectively scored and each is related to muscular strength and endurance (a component of fitness typically associated with reliable tests), it is expected that these items will possess an acceptable level of reliability.

In addition to test-retest reliability, criterion-referenced tests should demonstrate the ability to consistently classify participants as either passing or failing the test. This consistency of classification is sometimes expressed as P, the proportion of agreement over two administrations of the test. Some limited consistency of classification data were collected during Project Target (Winnick & Short, 1998) and are presented in Table 7. Each of these MS/E items was taken by participants with MR who were classified in accord with the specific standards presented in Table 2.
## Table 5  Reliability of Field Tests of Upper Arm and Shoulder Girdle Strength for Individuals With Disabilities

<table>
<thead>
<tr>
<th>Author</th>
<th>Disability</th>
<th>N</th>
<th>Gender</th>
<th>Age</th>
<th>Field Test</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Londere &amp; Johnson (1974)</td>
<td>Moderately MR</td>
<td>1105</td>
<td>M/F</td>
<td>6-21</td>
<td>flexed arm hang</td>
<td>spring and fall test-retest r = .48</td>
</tr>
<tr>
<td>Daquilla (1982)</td>
<td>visually impaired</td>
<td>50</td>
<td>M/F</td>
<td>10-17</td>
<td>flexed arm hang</td>
<td>same day test-retest a = .84</td>
</tr>
<tr>
<td></td>
<td>auditory impaired</td>
<td>50</td>
<td>M/F</td>
<td>10-17</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>orthopedically</td>
<td>50</td>
<td>M/F</td>
<td>10-17</td>
<td></td>
<td>a = .96</td>
</tr>
<tr>
<td></td>
<td>impaired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reid, Montgomery, &amp; Seidl (1985)</td>
<td>MR</td>
<td>20</td>
<td>M/F</td>
<td>20-39</td>
<td>push-ups</td>
<td>one month test-retest R = .62</td>
</tr>
<tr>
<td>Eichstaedt &amp; Lavay (1992)</td>
<td>Unclassified</td>
<td>189</td>
<td>M/F</td>
<td></td>
<td>unspecified</td>
<td>R = .83</td>
</tr>
<tr>
<td></td>
<td>school-aged</td>
<td></td>
<td></td>
<td></td>
<td>isometric push-up</td>
<td>one week test-retest r = .88</td>
</tr>
<tr>
<td>Winnick &amp; Short (1998)</td>
<td>MR</td>
<td>38</td>
<td>M/F</td>
<td>10-17</td>
<td>isometric push-up</td>
<td>test-retest a = .83</td>
</tr>
<tr>
<td></td>
<td>MR</td>
<td>12</td>
<td>M/F</td>
<td>13-17</td>
<td>15-lb dumbbell press</td>
<td>test-retest a = .98</td>
</tr>
<tr>
<td>Winnick &amp; Short (1998)</td>
<td>MR</td>
<td>11</td>
<td>M/F</td>
<td>11-17</td>
<td>extended arm hang</td>
<td>one week test-retest a = .85</td>
</tr>
<tr>
<td></td>
<td>MR</td>
<td>17</td>
<td>M/F</td>
<td>11-17</td>
<td>flexed arm hang</td>
<td>one week test-retest a = .93</td>
</tr>
<tr>
<td></td>
<td>MR</td>
<td>23</td>
<td>M/F</td>
<td>11-17</td>
<td>35-lb bench press</td>
<td>one week test-retest a = .91</td>
</tr>
</tbody>
</table>

*Note. r = interclass coefficient; R = intraclass coefficient; a = alpha coefficient.*
### Table 6  Reliability of Grip Strength Measures for Individuals With Disabilities

