DOCUMENT RESUME

ED 433 629	EC 307 374
AUTHOR	Short, Francis X.; Winnick, Joseph P.
TITLE	The Brockport Physical Fitness Test Technical Manual. [Project Target]. The National Fitness Test for Youth with Disabilities.
INSTITUTION	State Univ. of New York, Brockport. Coll. at Brockport.
SPONS AGENCY	Office of Special Education and Rehabilitative Services (ED), Washington, DC.
PUB DATE	1998-05-00
NOTE	164p.; For related documents, see EC 307 372-375.
CONTRACT	HO23C30091
AVAILABLE FROM	Human Kinetics, 1607 North Market St., P.O. Box 5076, Champaign, IL 61825-5076; Fax: 217-351-2674.
PUB TYPE	Guides - Non-Classroom (055) -- Tests/Questionnaires (160)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Adolescents; Aerobics; Body Composition; Child Health; Children; Criterion Referenced Tests; *Disabilities; Elementary Secondary Education; Muscular Strength; Physical Fitness; *Physical Fitness Tests; Standards; *Test Construction; Test Content; Test Items; *Test Reliability; *Test Validity
IDENTIFIERS	*Testing Accommodations (Disabilities)

ABSTRACT

This monograph documents the basis for selection of test items and health-related, criterion-referenced standards associated with the Brockport Physical Fitness Test (BPFT), a criterion-referenced fitness test for children and adolescents with disabilities. The manual is divided into separate chapters for the relevant components or sub-components of health-related fitness: aerobic functioning, body composition, muscular strength and endurance, and flexibility/range of motion. Each chapter includes information on both validity and reliability. The validity section of each chapter attempts to establish that the fitness component relates to health status. This section also defines criterion levels of the component that can be used as the basis for setting health-related physical fitness standards. A test-items sub-section provides a rationale for the inclusion of a specific item in the test battery, and a standards sub-section provides a rationale for the recommended criterion-referenced standards. Links between test scores to criterion levels of the components are provided. An attainability sub-section reports passing rates for the various tests by disability groups based on data collected on 1,542 youngsters. The final section on reliability focuses on available "norm-reference reliability" data for each test item. Each chapter concludes with a short discussion on ideas for future research. (Chapters include references.) (CR)

The Brockport Physical Fitness Test Technical Manual

The National Fitness Test for Youth with Disabilities

by

Francis X. Short, P.E.D.

and

Joseph P. Winnick, Ed.D.

Department of Physical Education & Sport
State University of New York, College at Brockport
Brockport, NY 14420

May 1998

This material was developed as a part of Project Target which was conducted at the State University of New York, College at Brockport. Project Target was supported by the Office of Special Education and Rehabilitative Services (OSE/RS), U.S. Department of Education, Project No. HO23C30091. The contents presented herein are those of the authors and do not necessarily reflect the position or policy of OSE/RS or SUNY, College at Brockport and no official endorsement should be inferred.

Project Target

Central Staff at the State University of New York
College at Brockport

Project Director:	Joseph P. Winnick
Project Coordinator:	Francis X. Short
	George Lawther (1993-94)
Graduate Assistants:	Kevin Biata
	Mary Powers
	Rob Korzeniewski
	Kevin Wexler
	Lori Erickson

Office of Special Education and Rehabilitative Services

Project Officer:	Melville Appell
	Doris Andres

Project Target Advisory Committee
and Panel of Experts

Kirk J. Cureton, Ph.D. - University of Georgia
Harold W. Kohl, Ph.D. - Baylor Sports Medicine Institute
Kenneth Richter, D.O. - Medical Director, United States Cerebral Palsy Athletic Association
James H. Rimmer, Ph.D. - Northern Illinois University
Margaret Jo Safrit, Ph.D. - American University
Roy J. Shephard, M.D., Ph.D., D.P.E. - The University of Toronto
Julian U. Stein, Ed.D. (retired) - George Mason University

Preface

This monograph is one element of the final report submitted to the U.S. Department of Education, Office of Special Education and Rehabilitative Services, for the grant entitled "Project Target: Criterion-Referenced Physical Fitness Standards for Adolescents with Disabilities." This document is designed to be used in concert with the Brockport Physical Fitness Test (BPFT). The BPFT was developed as part of Project Target and another element of this final report which appears under separate cover.

The purpose of this technical manual is to document the basis for the selection of test items and health-related criterion-referenced standards associated with the BPFT. To completely understand the rationale for the selection of test items and standards, readers should be familiar with the conceptual framework and health-related concerns and desired fitness profiles discussed in the BPFT.

Project Target was designed to develop a criterion-referenced health-related test of physical fitness. In pursuing this goal, it was decided to use the Prudential FITNESSGRAM as an important reference for test construction. The Prudential FITNESSGRAM was adopted by AAHPERD as its recommended test of health-related physical fitness for nondisabled youngsters and was considered to be conceptually consistent with the goals of Project Target. Also coordination with the Prudential FITNESSGRAM enhances measurement and evaluation at the practitioner level. Consequently, much of the rationale for the items and standards recommended for the general population already has been documented. Readers are referred to The Prudential FITNESSGRAM Technical Reference Manual for much of this material. Emphasis in this monograph is placed on the selection of test items and standards for youngsters with disabilities.

The selection of test items and standards for the BPFT was influenced by years of previous research in adapted physical activity, data collected on 1,542 youngsters over the life of Project Target, and the expert opinions of some of the leading professionals in the areas of fitness and adapted physical activity. We believe the final product represents a good beginning in the area of health-related criterion-referenced physical fitness testing for youngsters with disabilities. It is clear, however, that this area is fertile ground for research activity and we hope this technical manual will serve as a foundation for future work.

Francis X. Short
Joseph P. Winnick
Brockport, NY

Acknowledgments

It is difficult to separate people's contributions to Project Target into "test manual contributions" or "technical manual contributions" since the two documents are inter-related. The items and standards which appear in the Brockport Physical Fitness Test Manual (BPFT) are based on the rationale discussed here in the technical reference manual. Gratitude is expressed, therefore, to all who helped in the development of the BPFT in some way.

Special thanks are extended to those individuals whose contributions affected the conceptual development of the BPFT. First and foremost, the Project Target Advisory Committee is recognized in this regard. The Committee served as the projects' panel of experts and was instrumental in providing feedback, critiquing, brainstorming, and clarifying thinking on many topics throughout the life of the project. Members of the Committee included Kirk J. Cureton, Ph.D., University of Georgia; Harold W. Kohl, Ph.D., Baylor Sports Medicine Institute; Kenneth Richter, D.O., St. Joseph Mercy Hospital, Pontiac, MI; James H. Rimmer, Ph.D., Northern Illinois University; Margaret Jo Safrit, Ph.D., American University; Roy J. Shephard, M.D., Ph.D., D.P.E., University of Toronto (retired); and Julian U. Stein, Ed.D., George Mason University (retired).

Consultants to Project Target whose work enhanced the validation of the test included Bo Fernhall (George Washington University), Ken Pitetti (Wichita State University), Paul Surburg (Indiana University), and Tim Lohman (University of Arizona). Appreciation also is extended to the 1,542 youngsters, their parents, and their teachers, who helped to field-test the battery and who provided important statistical information used in setting criterion-referenced standards.

Finally, the authors would like to thank Kirk Cureton, Ken Richter, Paul Surburg, and Tim Lohman for reading and reacting to drafts of the chapters contained in this manual. Their comments helped to forge a stronger document. Any errors are those of the authors.

Table of Contents

List of Tables

List of Figures

Chapter I
Introduction

Since 1980 there have been two important trends in physical fitness testing. The first was the distinction between health-related and skill-related fitness with an emphasis on the assessment of components of fitness that were health-related for physical education purposes. The second trend was to assess student performance against criterion-referenced standards rather than norm-referenced standards. Examples of health-related criterion-referenced physical fitness tests developed and published in the 1980's included the South Carolina Physical Fitness Test (Pate, 1983), the first version of FITNESSGRAM (Cooper Institute for Aerobics Research, 1987) and AAHPERD's Physical Best (McSwegin, Pemberton, Petray, and Going, 1989). Although both of the latter tests referred to youngsters with disabilities in the test administration manuals, the criterion-referenced standards associated with these tests were clearly developed for nondisabled populations. As stated in the Physical Best manual, "Unfortunately, there is not enough objective information on the health and fitness status of many handicapped individuals; therefore, it is difficult to provide specific standards and guidelines" (McSwegin, et al, 1989, p. 23). Project Target attempted to address the need for criterion-referenced standards appropriate for youngsters with disabilities.

Project Target was a federally-funded research study designed to establish and validate health-related criterion-referenced physical fitness test items and standards for youngsters (aged 10-17) with selected disabilities. The disability groups included in the study were mental retardation with mild limitations in fitness (MR), visual impairments (blindness) (VI), cerebral palsy (CP), spinal cord injury (SCI), and congenital anomaly/amputation (CA/A). Participants with CP were sub-classified in accord with the eight-class (C1-C8) system used by the Cerebral Palsy International Sport and Recreation Association (CP-ISRA, 1993). SCI was sub-classified based on level of lesion and mobility method. Sub-classes of SCI included low level quadriplegia (LLQ), paraplegia-wheelchair (PW), and paraplegia-ambulatory (PA). Test item selection for youngsters with CA/A was a function of the site of the impairment(s) (one arm, two legs, etc). (Readers are referred to the test manual for more detail.) The resultant fitness test also is appropriate for youngsters in the general population (GP). The project was funded from June 1993-May 1998.

Work on Project Target served as the basis for the development of the Brockport Physical Fitness Test (BPFT) (Winnick and Short, in press). The framework for developing the BPFT is represented by Figure 1.1. This schematic, which is modified from a model described by Bouchard and Shephard (1994), attempts to demonstrate the relationships among physical activity, health, and health-related physical fitness. Understanding the meaning of each of these terms, and their relationships, is important in understanding the construction of the BPFT. Physical activity consists of any bodily movement produced by skeletal muscle resulting in a substantial increase over resting energy expenditure (Bouchard and Shephard, 1994). Health is defined as "human condition with physical, social, and psychological dimensions, each characterized on a continuum with positive and negative poles. Positive health is associated with a capacity to enjoy life and to withstand challenges; it is not merely the absence of disease. Negative health is associated with morbidity and, in the extreme, with premature mortality (Bouchard and Shephard, 1994, p. 84). Health-related fitness refers to those components of fitness that are affected by habitual physical activity and relate to health status. It is defined as a