<table>
<thead>
<tr>
<th>Author</th>
<th>Disability</th>
<th>N</th>
<th>Gender</th>
<th>Age</th>
<th>Field Test</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarick, Dobbins &amp; Broadhead (1976)</td>
<td>EMR</td>
<td>261</td>
<td>M/F</td>
<td>6-13</td>
<td>left grip</td>
<td>test-retest r = .90 - .96</td>
</tr>
<tr>
<td>Rarick &amp; Quillan (1977)</td>
<td>TMR</td>
<td>69</td>
<td>M/F</td>
<td>6-9</td>
<td>right grip</td>
<td>test-retest r = .88 - .98</td>
</tr>
<tr>
<td>Daquila (1982)</td>
<td>visually impaired</td>
<td>50</td>
<td>M/F</td>
<td>10-17</td>
<td>grip strength</td>
<td>test-retest r = .89 - .99</td>
</tr>
<tr>
<td></td>
<td>auditory impaired</td>
<td>50</td>
<td>M/F</td>
<td>10-17</td>
<td>grip strength</td>
<td>test-retest r = .84 - .90</td>
</tr>
<tr>
<td></td>
<td>orthopedically impaired</td>
<td>50</td>
<td>M/F</td>
<td>10-17</td>
<td>grip strength</td>
<td>same day test-retest</td>
</tr>
<tr>
<td>Reid, Montgomery &amp; Seidl (1985)</td>
<td>MR</td>
<td>20</td>
<td>M/F</td>
<td>20-39</td>
<td>grip strength</td>
<td>test-retest R = .88</td>
</tr>
<tr>
<td>Winnick &amp; Short (1998)</td>
<td>MR</td>
<td>36</td>
<td>M/F</td>
<td>11-17</td>
<td>dominant grip</td>
<td>one week test-retest a = .96</td>
</tr>
</tbody>
</table>

*Note. r = interclass coefficient; R = intraclass coefficient; a = alpha coefficient; EMR = educable mentally retarded; TMR = trainable mentally retarded.*
The number of participants used in the calculation of the $P$ coefficients in Table 7 is low so no definitive conclusions can be drawn from these data. These $P$ values, however, at least are encouraging in that all exceed .70, which would seem to be a minimal criterion for acceptable consistency of classification. More work in this area will be necessary.

### Table 7 Consistency of Classification for Selected MS/E Test Items for Participants With MR

<table>
<thead>
<tr>
<th>Test Item</th>
<th>$n$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant Grip Strength</td>
<td>36</td>
<td>.92</td>
</tr>
<tr>
<td>Bench Press</td>
<td>23</td>
<td>.82</td>
</tr>
<tr>
<td>Extended Arm Hang</td>
<td>11</td>
<td>.72</td>
</tr>
<tr>
<td>Flexed Arm Hang</td>
<td>17</td>
<td>.82</td>
</tr>
<tr>
<td>Modified Curl-up</td>
<td>25</td>
<td>.72</td>
</tr>
</tbody>
</table>

### Discussion

The rationale and validity of the muscular strength and endurance tests of the BPFT primarily are logically developed. Safrit (1990) has referred to this type of validity as domain-referenced validity and has argued that although it is logically developed, it should not be considered arbitrary. The logic for the selection of test items (and some standards) is linked to the health-related needs of youngsters with specific disabilities and follows a five-step process termed the "personalized approach," which was discussed in an earlier article in this issue.

Although the establishment of domain-referenced validity for the MS/E test items is an important and necessary step in the validation of the BPFT, more work is necessary. A future goal would be to establish decision validity for each of the items. According to Safrit (1990), decision validity refers to the accuracy of classification of a criterion-referenced test. Can the test and its associated standard accurately classify individuals into some health-related category (e.g., healthy vs. diseased, high risk vs. low risk, independent vs. dependent, etc.)?

The demonstration of decision validity requires the establishment of CR standards that have been linked statistically to some acceptable health index. Setting health-related CR standards for measures of musculoskeletal functioning, however, is a difficult chore, at least in part, because the amount of MS/E necessary for health-related indices will vary from task to task. Although other possibilities for standard setting exist (Cureton & Warren, 1990; Looney & Plowman, 1990), the most commonly-used approach for setting CR standards for MS/E items is through expert opinion. This was the technique used by the developers of the FITNESSGRAM (Plowman & Corbin, 1994) and, to a large extent, the BPFT.

One of the issues resolved through expert opinion pertaining to the CR standards associated with the items discussed in this paper was whether specific standards were required for any of the disability groups and, if so, which ones? Where specific standards are provided, it was believed that they were necessary
to account for the inherent influence of impairment on test performance, rather than to account for traditionally poor fitness levels per se. It seemed clear that no such standards were necessary for youngsters with SCI, VI, or CA/A provided that the items were appropriate. The rationale was that as long as the MS/E test required the use of nonimpaired muscle groups (or, in the case of youngsters with VI, did not put a premium on vision), youngsters with these disabilities should be expected to meet the standards associated with the general population. Project Target attainability data are limited for SCI and CA/A youngsters, but data for youngsters with VI suggest that the general standards are, in fact, in reach although some training may be necessary. Passing rates for youngsters with VI run a bit low for upper body measures (23-31%) but are higher for curl-ups (55%) and trunk lift (85%).