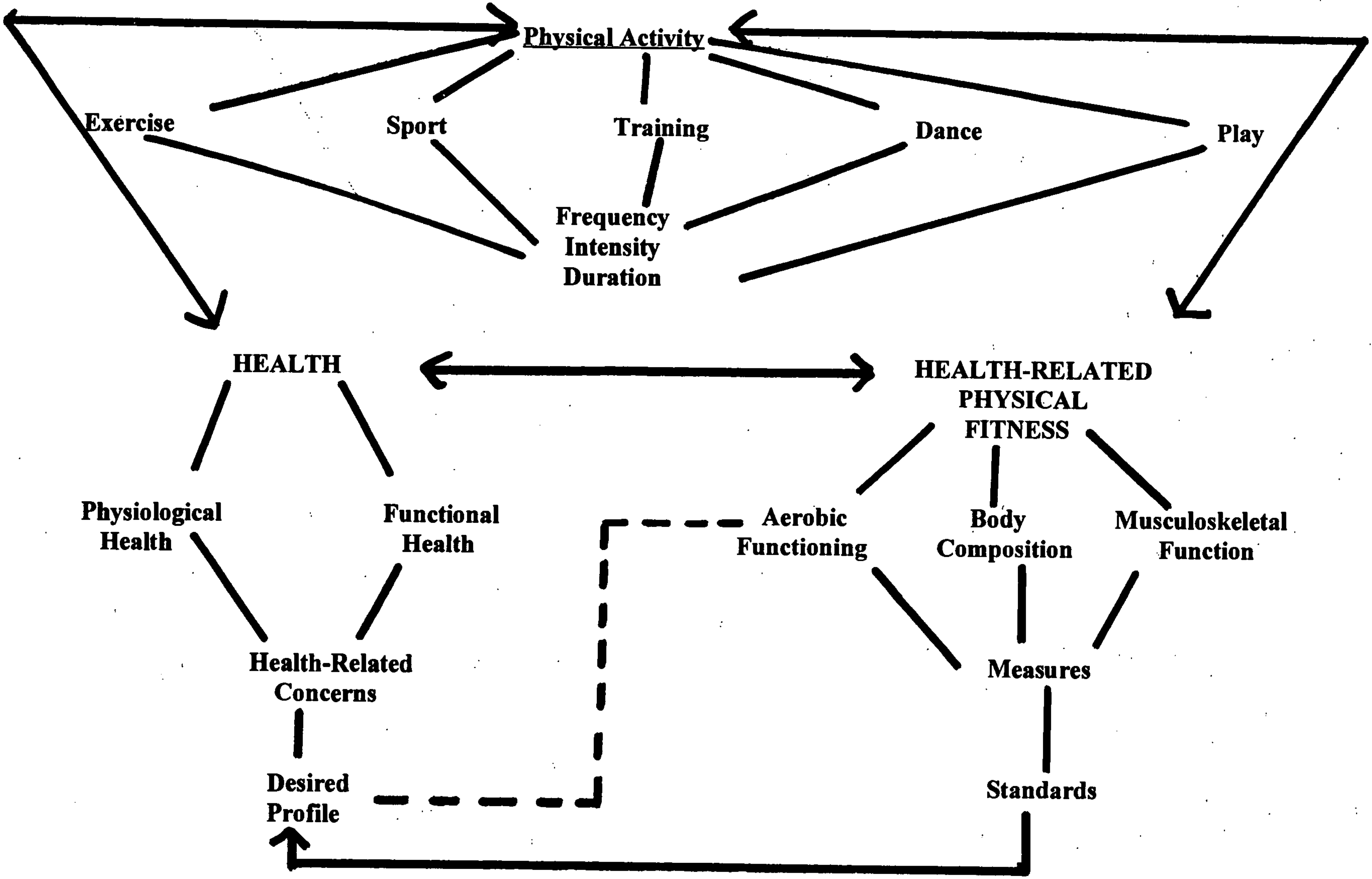

Figure 1.1: Relationships Among Health, Physical Activity and Health-Related Physical Fitness

state characterized by (a) an ability to perform and sustain daily activities and (b) demonstration of traits or capacities that are associated with a low risk of premature development of diseases and conditions related to movement (modified from Pate, 1988).

The BPFT includes 27 different test items under three components of health-related physical fitness: aerobic functioning, body composition, and musculoskeletal functioning (muscular strength/endurance and flexibility/range of motion). Criterion-referenced (CR) standards are provided for all test items. Some technical information is included in the BPFT test manual so that test-users may have a basis from which to evaluate the test. However, much greater detail is presented in this monograph. No other specific information on the development and validation of the BPFT battery has been published.

The purpose of this reference manual, therefore, is to provide interested readers with a detailed rationale for the selection of test items and standards associated with the Brockport Physical Fitness Test. The manual is divided into separate chapters for the relevant components or sub-components of health-related fitness: aerobic functioning, body composition, muscular strength and endurance, and flexibility/range of motion. (Muscular strength and endurance and flexibility/range of motion are sub-components of musculoskeletal functioning, but are treated separately here due to the large number of items associated with this component.) Each chapter includes information or both validity and reliability.

The validity section of each chapter includes opening paragraphs that attempt to establish that the fitness component, or sub-component, in question does, in fact, relate to health status. The opening paragraphs also attempt to define criterion levels of the component that can be used as the basis for setting health-related physical fitness standards (critical values of VO_{2max}, percent body fat, etc.). Sub-sections on test items, standards, and attainability follow the opening paragraphs.

The test items sub-section provides a rationale for the inclusion of a specific item in the test battery. Attempts are made to link the test item to the component or sub-component of fitness being discussed. (Readers will have to refer to the test manual for a complete description of test protocols.) The rationale for the inclusion of many of these test items in a battery that purports to be health-related is often logically-based, or what Safrit (1990) referred to as domain-referenced validity. Domain-referenced validity provides evidence that a test adequately represents a particular domain of behavior, such as aerobic capacity, upper body strength/endurance, and so forth. Although domain-referenced validity is logically-based it should not be viewed as arbitrary (Safrit, 1990).

The standards sub-section provides a rationale for the recommended CR standards. Links between test scores (laps, times, skinfolds, etc.) to criterion levels of the component (VO_{2max}, percent body fat, 20th percentile, etc.) are provided here. Attempts are made to link standards to indices of either physiological or functional health. Physiological health is related to the organic well-being of the individual. Indices of physiological health include traits or capacities that are associated with well-being, absence of a disease or condition, or low risk of developing a disease or condition. Functional health is related to the physical capability of the individual. Indices of functional health include the ability to independently perform important tasks, such as activities of daily living and the ability to sustain the performance of those tasks.

In the BPFT, health-related standards are either general or specific. (Testers also have the flexibility to develop individualized standards for youngsters as may be necessary. Readers may consult the test manual for more information on individualized standards.) A general standard is one believed to be appropriate for the general population. A specific standard is one that has been adjusted to account for the effects of a particular impairment or disability on test performance. For many items general standards are provided for both minimal and preferred levels. A minimal general standard represents the lowest acceptable criterion for health-related fitness for a particular item for the general population. A preferred standard is established to represent a good level of health-related fitness for members of the general population. In some cases, only a single general standard is provided for a particular item. Youngsters who attain a single general standard also are considered to have reached a good level of health-related fitness.

The attainability sub-section typically reports passing rates for the various tests by disability groups. In a strict theoretical sense, the issue of attainability in the development of a criterion-referenced test is moot. CR standards are selected because they are believed to reflect important elements of a particular domain (e.g., health). If the standards accurately reflect desirable levels of health-related fitness the fact that they may be "too easy" or "too hard" technically is irrelevant. In a practical sense, however, attainability is an important aspect in CR fitness development especially for youngsters with disabilities. One of the reasons for fitness testing is to draw both student and teacher attention to the importance of fitness and to motivate students to pursue higher (or at least healthy) levels of fitness. When test items cannot be performed and/or standards are perceived as being out of reach, the message seems to be that physical fitness is not an appropriate pursuit for youngsters with disabilities. One of the goals of the BPFT, therefore, was to select items and standards which could be linked to some index of health status, but also would be attainable for youngsters with disabilities.

Reliability sections generally focus on available "norm-referenced reliability" data for each test item. Test-retest information is expressed as either an interclass, intraclass, or alpha reliability coefficient. Some "criterion-referenced reliability" data (i.e., consistency of classification) also are presented, although this information is more limited. Each chapter concludes with a short discussion section that includes ideas for future research.

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Chapter II
Aerobic Functioning

For the Brockport Physical Fitness Test (Winnick and Short, in press), aerobic functioning refers to that component of physical fitness that permits one to sustain large muscle, dynamic, moderate to high intensity activity for prolonged periods of time. Aerobic functioning includes two subcomponents in the BPFT: aerobic capacity and aerobic behavior. Aerobic capacity refers to the highest rate of oxygen that can be consumed by exercising. In the BPFT, aerobic capacity is expressed by maximum oxygen uptake (VO_{2max}). Standards for VO_{2max} are expressed as ml/kg./min. Test items associated with aerobic capacity in the BPFT include the one-mile run/walk, and the 16m and 20m Progressive Aerobic Cardiovascular Endurance Run (PACER). Aerobic behavior refers to the ability to sustain physical activity of a specific intensity for a particular duration. The Target Aerobic Movement Test (TAMT) is the single measure of aerobic behavior in the BPFT.

Test items to measure aerobic functioning are depicted in Table 2.1. Test items are recommended (R) or optional (O) for defined groups and ages. A recommended test item is considered to be appropriate and most acceptable for the measurement of physical fitness when factors for selecting test items are equal. Optional test items are alternate test items considered to be appropriate and acceptable for the measurement of components of physical fitness. Readers must refer to the test manual for a complete description of test protocols.

Table 2.1
Test Selection Guide for the Measurement of Aerobic Functioning on the Brockport Physical Fitness Test

Group	Test Item			
	Aerobic Capacity			Aerobic Behavior
	One-mile Run/Walk	20m PACER	16m PACER	Target Aerobic Movement Test
General Population	R (Ages 10-17)	O (Grades 4-12) R (Grades K-3)	----	----
Mental Retardation	----	R (Ages 13-17)	R (Ages 10-12)	R
Visual Impairment	O (Ages 15-17)	R (Ages 10-17)	----	----
Spinal Cord Injury	----	----	----	R
Cerebral Palsy	----	----	----	R
Congenital Anomaly/ Amputation				
Arm Involvement Only	R	O	----	----
Others	----	----	----	R

R = recommended
O = optional

In the sections which follow, the validity and reliability related to tests of aerobic functioning in the BPFT will be discussed. The validity section includes information on test items, standards, and attainability and the reliability section primarily includes available test-retest data and some consistency of classification information. A discussion section is presented at the end of the manuscript.

Validity

Aerobic functioning and/or cardiovascular endurance has been considered an integral part of physical fitness for many years. Measures of aerobic functioning have been included in physical fitness tests which purport to measure both performance- and health-related aspects of fitness. Distance runs, for example, have been included in the Youth Fitness Test (AAHPERD, 1976), the Health Related Test (AAHPERD, 1980), and Project UNIQUE (Winnick and Short, 1985). In the BPFT, aerobic functioning is viewed as a health-related component of physical fitness. Although this chapter is not designed to be a definitive review of the benefits of aerobic fitness to health, it is important to stress that, in the past few years, research in support of a strong association of aerobic fitness and health status has accumulated (Blair, Kohl, et al. 1989; Erikssen, 1986; Peters, Cady, Bischoff, Bernsten & Pike, 1983; Sobolski, et. al. 1987; Tell & Vellar, 1988; and Wilhelmsen et. al., 1981). Also, strong scientific support linking physical activity and health has resulted in organizational support for regular physical activity for health benefits. The American Heart Association (AHA, 1992) identified physical inactivity as a major risk factor in coronary heart disease. The Center for Disease Control (CDC) and Prevention and the American College of Sports Medicine (Pate, et. al. 1995) recommended at least 30 minutes of moderate-intensity physical activity for every U.S. adult on most, preferably all, days of the week, for health-related benefits. The National Institutes of Health (NIH) (Consensus Development Conference, 1995) and The Second International Consensus Symposium (Bouchard, Shephard, & Stephens, 1994) confirmed the importance of physical activity for health. The Surgeon General's report (U.S. Department of Health and Human Services, 1996) emphasized that Americans can substantially improve their health and quality of life by including moderate amounts of physical activity in their daily routines.

Tests of aerobic capacity have long been considered preferred measures of aerobic functioning because they reflect cardiorespiratory capacity, the ability to carry out prolonged strenuous exercise, and because they are associated with a reduced risk (in adults) of hypertension, coronary heart disease, obesity, diabetes, some forms of cancer, and other health problems (Cureton, 1994). For these reasons measures of aerobic capacity are considered to be representative of "physiological health" in the BPFT. Physiological health is concerned with one's organic well-being. The Prudential FITNESSGRAM (CIAR, 1992), the only health-related criterion-referenced physical fitness test currently endorsed by AAHPERD, uses two field tests of aerobic capacity in its battery: the 20m PACER and the one-mile run/walk (MRW). The CR standards associated with both of these tests are linked to maximum oxygen uptake (VO_{2max}) values. VO_{2max} therefore, serves to define appropriate levels of aerobic capacity for health-related purposes and provides a basis for CR standards for specific test items. Critical VO_{2max} values associated with the Prudential FITNESSGRAM, and adopted by the BPFT, are presented in Table 2.2.

Table 2.2
VO_{2max}, One-Mile Run/Walk, 20m PACER, 16m PACER, and Target Aerobic Movement Test General Standards

Age	VO2max (ml/kg/min) M	VO2max (ml/kg/min) P	One Mile (min/sec) M	One Mile (min/sec) P	20m PACER (# laps) M	20m PACER (# laps) P	16m PACER (# laps) M	TAMT[1] (min) M
Males								
10	**42**	52	**11:30**	9:00	**17**	55	**25**	**Pass**
11	**42**	52	**11:00**	8:30	**23**	61	**33**	**Pass**
12	**42**	52	**10:30**	8:00	**29**	68	**40**	**Pass**
13	**42**	52	**10:00**	7:30	**35**	74	**48**	**Pass**
14	**42**	52	**9:30**	7:00	**41**	80	**55**	**Pass**
15	**42**	52	**9:00**	7:00	**46**	85	**61**	**Pass**
16	**42**	52	**8:30**	7:00	**52**	90	**69**	**Pass**
17	**42**	52	**8:30**	7:00	**57**	94	**75**	**Pass**
Females								
10	**39**	47	**12:30**	9:30	**7**	35	**13**	**Pass**
11	**38**	46	**12:00**	9:00	**9**	37	**15**	**Pass**
12	**37**	45	**12:00**	9:00	**13**	40	**20**	**Pass**
13	**36**	44	**11:30**	9:00	**15**	42	**23**	**Pass**
14	**35**	43	**11:00**	8:30	**18**	44	**26**	**Pass**
15	**35**	43	**10:30**	8:00	**23**	50	**33**	**Pass**
16	**35**	43	**10:00**	8:00	**28**	56	**39**	**Pass**
17	**35**	43	**10:00**	8:00	**34**	61	**46**	**Pass**

M = Minimal
P = Preferred

1 Scored as pass/fail. Youngsters pass when they sustain moderate physical activity for 15 minutes.

These critical VO_{2max} values range from 42 ml/kg/min. to 52 ml/kg/min. for boys and from 35 ml/kg/min. to 47 ml/kg/min. for girls. In the FITNESSGRAM these ranges define a "healthy fitness zone." In the BPFT the lower values in the range represent "minimal" standards and the higher values "preferred" standards. As pointed out by Cureton(1994), the rationale for the upper and lower boundaries of the healthy fitness zones is based on data linking VO_{2max} with disease in adults. The rationale for the use of VO2max in the Prudential FITNESSGRAM as a health-related physical fitness test standard, the basis for the standards identified, and the specific calculations used in order to determine values is explained in detail by Cureton (1994).

Most relevant for the purposes of this manuscript is a description and analysis of the adjustments of VO_{2max} values for individuals with disabilities. In this regard, two populations were considered for possible adjustments for VO_{2max}, individuals who are blind and those who are mentally retarded and have mild limitations in fitness. Based on a review of literature, the Project Target staff and panel of experts concluded that there is no physiological reason why VO_{2max} performance could not be developed for blind youngsters to the extent that it is expected in sighted populations. The decision to adopt the Prudential FITNESSGRAM values for maximum oxygen intake for adolescents with visual impairments and/or blindness was supported by several studies (Lee, Ward, and Shephard, 1985; Hopkins, Gaeta, and Hill, 1987; Sundberg, 1982) and by Cumming, Goulding & Baggley (1971) who indicated that levels of habitual activity play an important role in the development of maximum oxygen uptake. The decision to use the identical VO_{2max} values for blind and sighted youngsters also was influenced by the opinion of Buell (1973) who indicated that students who are blind need a vigorous program of physical activity to give them superior levels of physical fitness because they must work harder to reach the same level of success as their sighted peers (See Table 2.3).

The BPFT, on the other hand, does recommend adjustments to VO_{2max} in the case of youngsters with mental retardation and mild limitations in physical fitness (See Table 2.4). In the BPFT, specific VO_{2max} values recommended for individuals with MR are lowered 10% from those required of the general population. The 10% lowering of the VO_{2max} values was meant to adjust for the discrepancy which has been repeatedly observed between youngsters with and without MR on measures of aerobic capacity. In this regard Shephard (1990) estimated that the scores of individuals with MR are 8 to 12% below those for nondisabled peers of the same age. Following a review of literature, Fernhall, Tymeson, and Webster (1988) reported that the cardiovascular fitness levels of persons (including children, adolescents, and adults) with mental retardation ranges between 10 to 40% below those of their nondisabled peers.

Shephard (1990) reported that the maximum oxygen intake of individuals with mental retardation is generally lower than in the population of nondisabled peers although values reported have ranged quite widely among various studies. In view of the wide variation in studies reporting the maximum oxygen intake values of youngsters with mental retardation, the panel of experts associated with Project Target and authors of the BPFT adopted the 10% downward adjustment in values to serve as a specific standard. This standard was selected for several reasons. First, it is viewed as a realistic but conservative adjustment for scientifically unaccounted for discrepancies between youngsters with and without mental retardation relative to aerobic capacity. Second, it serves as a realistic and attainable standard which leads toward, and reasonably approaches, improved health status associated with the general population.

Table 2.3
VO2max, One-Mile Run/Walk, 20m PACER Specific Standards for Youngsters Who Are Blind[1]

Males			
		Aerobic Capacity	
Age	Minimal General VO2max (ml/kg/min)	One-Mile Run/Walk (min,sec)	20m PACER (# laps)
10	42	12:30	15
11	42	12:00	21
12	42	11:30	26
13	42	11:00	32
14	42	10:30	37
15	42	10:00	41
16	42	9:30	47
17	42	9:30	51
Females			
10	39	13:30	6
11	38	13:00	8
12	37	13:00	12
13	36	12:00	14
14	35	11:30	17
15	35	11:00	22
16	35	10:30	27
17	35	10:30	32

[1]These specific standards in the one-mile run/walk and the 20M PACER are based upon a bonus of 10 percentile points given to youngsters who are blind and require physical assistance in performing runs. The VO2max values associated with these specific standards are the same as the minimal general standards.

Table 2.4
VO_{2max} and PACER
Specific Standards for Youngsters with Mental Retardation

Males			
Age	VO_{2max} (ml/kg/min.)[1]	PACER (20m) (# laps)[2,3]	PACER (16m) (# laps)[2,3]
10	38	4	9
11	38	10	16
12	38	16	24
13	38	21	30
14	38	27	38
15	38	33	45
16	38	38	57
17	38	44	59
Females			
10	35	1	5
11	34	1	5
12	33	1	5
13	32	4	9
14	31	6	11
15	31	12	19
16	31	17	25
17	31	22	31

[1] Specific standards associated with a 10% downward adjustment of VO_{2max} from minimal general standards.

[2] Laps for the 16m are based upon estimates from 20m PACER lap scores.

[3] 16m laps = 1.25 (20m laps) + 3.8, S.E. = 7.4. 20m laps = .71 (16m laps) - .87, S.E. = 5.5. 20m lap values are approximately 63% of 16m lap scores.

Third, the standard advances the individual from levels which are considered by authorities as reflective of poor condition and a sedentary lifestyle. A lower standard (e.g., a 40% adjustment) could possibly be misinterpreted as a positive level of health-related aerobic fitness.

Although tests of aerobic capacity may be the preferred measures of aerobic functioning because of their association with "physiological health," tests of aerobic behavior also may play a role in the assessment of aerobic functioning. Tests of aerobic behavior measure the ability to sustain aerobic activity. Since such an ability has relevance for the execution of daily activities (including education and recreation) it is considered to be an indication of one's "functional health". In the BPFT individuals demonstrating the ability to sustain moderate physical activity for 15 minutes meets the minimal general standard for health-related aerobic behavior. An exercise heart rate of at least 70% of maximum predicted heart rate adjusted for disability or mode of exercise represents moderate exercise. Not only does this kind of activity have implications for functional health, but it is also believed to reflect behavior, that when performed regularly, is consistent with existing general recommendations for health enhancement or maintenance (ACSM, 1990, 1995; U.S. Department of Health and Human Services, 1996) and is sufficiently intense to stimulate an aerobic training effect (McArdle, Katch, Katch, 1994). More specifically, the critical values for aerobic behavior were established using the guidelines recommended by the American College of Sports Medicine (1991, 1995). These guidelines recommend that physical activity elevate heart rate between 60 and 90 percent of maximum heart rate for a period of 15 to 60 minutes, and be performed 3 to 5 days a week in order to confer health benefits and improve or maintain cardiorespiratory fitness.

The BPFT tests of aerobic functioning are discussed on the following pages of this chapter. The three measures of aerobic capacity, the one-mile run/walk and two versions of the PACER, are covered first, followed by the single measure of aerobic behavior, the TAMT.

One-Mile Run/Walk

The one-mile run/walk is included in the Brockport Physical Fitness Test to estimate VO_{2max}. In discussing the validity of the MRW to estimate $VO_{2max,}$ Cureton (1994) referred to both construct and concurrent validity. In regard to the test items for nondisabled children and adolescents, Cureton established a rationale for using the MRW by pointing out the important contribution of VO_{2max} compared to other physiological and behavioral factors in run performance. In regard to concurrent validity, Cureton (1994) summarized his and other studies and reported Pearson r's ranging from .60 to .85 between distance run time and $V0_{2max}$. Based on these data, Cureton (1994) concluded that the one-mile run/walk has moderate concurrent validity as a measure of VO_{2max}. In the BPFT, the MRW is a recommended test item for youngsters in the general population, those with arm only involvement and classified as CA/A, or an optional test item for individuals who are VI.