As already seen, specific standards have been developed and are recommended for use with youngsters with mental retardation and mild limitations in fitness. (In the BPFT no distinction is made between youngsters with and without Down syndrome despite the acknowledgment that the presence of Down syndrome may affect fitness test performance. Nevertheless, some youngsters with Down syndrome might have “mild limitations in fitness” and can pursue the standards associated with the BPFT; others might have more severe limitations in fitness. Teachers must develop standards, measure physical activity instead of fitness, or utilize task analytic procedures for youngsters with severe limitations in fitness regardless of the presence of Down syndrome.) Although the musculature of people with MR appears to be nonimpaired, it is well-documented that they score below people without disabilities on measures of fitness (Eichstaedt & Lavay, 1992). If their relatively poor scores could be attributed strictly to problems with cognition, it would be expected that youngsters with MR would do well on tasks with few cognitive requirements, but this does not seem to be the case. As Eichstaedt and Lavay (1992) wrote, “Their limited cognitive ability doesn’t explain it” (p. 200). Until such time as the mechanism that underlies the poor strength and endurance performance of persons with MR is more fully understood, it seemed prudent to offer specific standards for this group. The attainability data presented as part of this manuscript suggests that the addition of specific standards for youngsters with MR is appropriate. Passing rates for specific standards range from 24% to 55% compared to a range of only 8% to 32% for minimal general standards. It is assumed that standards that are perceived to be “within reach” of youngsters with disabilities will serve to better motivate youngsters (and their teachers) to pursue higher levels of health-related fitness.

The decision to not develop and offer specific standards for youngsters with CP on MS/E items such as grip strength and dumbbell press may be of particular interest to some readers. Research has established that participants with CP typically produce inferior scores on measures of strength and endurance compared to those without disabilities and, in some cases, the differences are vast (Winnick & Short, 1982). It also is clear that the musculature of people with CP can be negatively affected by spasm, athetosis, rigidity, ataxia, and a general lack of tone (Shephard, 1990). Nevertheless, MS/E performance of individuals with CP varies as a function of the type, location, and degree of the impairment suggesting that, depending on the test item, some youngsters with CP can be expected to meet general standards. In other cases, tests that are relevant for people with CP (e.g., 40-m push, wheelchair
ramp test) are not germane to people without disabilities and, therefore, are not associated with general standards per se.

Consequently, the approach taken in the BPFT for MS/E items was to accommodate youngsters with CP by adjusting test items rather than by adjusting standards. More generic measures of upper body strength and endurance such as grip strength and dumbbell press are suggested primarily for classes C4, C5, C7, and C8, and participants are required to meet general standards for at least one side of the body only (i.e., dominant or preferred limb). Members of each of these classes are described as having good (or normal) functional strength or ability in at least one upper extremity (Peacock, 1988). Youngsters in classes C2 (U and L), C3, and C6 have upper body impairments and take MS/E test items with standards that have been linked to activities of daily living or values found in the literature rather than to normative data. More attainability data will need to be collected to determine if these standards are "realistic," but the preliminary findings for grip strength are encouraging.

The reliability data available for the MS/E items in the BPFT generally suggests good score consistency although additional test-retest work is necessary for some items. It also would be important to further examine the consistency of classification as a criterion-referenced form of reliability (Safrit, 1990).

Many research possibilities exist pertaining to the ongoing validation of the BPFT. Future research ideas regarding the MS/E test items include the following:

- Gather additional evidence to support or refute the 20th percentile as a criterion referenced health-related standard (or develop alternative bases for standards);
- collect additional reliability data for curl-up, modified curl-up, and trunk lift;
- determine/confirm consistency of classification for all items;
- collect additional attainability data especially on youngsters with physical disabilities; and
- collect additional data (including reliability and attainability) on the 40-meter push/walk, seated push-up, wheelchair ramp test, and reverse curl.

Future research on the health-related criterion-referenced physical fitness of children and adolescents with disabilities most certainly will result in modifications to the Brockport Physical Fitness Test. The current version of the BPFT, however, is seen as an important step in what hopefully will be an evolutionary process with the help of many physical activity professionals, including teachers and researchers. Nevertheless, the current version is believed to possess sound levels of validity and reliability sufficient for the BPFT to be a useful tool when assessing the MS/E health-related fitness of youngsters with disabilities.

References


Hayden, F.J. (1964). *Physical fitness for the mentally retarded*. Toronto, Canada: Metropolitan Toronto Association for Retarded Children.