Standards

Minimal and preferred general standards for the one-mile run/walk are recommended for the general population, youngsters with CA/A, and youngsters who exhibit visual impairments but who are not blind. General standards for the MRW are presented in Table 2.2. Minimal general standards are believed to be consistent with positive health and functional capacity for daily living in adult men and women and preferred standards are based on a level of VO_{2max}

which is thought to be good and associated with lower disease risk and mortality in adults (Cureton, 1994). Mile run/walk CR standards used in the Prudential FITNESSGRAM and the Brockport Physical Fitness Test are described by Cureton and Warren (1990) and Cureton (1994). Inasmuch as the process of linking MRW times to critical values of VO_{2max} is somewhat involved it will not be reiterated here, but the performance standards "were estimated using data on the energy cost of running at different speeds and by assuming that a certain percentage of the aerobic capacity was utilized during running" (Cureton and Warren, 1990, p.11). Cureton (1994) indicated that the upper boundary (or "preferred") standards correspond to the 60-70th percentile of the National Children and Youth Fitness Study (NCYFS) norms for boys and the 80-99th percentile for girls. Cureton and Warren (1990) evaluated the validity of the 1987 FITNESSGRAM criterion-referenced standards using data on 578 nondisabled children, ages 7-14. They reported that the standards that were established were reasonably valid in classifying VO_{2max}. The percentage of children classified correctly averaged 85% for the original FITNESSGRAM standards.

Specific standards are provided for the one-mile run/walk for youngsters who are blind (See Table 2.3). Buell (1983) recommended that a "bonus" of ten percentile points be given to a blind performer in long distance runs for equitable comparisons of performance with sighted peers. He felt that such an adjustment is warranted because the runners are slowed down by either running side by side, touching elbows from time to time, or holding the elbow of a sighted person. Using the 10 percentile adjustment as the basis, several computational steps were followed in adjusting the MRW standards for runners who are blind from minimal general standards. The steps for the calculations can be obtained from the authors of this manuscript.

Leeway was given for "rounding" or "smoothing" of the standards. It can be noted that specific standards for blind males ages 15-17, are 60 seconds below minimal general standards. The specific standards for blind females between the ages of 15-17 is 30 seconds slower than that of the minimal general standards for females. Although the one-mile run/walk is only identified as an optional test item for youngsters with visual impairments, ages 15-17, the specific standards for youngsters who are blind extend from ages 10-17 in Table 2.3. These are provided so that practitioners can use these data as guidelines in training programs designed to improve the one-mile run/walk performance of individuals who are blind. Although the provision of specific standards is warranted, the Brockport Physical Fitness Test encourages individuals who are blind to pursue the minimal standards for the general population. Also, it must be emphasized that standards for youngsters with visual impairments who are not blind (i.e., partially sighted) are identical to those used in the general population.

Attainability

Since the one-mile run/walk has not traditionally been used as an item in tests of physical fitness involving blind youngsters, data related to the performance of typical youngsters who are blind were not found. However, information related to the attainability of specific standards for males and females from the general population can be drawn from an analysis of data associated with the NCYFS (Ross, Dotson, Gilbert, and Katz, 1985). In reviewing these data, it may be noted that specific standards for males who are blind are associated with the 10th percentile performance of sighted males, ages 15 to 17. The specific standards for females who are blind approximate performance of sighted females at the 60th percentile at age 15, the 50th percentile at age 16, and the 50th percentile at age 17. The minimal general standards for males are associated with performance at the 20th percentile relative to the NCYFS. The minimal general standards for females correspond to approximately the 60th percentile of sighted youngsters on the NCYFS for ages 15-17. Although the analysis was conducted on a data set for nondisabled youngsters, it suggests that blind girls might find the CR standards more challenging than blind boys, but to the extent that blind youngsters have the potential to achieve the critical VO_{2max} values recommended for sighted youngsters, and providing the 10 percentile "bonus" is appropriate, the standards appear to be within reach for both genders.

Although satisfactory data related to the MRW performance of youngsters with visual impairments is unavailable, the aerobic power of students who are blind has been studied and provides insight on the ability to perform. For example, Lee, Ward, & Shephard (1985) found that the average VO_{2max} score after training, of males who are blind was 51.7 ml/kg/min. For females the average value was 38.0 ml/kg/min. (The 10 males and 9 females were between 11 and 18 years of age.) These values exceed the recommended specific and minimal general VO_{2max} values for males and females between the ages of 15-17, on the Brockport Physical Fitness Test. It is expected that youngsters with these aerobic abilities are capable of reaching these standards on the one-mile run/walk on the BPFT.

PACER

The 16m and 20m PACER tests are also included as items in the BPFT to estimate aerobic capacity (VO_{2max}). In reviewing the validity of the 20m PACER, Cureton (1994) asserted that the PACER has high content validity in that it closely simulates a graded speed incremented treadmill test used in the laboratory to directly measure VO_{2max}. Cureton (1994) indicated that the concurrent validity of the PACER is moderate and approximately the same as distance runs for estimating VO_{2max}. He reviewed literature regarding the concurrent validity of the PACER test in children and adolescents and reported validity coefficients ranging from .51 to .90 (Cureton, 1994). Although currently available information suggests acceptable levels of validity, Cureton (1994) felt that more studies investigating the relative value of the PACER and other distance runs for predicting VO_{2max} and for classifying VO_{2max} using criterion-referenced standards are needed.

The 20m PACER, which was selected as a test item in the BPFT to estimate aerobic capacity, appears to have high content validity and moderate concurrent validity. However, when administered to youngsters with MR, particularly ages 10-12, it was observed that (1) younger children had difficulty reaching the 20m distance even during the first two or three laps of the test; (2) the time spent running during the total test was low; and (3) too large a number of participants failed to complete one lap, possibly because of shorter stature and overall inefficiency of running. For these reasons, the investigators were prompted to shorten the distance of the run. In a study conducted in connection with Project Target in the spring of 1995, data collected using 21 subjects with MR demonstrated that the laps and distance run at a known intensity when changing from the 20m PACER to the 16m PACER moved from 6.8 laps (approx. one minute) or 135m, to 13 laps (approx. two minutes), or 207m. Sixteen of 21 subjects increased total distance run in the study as a result of shortening laps. Also, three more subjects ran at least one minute when the shorter distance was used.

In a second study using 34 subjects with mental retardation in the summer of 1995, data were collected on the 16m PACER, the 20m PACER, the 600-yard run/walk, and peak oxygen consumption (VO_2 peak) (Fernhall, et al, 1998). The average number of laps increased from 15.5 (approx. 136 seconds) to 23.1 (approx. 233 seconds) and the average distance covered increased from 310m to 370m when comparing performance on the 20m and 16m PACER. Again, time engaged in running and distance of run at a known intensity increased with an increase in laps performed. In a third study conducted in the spring of 1997, 31 subjects with mental retardation and mild limitations in physical fitness were tested on both the 20m and 16m PACER. Again, average number of laps completed increased from 10.3 (approx. 86 sec.) to 21.4 (approx. 180 sec.) and the average distance covered increased from 206m to 342m. In the 20m test, 7 of 31 subjects failed to run for at least one minute, whereas only 2 of 31 subjects were unable to run the test for at least one minute when laps were shortened to 16m.

Although shortening the distance of the 20m PACER for youngsters with MR has advantages in terms of time and distance of running, a disadvantage is that more research is needed to clearly support the 16m PACER run as a test of aerobic capacity. The study conducted in the summer of 1995 provides some information in this regard (See Table 2.5) (Fernhall, et al, 1998). In that study a correlation coefficient of $r=.77$ ($p<.01$) was found between VO_2peak and the 16m PACER. This was comparable to the $r=.74$ ($p<.01$) found between the 20m PACER and VO_2peak. Also a very strong relationship ($r=.94$, $p < .01$) was found between the 16m and 20m PACER and some support for the 16m PACER as a test of long distance running was given by the $r= -.62$ ($p <.01$) between the 600 yd. run/walk and the 16m PACER. While these statistics are encouraging, there is a clear need to continue study of the 16m PACER as a test of aerobic capacity.

Table 2.5
Relationships Among PACER and Distance Runs, and VO_2peak in Males and Females, Ages 10-18, (N=34) with Mental Retardation and Mild Limitations in Physical Fitness

	VO_2Peak	20m PACER	16m PACER	600 yd. run/walk
20m PACER	.74**	1.00**	.94**	-.62**
16m PACER	.77**	.94**	1.00**	-.64**
600 yd. run/walk	-.80**	-.62**	-.64**	1.00**

* $p<0.05$
** $p<0.01$

The 20m PACER is a recommended or optional (dependent upon age) test item for youngsters in the general population; a recommended item for youngsters with mental retardation and mild limitations in physical fitness, ages 13-17; a recommended test item for youngsters with visual impairments, ages 10-17; and for youngsters, ages 10-17, with arm only involvement classified as a congenital anomaly or amputation. The 16m PACER is only recommended for youngsters with MR, ages 10-12.

Standards

Minimal and preferred general standards for the 20m PACER are recommended for the general population, youngsters with visual impairments but who are not blind (i.e., partially sighted), and for youngsters with arm only involvement classified as a CA/A (See Table 2.2). These are the same standards used in the Prudential FITNESSGRAM. According to Cureton (1994), both the upper and lower boundaries of the healthy fitness zone for the 20m PACER in the Prudential FITNESSGRAM were determined from a regression equation provided by Leger et al. (1988):

- VO_{2max} = 31.025+3.238 (maximal PACER running speed) - 3.248 (age) +.1536 (maximal PACER running speed) (age)

This equation had a multiple R of .71 with VO_{2max} and a standard error of estimate of 5.9 ml/kg/min. The Leger et al. (1988) equation was rearranged to predict maximal PACER running speed from age and the critical VO_{2max} value. Predicted speed was then converted to laps for use as the CR standard (Cureton, 1994).

Although minimal and preferred general standards have been adopted for use in the BPFT for certain groups of youngsters on the 20m PACER, specific standards are also recommended for youngsters who are blind or who have mental retardation and mild limitations in physical fitness. The specific standards developed for youngsters who are blind was based upon the "bonus" of ten percentile points recommended by Buell (1983) mentioned earlier. Again, the adjustment is believed to be warranted in selecting a minimal specific standard because of inefficiency in running.

Several computational steps were used in adjusting the minimal general standards to specific standards for youngsters who are blind and detailed information in regard to these may be obtained from the authors. The first step, however, was to determine an adjustment percentage for each age and gender. This was based on a percentage comparison between minimal general and specific standards for youngsters who are blind on the one-mile run/walk. Once percentage difference was determined for each age and gender, an average adjustment factor was obtained. For males, specific standards ranged from 89% to 92% of minimal general standards, ages 10-17. For females the differences in standards ranged from 92% to 93 %, ages 10-12 and 95% to 96%, ages 13-17. Thus, the specific standards were based on a 10% adjustment for males, ages 10-17 and for females, ages 10-12. A 5% adjustment was used for females, ages 13-17. The 5 to 10% adjustment based on running performance in the one-mile run/walk was applied to lap performance in the 20m PACER (See Table 2.3).

The specific CR standards for youngsters with mental retardation and mild limitations in physical fitness on the 20m PACER were based on the 10% downward adjustment in VO_{2max} discussed earlier in the chapter (See Table 2.4). Using the Leger et al (1988) equation, Cureton calculated laps to serve as the specific CR standards from these adjusted $V0_{2max}$ values (K.J. Cureton, personal communication, October 15, 1996). Readers should note that the specific standards for 10-and 11-year old girls were arbitrarily set at one lap when the equation predicted zero laps using the adjusted $V0_{2max}$ values. Consequently, the one-lap standard for these two age groups actually represents a slightly higher critical $V0_{2max}$ value than is shown in Table 2.4.

Although the 16m PACER is only recommended for youngsters with MR aged 10-12, both minimal general and specific standards are provided throughout the 10-17 age range. Minimal general standards are provided in order to place the specific standards in some context; youngsters with MR should be encouraged to strive to achieve the same standards recommended for nondisabled youngsters when appropriate. Standards provided for 13-17 year-old youngsters may be used at the discretion of the tester in cases where the 20m PACER may be inappropriate.

The specific standards for the 16m PACER are based upon estimates from 20m lap scores attained in the study conducted in the summer of 1995 as part of Project Target (Fernhall, et al, 1998). In that study, 34 youngsters with MR, (22 males and 12 females) between the ages of 10-18 were tested on both the 16m and 20m PACER tests with a 2-5 day separation between tests. Results indicated that 20m lap values were approximately 63% of 16m lap scores. A regression analysis was used to develop a formula to predict 16m lap values from the 20m standards. Since the specific 20m PACER CR standards were arbitrarily established for 10-and 11-year old girls, the predicted 16m PACER CR standards, by necessity, have a similar limitation.

Attainability

Because of the lack of success by researchers in developing a valid and reliable test of aerobic capacity for youngsters with MR in the past, considerable attention was given to this task as a part of Project Target. Between 1994 and 1995, 114 youngsters, ages 10-17, were tested on the 20m PACER in different locations throughout the country. Using the minimal general standard associated with the Prudential FITNESSGRAM (CIAR, 1992), it was found that only nine of 114 (8%) males and females met the standard. Because of this finding and difficulties with the 20m PACER identified earlier in this manuscript, it was decided by the Project Target staff to experiment with reducing the length of the test to 16m and use the 16m PACER specific standards presented in Table 2.4 as the criterion for passing. Between 1996 and 1997, 84 youngsters (ages 10-17) were tested and 29 (34%) passed the test using these standards. As a matter of interest, the 20m specific standards were applied to two samples including 57 subjects. Using the 20m PACER specific standards, a passing rate of 30% was found (17 of 57 subjects met or surpassed the standard). In order to compare passing rates resulting from the 16m and 20m specific standards, the standards were applied to one sample (n=30) in which both the 16m and 20m runs were administered to the same subjects. Using the 16m specific standards, a passing rate of 37% (11 of 30) was found and using the 20m specific standards, a passing rate of 33 % (10 of 30) was found. Although the results suggest similar passing rates, more research with greater subject numbers is needed to draw more definite conclusions in this regard.

The 20m PACER is also a recommended test item for youngsters with visual impairments. In addition, adjusted specific standards may be used in the BPFT for youngsters who are blind. Two studies were conducted in regard to this population as a part of Project Target. The first study included 39 youngsters who were blind, ages 10-14, attending camps in Michigan. When the general standards were applied as a criterion for passing the 20m PACER, 11 of 39 (28%) passed the test item. When the specific standards were applied, 13 of 39 (33%) of the sample passed the test item. Results suggested that "fit" subjects will pass either criterion and "unfit" youngsters will fail either criterion.

The second study was conducted in New York City and included 50 youngsters with visual impairments, ages 10-17. A total of 28 of these youngsters were blind. When the 20m PACER was administered to the total sample, 5 of 31 (16%) males and 10 of 19 (53%) females passed the test using the minimal general standards for the 20m PACER. When the same general standards were applied to just the blind youngsters, 7 of 28 (25%) passed the test item. When the specific standard for youngsters who are blind were applied to the sample of blind youngsters, the same 25% passing rate was found. In regard to this sample, females with visual impairments as a group and females who were blind as a group exceeded a 50% passing rate. Conversely, the passing rate for males ranged from 11% for males who were blind to 26% for males who were designated as youngsters with visual impairments (i.e., included youngsters who were partially sighted). The identical passing rate (25%) was found whether a minimal general or specific standard was applied in the case of youngsters who are blind. However, when the total sample of visually impaired subjects was considered, the passing rate moved from 30% to 38% when the minimal general standard was supplanted by the specific standard.

Target Aerobic Movement Test

The TAMT is a test that is designed to directly measure a youngster's ability to engage in physical activity at an intensity and duration consistent with recommendations for good aerobic behavior. Youngsters who pass the test have demonstrated the ability to sustain at least moderate physical activity. Specifically the test requires participants to exercise for 15 minutes within a target heart rate zone with a lower limit set at approximately 70% of one's predicted maximum heart rate. (Testers also have the option of raising the threshold of the target heart rate zone to 75% or 80% of predicted maximum heart rate if more intense levels of activity are desired. These more intense criteria constitute levels II and III of the TAMT.) Adjustments to the target heart rate zone are made for youngsters with quadriplegia and for those youngsters who engage in arms-only forms of physical activity (including those with paraplegia). These adjustments are necessary to account for the effects of quadriplegia and arms-only activity on maximal heart rate (Shephard, 1990).

Although recommendations in the literature for the duration of aerobic activity may go as high as 60 minutes (ACSM, 1995), the TAMT requires 15 minutes in order to make the test practical for use in field situations and school settings. While the TAMT does not measure the frequency of aerobic behavior (unless testers choose to administer on a regular basis), the 15-minute duration is supported in part by research "showing that cardiorespiratory fitness gains are similar when physical activity occurs in several short sessions (e.g., 10 minutes) as when the same total amount and intensity of activity occurs in longer sessions (e.g., 30 minutes)" (U.S. Department of Health and Human Services, 1996, p.5). The TAMT is a recommended test item for youngsters with MR, CP, SCI, and some forms of CA/A.

Standards

General criterion-referenced standards in connection with the TAMT are recommended for all populations (no specific standards are provided). The standard for the TAMT is for a youngster to exercise for 15 minutes within a selected target heart rate zone (THRZ). With exceptions associated with selected physical disabilities, the THRZ is 70 (moderate level of physical activity) to 85% of maximum predicted heart rate. Participants can engage in virtually any physical activity as long as the activity is of sufficient intensity to reach a minimum target heart rate (THR) and to sustain heart rate in the target heart rate zone appropriate for the individual.

Attainability

The TAMT was administered to 75 males and females with disabilities in connection with Project Target. The first sample included 28 males and females with spina bifida myelomeningocele, ages 10-18, who attended a residential summer camp in 1995. In this study, all the subjects propelled wheelchairs while performing the TAMT. They performed the TAMT in groups of six or less a minimum of two times with a one-day rest between tests. A total of 27 out of 28 eligible subjects (96%) passed test 1 and 25 out of 27 eligible subjects (93%) passed test 2 (i.e., met the criterion for successful completion of the TAMT) (Rimmer, Connor-Kuntz, Winnick, and Short, 1997).

The TAMT was administered in a second study including 25 subjects in connection with the New York State Games for the Physically Challenged in Brockport, New York in 1995 (Winnick and Short, 1995). The subject sample included 11 females ranging in age from 10 to 18 with an average age of 13.4 years and 14 male subjects in the 10 to 17 age range with a mean age of 12.7 years. Five of the subjects had a spinal cord injury (SCI); 11 had cerebral palsy (CP); eight were classified as Les Autres (LA); and one had a congenital anomaly or amputation (CA/A). A total of 20 of the 25 subjects attempted the TAMT. Of the 20 subjects who took the test, 15 passed. The 15 successful subjects included two with SCI, seven with CP (classes C4 through C8), and six with LA conditions. Nine of the 15 subjects used arm ergometry as their activity of choice while the other six ran. Of the five subjects who could not meet the test criteria, four were unable to achieve the target heart rate zone. Two of the four unsuccessful subjects were youngsters with class 1 CP, a third was classified as C7, and a fourth was classified as T4 SCI. The fifth unsuccessful subject complained of dizziness a minute or two into the test and the test was terminated at that time for that individual.

In a third study conducted at the school of the Holy Childhood in Rochester, New York, during the Spring 1996, 27 subjects with mental retardation and mild limitations in physical fitness were administered the TAMT (Winnick and Short, 1996). The sample included 14 females and 13 male subjects between the ages of 10 and 17. The activities performed during the test included a fast walk, playing tag, and running. A total of 24 of the 27 subjects (89%) passed the test item.

In summary, 75 subjects were administered the TAMT in the three studies. A total of 66 of 75 (88%) passed thereby demonstrating the ability to sustain moderate physical activity and providing evidence that the standards are attainable by youngsters with disabilities.

Reliability

One-Mile Run/Walk

Based on a review of literature, Safrit and Wood (1995) concluded that performance on long distance runs is usually highly reliable. A review of literature on reliability indicates that for children and adolescents nine years of age (3rd grade) and older, the reliability is higher than for younger children (See Table 2.6). Research reported by Colgan (1978), Vodola (1978), Doolittle and Bigbee (1968), Doolittle, Dominic, and Doolittle (1969), Buono, Roby, Micale, Sallis, & Shepard (1991), and Rikli, Petray, & Baumgartner (1992) indicate that the reliability of long distance runs is high (.80 to.98). Rikli, et al (1992) computed P values (proportion of agreement) on the one-mile run/walk using 1987 FITNESSGRAM CR standards and reported values of .70 or greater for males and females, ages seven to nine. These criterion-referenced reliability values support the investigators' conclusion that distance runs can be used as a reliable instrument for youngsters at these age levels. Reliability may be enhanced by having children prepared to pace themselves appropriately during the run and for test administrators to pay particular attention to motivating youngsters to perform to their upmost ability.

PACER

The PACER appears to be a highly reliable test item (See Table 2.6). A test-retest correlation of r = .89 was reported by Leger, Mercier, Gadoury, and Lambert (1988) using 188 nondisabled subjects between the ages of 8-19 on the 20m shuttle run. In a study conducted in the summer of 1995 as a part of Project Target, 20 males and females with MR were tested and retested on the 16m PACER (Winnick and Short, 1996). A test-retest alpha (a) coefficient of .98 was attained on the sample of youngsters, ages 10-17. In 1996, another study was conducted as a part of Project Target in which test-retest data were collected on 34 males and females with MR on both the 16m and 20m PACER (Winnick and Short, 1996). A test-retest a = .96 was reported for the 16m PACER and a = .97 was reported using the 20m PACER. Subject ages ranged from 10 to 18. Finally, in the spring of 1997, another study including 35 males and females with MR, ages 10-17 was conducted (Winnick and Short, 1997). In that study, youngsters were tested and retested on the 16m PACER. An a = .98 was found between the two tests administered one-week apart. A proportion of agreement (P) was also computed in the study as an estimation of criterion-referenced reliability. Youngsters were studied to determine consistency in reaching criterion-referenced specific standards for their age and gender on the Brockport Physical Fitness Test. A P = .93 indicating high reliability was obtained.

Table 2.6
Reliability Data Associated with Test Items Designed to Measure Aerobic Function

Study	Population	N	Gender	Age/Grade	Test Item	Reliability
Leger, Mercier, Gadoury, & Lambert (1988)	Nondisabled	189	M/F	Ages 8-19	20m Shuttle Run	test-retest r =.89
Winnick & Short (1995)	MR	20	M/F	Ages 10-17	16m PACER	test-retest a =.98
Winnick & Short (1996)	MR	34	M/F	Ages 10-18 10-18	16m PACER 20m PACER	test-retest a =.96 a =.97
Winnick & Short (1997)	MR	35	M/F	Ages 10-17	16m PACER	test-retest a =.98
Rimmer, Connor-Kuntz, Winnick, & Short (1997)	SCI	28	M/F	Ages 10-17	TAMT	No significant difference in proportion of subjects passing test-retest
Colgan (1978)	Nondisabled	326	M/F	Ages 10-18	Mile Run/Walk	test-retest r =.96 m r =.87f
Vodola (1978)	Nondisabled	90	M/F	Ages 14-17	Long Distance Run	test-retest r =.80
Doolittle & Bigbee (1996)	Nondisabled	153	M	9th Graders	Long Distance Run	test-retest r =.94
Doolittle, Dominic, & Doolittle (1969)	Nondisabled	100	F	9th & 10th Graders	Long Distance Run	test-retest r =.89
		45	F	9th Graders	Long Distance Run	test-retest r =.89
		15m & 15f	M/F	5th Graders	Mile Run/Walk	test-retest r =.91
Buono, Roby, Micale, Sallis, & Shepard (1991)	Nondisabled	15m & 15f	M/F	8th Graders	Mile Run/Walk	test-retest r =.93
		15m & 15f	M/F	11th Graders	Mile Run/Walk	test-retest r =.98
Rikli, Petray, & Baumgartner (1992)	Nondisabled	44m & 37f	M/F	4th Graders	One-Mile Run	R =.87m R =.85f

MR = mental retardation
SCI = spinal cord injury
TAMT = target aerobic movement test

r = interclass coefficient
R = intraclass coefficient
a = alpha coefficient

TAMT

The Target Aerobic Movement Test is a relatively new item designed in association with Project Target and is recommended for use with the Brockport Physical Fitness Test. As a part of Project Target, one study was conducted to determine the reliability of the TAMT for a group of youngsters with spina bifida (Rimmer, Connor-Kuntz, Winnick, and Short, 1997). A sample including 32 children (11 subjects with thoracic lesions, 21 subjects with lumbar lesions) volunteered for the study. The same subjects performed the TAMT on two different days. All subjects participated by propelling a wheelchair. Out of 24 subjects who performed two trials of the test, 22 passed both trials (proportion of agreement = .92). All 24 subjects passed one of the two tests. A t-test indicated that there was no significant difference in the proportion of subjects who passed test 1 or test 2 ($p < 0.05$).

Discussion

In developing a health-related criterion-referenced test of physical fitness for youngsters with disabilities, it was particularly important to address three major needs in regard to the measurement and assessment of aerobic functioning. First, it was considered important to develop a test and standards for the measurement of aerobic functioning for youngsters with mental retardation and mild limitations in physical fitness that reflects at least the ability to sustain moderate physical activity and could be efficiently used in schools and/or other field settings. Secondly, there was a need for some measure and standards of health-related aerobic functioning for those youngsters restricted in the ability to ambulate. This primarily included individuals with physical disabilities. Third, there was a need to adopt a test and standards of health-related aerobic functioning for youngsters who are blind. The authors feel that much progress was made in addressing these needs in the BPFT and preceding paragraphs reflect the ways in which these needs were met.

In regard to the measurement of aerobic capacity for youngsters with MR, the 16m and 20m PACER tests were finally selected as the suggested test items and specific standards were developed for each. Results of research associated with Project Target clearly demonstrated that those test items can be learned and, indeed, are reliable when used with this population. The specific lap values for both the 16m and 20m PACER are based upon a 10% $V0_{2max}$ downward adjustment. The adjustment in lap values for the 20m PACER was applied to data in which 20m PACER performance was matched with $V0_{2max}$. Corresponding lap values for the 16m PACER were estimated from a regression equation predicting them from 20m values. Additional research is needed regarding concurrent validity in which the relationship of 16m PACER performance and $V0_{2max}$ is established and used as the basis for specific standards. Data collected as a part of Project Target also suggest a disproportionately higher passing rate for females than males on the PACER. It is recommended that gender be addressed to a greater extent in future research relating to $V0_{2max}$ and the 16m and 20m PACER standards.

The 20m PACER for ages 10-17 and the one-mile run/walk for ages 15-17 are recommended test items for the measurement of aerobic capacity on the BPFT for youngsters with visual impairments. The same standards recommended for the general population are recommended for youngsters who are partially sighted. Also, general $V0_{2max}$ values are recommended for use with all youngsters with visual impairment, however, for blind youngsters who require assistance, CR standards associated with the one-mile run/walk and PACER are based upon a bonus of 10 percentile points. With few exceptions, these test items have not traditionally been a part of physical fitness tests used with this population. Field-testing as a part of Project Target clearly demonstrates acceptability of the PACER as a test item. Less data were collected relative to the one-mile run/walk, but the data that were collected supported use of the test item. The decision to use the one-mile run/walk was strongly advocated by the Project Target panel of experts. The rationale essentially reflected the position that youngsters with visual impairments can and should reach the same critical $V0_{2max}$ values as their sighted counterparts, but the CR standards associated with the test items need to be adjusted for youngsters who are blind to account for the higher energy demands of running with assistance.

It appears that the BPFT has effectively addressed the measurement and evaluation of aerobic functioning of individuals with ambulation problems. After spending considerable time and energy in trying to develop an acceptable field-based test to measure aerobic capacity and not being successful, it was decided to emphasize the measurement of aerobic behavior instead. This functional orientation emphasizes the ability to sustain physical activity of a specific intensity for a particular duration. The term aerobic behavior was selected to reflect levels of intensity and duration of activity, that when performed regularly, result in improved aerobic functioning. Following considerable research, the TAMT was adopted as the measure of aerobic behavior. Logic is the basis for its validity (content validity). Research conducted as a part of Project Target has clearly substantiated attainability and has provided data supporting the reliability of the test item. One beauty of the TAMT is the acceptability of using a variety of exercise modes in elevating heart rate. This is critical in instances in which movement abilities are diverse. In regard to future research, it is recommended that the TAMT be further examined for use with youngsters severely impaired; to study the worthiness of higher levels of the test; and the possible use of the test in measuring aerobic capacity. Overall, the authors feel that the TAMT is valid, reliable, and otherwise an appropriate test of aerobic behavior for use in field situations with individuals with a variety of movement impairments.

As the discussion section and other parts of this manuscript are read, it will become readily apparent that continued research on several related topics would be beneficial. The following list summarizes suggested areas of research and in some instances recommendations regarding priority needs.

- A high priority need is to provide additional concurrent validity data regarding the use of the 16m PACER as a test of maximum oxygen uptake for all youngsters but particularly for youngsters with mental retardation, ages 10-12.
- There is a need to further study reliability of the 16m PACER test item.
- The feasibility, reliability, and validity of the TAMT (including the higher THRZ versions) should be investigated using subjects from the general population as well as subjects with disabilities.
- The validity of higher levels of the TAMT as a predictor of aerobic capacity should be investigated.
- The efficiency of youngsters who are blind running with partners in the one-mile run/walk needs investigation.
- Investigate the running efficiency of youngsters with mental retardation on the 16m and 20m PACER.

- The validity and reliability of the TAMT using various modes of activity with diverse populations should be investigated.
- Determine heart rate zones to represent moderate physical activity intensity for youngsters with quadriplegia on the TAMT.
- There is a need to continue investigating test reliability of items on the BPFT with a variety of youngsters with disabilities.
- Examine the role of gender in developing CR standards related to aerobic capacity.

In closing, the authors of the BPFT feel that the test has made significant advances in the measurement of health-related assessment of aerobic functioning of youngsters with disabilities. Particularly noteworthy is its willingness to conceptualize and measure aerobic behavior. This orientation from the focus of measurement of aerobic capacity to the measurement of aerobic behavior appears appropriate for the populations for which it is recommended in field situations.

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Chapter III
Body Composition

Body composition is that component of health-related physical fitness that provides either an estimate of one's body weight that is due to fat or an indication of the appropriateness of one's body weight for a given height. Tests of body composition in the Brockport Physical Fitness Test (Winnick and Short, in press) include skinfolds (triceps, subscapular, and calf) and body mass index. Testers have some latitude in the selection of body composition test items, but the sum of two skinfolds generally is the recommended test item and body mass index (where appropriate) is usually the optional test item. Test item selection for recommended (R) and optional (O) items is summarized in Table 3.1. For a description of test items or more specific information on test item selection, readers are referred to the test manual (Winnick and Short, in press).

Information pertaining to the validity and reliability of the BPFT body composition test items is discussed below under separate headings. The validity section attempts to establish relationships between skinfold measures or body mass index and health, provide the bases for the criterion-referenced standards, and present available attainability data for the groups associated with a disability covered by the BPFT. Following the reliability section is a brief discussion including recommendations for future research.

Validity

Since about 1980, measures of body composition have been included in test batteries which purport to assess health-related aspects of physical fitness. For example, skinfolds and/or body mass index have been included in the following tests: Health Related Physical Fitness Test (American Alliance for Health, Physical Education, Recreation, and Dance, 1980), Project UNIQUE (Winnick and Short, 1985), Physical Best (McSwegin, Pemberton, Petray, and Going, 1989), and the Prudential FITNESSGRAM (Cooper Institute for Aerobics Research, 1992). The inclusion of measures of body composition in fitness tests for children and adolescents typically is justified on the grounds that the prevention of obesity can reduce the risk of heart disease, as well as by the observation that today's youngsters are fatter than those of previous generations (CIAR, 1992). Measures of body composition, therefore, are linked to body fat values in the establishment of criterion-referenced standards.

Table 3.1
Body Composition Test Item Selection Guide
By Target Population

	GP	MR	VI	CP	SCI	CA/A
Skinfolds						
Triceps and Calf	R	R	R			R/O*
Triceps and Subscapular		O		R	R	R/O*
Triceps (only)				O	O	R/O*
Body Mass Index	O	O	O	O		

GP = general population
MR = mental retardation
VI = visually impaired
CP = cerebral palsy
SCI = spinal cord injury
CA/A = congenital anomaly/amputation
R = recommended test item
O = optional test item

*The combination of triceps skinfold with either the calf or subscapular skinfold is a function of the site or sites of the impairment; consult test manual for more specific information.

It is well-established that obesity represents a significant health problem for both children and adults alike (CIAR, 1992). Obesity is typically defined in terms of the presence of a large amount of body fat expressed as a percentage of total body mass. High percent body fat values have been tied to higher mortality and morbidity rates in adults and with risk factors associated with heart disease in children. Lohman (1994) has summarized some of the literature that describes the relationship of body composition to health. This information will not be reiterated here, but as Rimmer (1994) has written, "there is little argument that obesity is linked to a number of diseases that increase the likelihood of early death" (p. 114).

The BPFT has adopted the percent body fat healthy fitness zone values recommended in the Prudential FITNESSGRAM (CIAR, 1992) to represent the criterion standards for appropriate body composition. The FITNESSGRAM utilizes a 10-25% body fat range for boys and a 17-32% body fat range for girls. Individuals who are able to stay below the higher value (i.e., 25% for boys and 32% for girls) in the range as adults "will not be at greater risk for cardiovascular disease and diabetes" (Lohman, 1994, p. 64). Youngsters should also strive to stay above the lower value in the range. Individuals who are excessively lean may also experience health-related problems, especially if the leanness can be traced to poor nutrition (CIAR, 1992).

In the Prudential FITNESSGRAM the percent body fat ranges discussed above comprise what is called a "healthy fitness zone." Although youngsters, at the very least, should attempt to stay within the healthy fitness zone, Lohman (1994) recommended a more optimal range. The optimal range is 10-20% for boys and 17-25% for girls. The rationale for the optimal range is that children will tend to get fatter with increasing age. It was reasoned, therefore, that if a youngster can stay within the optimal range as a child, he or she will more likely be able to stay within the healthy fitness zone as an adolescent or adult even if some body fat is added (Lohman, 1994). The lower percent body fat boundaries are the same for the healthy fitness zone and the optimal range. In the Prudential FITNESSGRAM, CR standards are provided for the healthy fitness zone percentages only.

In the BPFT the criterion-referenced standards for the skinfold measures and body mass index scores are related to both sets of percent body fat ranges. For boys, the 10-25% range constitutes a basis for "minimal" standards, while the 10-20% range is considered to be the basis for "preferred" standards. For girls, the basis for the minimal standards is represented by the 17-32% range of body fat, while the 17-25% range is the basis for the preferred standards. These values were developed from the work of Williams, et al (1992) where it was found that cardiovascular risk factors increased for boys above 25% fat and for girls above 32% fat using data from the Bogalusa Heart Study (Lohman, 1992).

Skinfolds

Three skinfold options exist in the BPFT: sum of the triceps and calf (TC) skinfolds, sum of the triceps and subscapular (TS) skinfolds, and triceps (only) (TO) skinfold. The TC skinfold is the recommended test item in the Prudential FITNESSGRAM. It was selected because it has acceptable levels of validity and reliability (Lohman, 1994) and presumably because the calf site is often more easily accessible to a tester than the subscapular site. Evidence of concurrent validity for the TC skinfolds is provided, in part, by a correlation of .88 between the sum of the triceps and calf skinfolds and a multicomponent model (bone density, water content of the body, and mineral content of the body) used to determine percent body fat (Lohman, 1994).

In the BPFT the TC skinfolds is recommended for youngsters with MR, VI, and, depending upon the nature of the impairment, CA/A. For youngsters with CP, SCI, and some forms of CA/A, however, the recommended item is the TS skinfolds. Concurrent validity can also be claimed for the TS skinfolds in part because of a correlation of .89 with the multicomponent model of determining percent body fat (Lohman, 1994). Although the subscapular site generally is more difficult to access than the calf site, it is preferred for individuals with lower limb disabilities because the subscapular measure more likely will be taken over active muscle. Some experts feel that measures taken over paralyzed (or possibly impaired) musculature will yield considerably higher skinfold readings (Rimmer, 1994), thus overestimating percent body fat.

Although the subscapular skinfold is a more desirable site than the calf for people with lower limb disabilities, it may not be easily accessible. Wheelchair-backs or body braces may prevent reasonable access to the subscapular site. In cases such as these, testers have the option of measuring only the triceps fold. The TO skinfold also was used as an optional test of body composition in the Physical Best physical fitness test. The relationship between a single skinfold and percent body fat, however, generally is less than when multiple skinfold sites are used (McSwegin, et al, 1989). Consequently, testers should use the TO skinfold to assess body composition only when no other options are available.

<u>**Standards**</u>

Both minimal and preferred standards for the three sets of skinfold tests are given in Table 3.2. The TC skinfold standards were derived from equations provided by Lohman (1994):

- %fat (males, aged 6-18) =.735 (TC skinfold) + 1.0
- %fat (females, aged 6-18) =.610 (TC skinfold) + 5.0

Depending upon level of maturation for subjects 8-18 years of age, coefficients of determination (R^2 values) ranged from .77 -.80 and standard errors of estimate varied from 3.4 - 3.9% body fat when the TC skinfold equations were used to predict body fat from a multicomponent model (Slaughter, et al, 1988).

TS skinfold standards also come primarily from the work of Slaughter, et al (1988). The equations from which the CR standards were derived are as follows:

- % fat (females, aged 6-18) = 1.33 (TS skinfold) - .013 $(\text{TS skinfold})^2$ + 2.5
  (when TS skinfold is 35 mm or less)
- % fat (females, aged 6-18) =.546 (TS skinfold) + 9.7
  (when TS skinfold is greater than 35 mm)
- % fat (males) = 1.21 (TS skinfold) - .008 $(\text{TS skinfold})^2$ - I
  where I = 2.6 (10-year olds)
  I = 3.1 (11-year olds)
  I = 3.6 (12-year olds)
  I = 4.3 (13-year olds)
  I = 4.9 (14-year olds)
  I = 5.5 (15-year olds)
  I = 6.1 (16-year olds)
  I = 6.1 (17-year olds)

The intercepts for the males were extrapolated to age from stages of maturity based on values provided in Lohman (1992) (T.G. Lohman, personal communication, January 12, 1998). Coefficients of determination ranged from .76 - .82 and standard errors of estimate varied from

Table 3.2
Minimal General Standards for Measures of Body Composition

Age	Percent Fat M U	Percent Fat M L	Triceps plus Subscap. Skinfold (mm.) M U	Triceps plus Subscap. Skinfold (mm.) M L	Triceps plus Calf Skinfold (mm.) M U	Triceps plus Calf Skinfold (mm.) M L	Triceps Skinfold (mm.) M U	Triceps Skinfold (mm.) M L	Body Mass Index M U	Body Mass Index M L
Males										
10	10	25	11	28	12	33	7	19	15.3	21.0
11	10	25	12	29	12	33	7	19	15.8	21.0
12	10	25	13	30	12	33	7	19	16.0	22.0
13	10	25	13	30	12	33	7	18	16.6	23.0
14	10	25	14	31	12	33	7	18	17.5	24.5
15	10	25	14	32	12	33	7	17	18.1	25.0
16	10	25	15	33	12	33	7	17	18.5	26.5
17	10	25	15	33	12	33	7	16	18.8	27.0
Females										
10	17	32	18	41	20	44	10	24	16.6	23.5
11	17	32	18	41	20	44	10	24	16.9	24.0
12	17	32	18	41	20	44	10	24	16.9	24.5
13	17	32	18	41	20	44	10	23	17.5	24.5
14	17	32	18	41	20	44	10	23	17.5	25.0
15	17	32	18	41	20	44	10	23	17.5	25.0
16	17	32	18	41	20	44	10	22	17.5	25.0
17	17	32	18	41	20	44	10	22	17.5	26.0

L = lower boundary
U = upper boundary

Table 3.2 (cont'd)
Preferred General Standards for Measures of Body Composition

Males										
Age	Percent Fat P		Triceps plus Subscap. Skinfold (mm.) P		Triceps plus Calf Skinfold (mm.) P		Triceps Skinfold (mm.) P		Body Mass Index P	
	U	L	U	L	U	L	U	L	U	L
10	10	20	11	22	12	26	7	16	15.3	20.0
11	10	20	12	23	12	26	7	16	15.8	20.0
12	10	20	13	24	12	26	7	16	16.0	20.5
13	10	20	13	24	12	26	7	15	16.6	22.0
14	10	20	14	25	12	26	7	15	17.5	23.0
15	10	20	14	25	12	26	7	14	18.1	24.0
16	10	20	15	26	12	26	7	14	18.5	25.0
17	10	20	15	26	12	26	7	14	18.8	25.5
Females										
10	17	25	18	30	20	33	10	19	16.6	21.5
11	17	25	18	30	20	33	10	19	16.9	22.0
12	17	25	18	30	20	33	10	19	16.9	23.0
13	17	25	18	30	20	33	10	19	17.5	23.0
14	17	25	18	30	20	33	10	19	17.5	23.0
15	17	25	18	30	20	33	10	19	17.5	23.0
16	17	25	18	30	20	33	10	18	17.5	23.5
17	17	25	18	30	20	33	10	18	17.5	23.5

L = lower boundary
U = upper boundary

3.2 - 3.8% body fat as a function of maturity level among 8-18 year-old subjects when the TS skinfold equations were used to predict percent body fat from a multicomponent model (Slaughter, et al, 1998).

TO standards were calculated by Lohman (T.G. Lohman, personal communication, March 7, 1997 and May 16, 1997) and provided directly to Project Target staff for use in the BPFT. He determined percentile ranks for both BMI and triceps (only) skinfold measures using data from the National Children and Youth Fitness Study. The TO standards have percentile ranks that correspond to the same percentile ranks for each of the previously established BMI standards.

The TO standards fluctuate somewhat with age. TO standards associated with the larger percent body fat values that define the ranges for both minimal and preferred standards (i.e. 20% and 25% for boys; 25% and 32% for girls) decline slightly with age. This decline reflects the changes in fat distribution that occur during adolescence; that is, a greater proportion of body fat accumulates in the trunk relative to the extremities with increasing age in adolescence. The standards associated with the smallest percent body fat values that define the ranges for both minimal and preferred standards (i.e. 10% for boys; 17% for girls), however, remain constant throughout the 10-17 age range. These TO standards do not decline with age because the proportion of trunkal fat does not increase with age among leaner adolescents (T.G. Lohman, personal communication, October 22, 1997).

Of particular significance is the fact that no specific standards for any recommended or optional measure of body composition are provided in the BPFT; that is, regardless of disability youngsters are expected to achieve the same skinfold (or body mass index) standards that are recommended for youngsters without disabilities. Although previous research has reported significantly larger skinfold values for subjects with mental retardation (Rarick, Dobbins and Broadhead, 1976; Rarick and McQuillan, 1977), and visual impairment, spinal neuromuscular conditions, and congenital anomalies and amputations (Winnick and Short, 1982) when compared to subjects without disabilities, no literature was found to suggest that these larger values should be considered acceptable. While a sedentary lifestyle, a frequent correlate of disability, helps to explain larger skinfolds in youngsters with disabilities, it does not justify it. To the contrary, excessive body fat, in its own right, represents a significant health-related concern for persons with disabilities and may exacerbate other disability-related conditions as well. Although it may be more difficult for certain youngsters with disabilities to achieve the general skinfold standards than their nondisabled peers, it may be more important that they do so.

Using regression equations developed on nondisabled subjects for predicting percent body fat in people with physical disabilities has been questioned (Shephard, 1990). Rimmer (1994), however, has reported that equations developed from upper body skinfolds have been used in investigations using subjects with SCI. He acknowledges that while these equations may be less accurate for those with SCI, "using them as a general index of fatness is acceptable" (Rimmer, 1994, p.224). In the absence of widely accepted alternative equations for persons with disabilities, the equations developed by Lohman and colleagues for people without disabilities have been adopted for use in the BPFT. It is possible, therefore, that some additional error may be operative in predicting percent body fat in youngsters with physical disabilities. As a result, testers may prefer to interpret skinfold results directly in terms of the size of the fold rather than in terms of percent body fat, but either way, the skinfold standards are not adjusted for disability.

Attainability

To determine if the minimal BPFT skinfold standards were within reach of youngsters with disabilities, they were applied to TS data previously collected during Project UNIQUE (Winnick and Short, 1982). Passing rates for youngsters with cerebral palsy, spinal neuromuscular conditions (consisting primarily of subjects with SCI), blindness, and congenital anomalies or amputations are summarized in Table 3.3.

Passing rates (denoted by values "within zone") vary from 52% for boys with spinal neuromuscular conditions to 80% for girls with CA/A. It would appear from these data that the standards will present the greatest challenge to youngsters with SCI; approximately 1/3 of all youngsters with spinal neuromuscular conditions tested during Project UNIQUE were above the minimal range. This finding is not surprising since people with less active muscle mass will have a lower potential for caloric expenditure. In essence, the mode of exercise is reduced to arms-only activities rather than "whole-body" activities which generally are recommended for weight loss. Many youngsters with SCI pursuing the TS standards will need to counter the "reduction" in exercise mode by increasing exercise frequency and/or duration.

It is interesting to note that more girls with CP were below the range than above it. Being below the range, however, probably is a less serious concern for those with CP since certain characteristics of the disability (e.g., hypertonicity, spasticity, inefficiency of movement) probably contribute more to a youngster's leanness than poor diet or nutrition, or other correlates of leanness which are associated with negative health.

Table 3.3
Pass Rates for Youngsters with Disabilities on Sum of Triceps and Subscapular Skinfolds

		Total N	Below Zone N	Below Zone %	Within Zone* N	Within Zone* %	Above Zone N	Above Zone %
Cerebral Palsy								
	Boys	207	37	18	134	65	36	17
	Girls	173	49	28	111	64	13	8
Spinal Neuromuscular								
	Boys	67	4	6	35	52	28	42
	Girls	72	13	18	42	58	17	24
Blind								
	Boys	82	13	16	58	71	11	13
	Girls	76	14	18	47	62	15	20
Congenital Anomaly/Amputation								
	Boys	35	5	14	19	54	11	31
	Girls	25	3	12	20	80	2	8
Combined								
	Boys	391	59	15	246	63	86	22
	Girls	346	79	23	220	64	47	14
	Total	737	138	19	466	63	133	18

*defined by the upper and lower boundaries provided in Table 3.2.

Looney and Plowman (1990) determined passing rates for nondisabled youngsters on the original (1987) FITNESSGRAM skinfold measures. In the original version, percent body fat standards were provided only for the upper values in the range (i.e, 25% for boys and 32% for girls). Using TS data from the National Children and Youth Fitness Study (I and II) they found passing rates of 89% for the males and 91% for the females. So, the percentage of youngsters who were above the range in their analysis varied from 9-11 %. These values certainly are lower than the "above zone" values appearing in Table 3.3. Nevertheless, the majority (63%) of youngsters with disabilities from Project UNIQUE were able to meet the minimal standards and it is reasonable to assume that, with increased attention to body composition, an additional number of their peers could do so as well.

Without access to a skinfold database for youngsters with MR, a determination of pass/fail rates was not possible for this paper. Some evidence of attainability, however, was provided by the norm-referenced data reported by Eichstaedt, Wang, Polacek, and Dohrmann (1991). These data suggest that the triceps-only skinfolds of moderately retarded boys will exceed the minimal standards (i.e., will be "above zone") in approximately 21% of the cases. For moderately retarded girls it appears that the standards may be more difficult to achieve as the triceps standards were exceeded (i.e., "above zone") about 30% of the time in the Eichstaedt, et al (1991) data. Still, it appears that the standards are within reach for many youngsters with mental retardation and mild limitations in fitness.

Body Mass Index

Body mass index is calculated by dividing a person's weight (in kilograms) by the square of their height (in meters). BMI provides an indication of the appropriateness of one's weight relative to height; it does not, however, provide a very accurate estimate of percent body fat. Correlations between BMI and percent body fat reported in the literature range from .70 to .82 for adults (Lohman, 1992), values which are lower than those reported for skinfolds. Perhaps of greater concern, however, is the finding that standard errors of estimate associated with the prediction of percent body fat from BMI data tend to be higher (and in some cases, considerably higher) than those utilizing skinfold data (Lohman, 1992). High BMI values, therefore, are more appropriately considered to be indications of being "overweight" rather than "obese." "Although most overweight people are also obese, it is possible to be obese without being overweight (i.e., sedentary individuals with a small muscle mass) and overweight without being obese (i.e., body builders and certain athletes)" (VanItallie and Lew, 1992, p. 5). For these reasons, BMI is an optional, rather than recommended, measure of body composition in the BPFT. (The BMI is not suggested for use with youngsters with SCI or CA/A.)

Although BMI does not measure percent body fat very accurately, it is a health-related measure of body composition. High BMI scores are related to increased mortality rates and the risk increases proportionately with increasing BMI (Lohman, 1994). High BMI also has been linked to the increased risk of developing hypertension, hypercholesterolemia, cardiovascular disease, non-insulin-dependent diabetes, certain cancers, and other medical problems (Lohman, 1992). There also is evidence that a higher BMI value (> 75th percentile) in adolescence translates to greater relative risk of all-cause mortality and coronary heart disease mortality in adulthood when compared to lower (between the 25th and 50th percentiles) adolescent BMI values (Solomon, Willett, and Manson, 1995).

Very low BMI values also have been linked to higher all-cause mortality rates (Skinner and Oja, 1994). The significance of this relationship, however, is not completely understood since there is contradictory evidence suggesting that the risk of mortality does not increase among those with the lowest BMIs (Lindsted, Tonstad, and Kuzma, 1991) and because of the suggestion that any relationship between low BMI and mortality may be the result of other concomitant relationships. "The excess risks of being underweight appear to be largely if not entirely artifactual, due to inadequate control of confounding by chronic or subclinical illness and/or cigarette smoking" (Solomon, Willett, and Manson, 1995, p. 9). So, any relationship that might exist between low BMI and increased risk of mortality may really be due to illness or smoking, conditions which would contribute to lowering BMI while increasing the risk of mortality.

Standards

Unlike most of the skinfold standards, the BMI standards fluctuate with age (see Table 3.2). Since the BMI includes the weight of muscle and bone (in addition to fat), it is apparent that BMI values will increase during the developmental period. In order to determine BMI standards for the Prudential FITNESSGRAM, Lohman (1994), using the NCYFS data, developed individual regression equations for males and females aged 6-17. These equations were used to identify BMI values that correspond to 10 and 25% body fat in males and 17 and 32% body fat in females, the same criteria used for the skinfold standards. These BMI values serve as the minimal standards in the BPFT. Using the same regression equations, Lohman (T.G. Lohman, personal communication, May 16, 1997) calculated BMI standards for 20% body fat in males and 25% in females to serve as the basis for the preferred standards in the BPFT. As with the skinfold measures, no specific standards are recommended for youngsters with disabilities.

Attainability

Pass/fail rates for the minimal standards for BMI were calculated for males and females with cerebral palsy or blindness who were part of the Project UNIQUE data base. These results are summarized in Table 3.4.

Table 3.4
Pass Rates for Youngsters with Disabilities on BMI

			Below Zone		Within Zone*		Above Zone	
		Total N	N	%	N	%	N	%
Cerebral Palsy								
	Boys	209	83	40	98	47	28	13
	Girls	170	48	28	102	60	20	12
Blind								
	Boys	82	15	18	56	68	11	13
	Girls	77	12	16	48	62	17	22

*defined by the upper and lower boundaries provided in Table 3.2.

Pass rates (defined as "within zone") ranged from 47% for CP boys to 68% for blind boys. In comparing the pass/fail rates for youngsters with CP or blindness on BMI with the corresponding values on TS skinfolds, it is interesting to note that the percentages for each category do not vary by more than a few percentage points except in the case of boys with CP. For this group, the differences are more dramatic. Twenty-two percent more males with CP were identified as "below zone" (i.e., underweight) using BMI as opposed to TS skinfolds. An accurate assessment of height is sometimes difficult to determine when a youngster's posture is characterized by exaggerated flexor tone, as is the case with some youngsters with CP. The tendency, however, would be that measuring stature (i.e., standing height without regard to flexed knees or hips) rather than body length (i.e., measuring body segments and summing the parts) would result in smaller values for "height" in the BMI equation. If height is underestimated, however, BMI will be overestimated and that certainly does not appear to be the case with CP boys. Explaining these differences becomes even more difficult when it is noted that the percentages in each category for the girls with CP are quite similar for BMI and TS skinfolds. It appears that more work will need to be conducted to better understand the skinfold and BMI pass rate differences for boys with CP. It may be that more boys with CP are "underweight" than are excessively "lean" suggesting that a BMI-based body composition intervention program should include muscle development since increased musculature will also tend to raise BMI. In the meantime, testers should realize that the body composition pass rates for males with CP may be higher with TS skinfolds than with BMI (although the "above zone" rates should be similar).

Looney and Plowman (1990) investigated the passing rates of nondisabled children and youth on the original (1987) FITNESSGRAM standards for BMI using scores from the NCYFS. They reported passing rates of 88% for the males and 85% for the females, but it is important to note that the original standards generally were more rigorous (i.e., required lower BMI values) than the current (1992) Prudential FITNESSGRAM standards. It is also important to remember that the original FITNESSGRAM only provided a single standard (at the high end of the scale) rather than a range of scores, so it was not possible for youngsters to fail because they were too light for their height.

In an effort to place the attainability of BMI standards of youngsters with MR into some context, we used the median height and weight data of moderately mentally retarded subjects as reported by Eichstaedt, et al (1991). BMI values were calculated for both males and females across the 10-17 age range using median height and weight values. In all cases the resultant BMI fell within the range of the minimal standards associated with BPFT. Although such an analysis does not provide specific pass/fail rates, it does suggest that the standards are within reach of youngsters with MR and mild limitations in fitness.

Reliability

Test-retest reliability of various skinfold measures has been shown to be high. Lohman (1994) reported that reliability coefficients generally exceed .90 in studies that have investigated intrarater reliability (i.e., the precision of several measures taken at the same sites by the same tester). A few studies have looked at intrarater reliability of skinfold measures when persons with disabilities served as subjects. These studies are summarized in Table 3.5. Reliability coefficients reported in these investigations have also been quite high, ranging from .90-.99.

Results of studies that have investigated interrater reliability of skinfold testing (i.e., the precision of several measures taken at the same sites by different testers) suggest a greater source of error compared to intrarater reliability (Lohman, 1994). At least some of the error attributed to interrater reliability appears to be due to differences in training methods. Lohman (1994) suggested that interrater reliability can be improved by using videotapes to standardize the training of testers and recommended that testers view such a tape prior to collecting skinfold data. Jackson, Pollock, and Gettman (1978) reported intraclass R's of .98 for the means of both triceps and subscapular skinfolds from 35 subjects as measured by three testers. They reported standard errors of 1.82 for triceps and 2.25 for subscapular folds.

Due to the objective nature of the measurements that comprise body mass index, reliability is not as serious a concern for this test of body composition. "The reliability of BMI is very high because the measurement of height and weight is very precise when following a standardized protocol" (Lohman, 1994, p. 59).

Table 3.5
Intrarater Reliability of Skinfold Measures Using Subjects with Disabilities

Author	Disability	N	Gender	Age	Field Test	Reliability Coefficient
Reid, Montgomery, & Seidl (1985)	MR	20	M/F	20-39	percent body fat from triceps, biceps, subscapular and supra-iliac	R = .95
Rarick & McQuillan (1977)	TMR	102	M/F	11-15	triceps, subscapular, calf	r = .91-.99
Pizarro (1990)	MR	81	M/F	12-15	triceps	r = .98-.99
Daquila (1982)	VI	50	M/F	10-17	triceps, subscapular, abdominal	a = .99 (all sites)
	AI	50	M/F	10-17		a = .90-.99
	OI	50	M/F	10-17		a = .97-.99

r = interclass coefficient
R = intraclass coefficient
a = alpha coefficient
TMR = trainable mentally retarded
AI = auditory impaired
OI = orthopedically impaired

Discussion

In developing the BPFT, the validity claimed for test items measuring muscular strength, muscular endurance, and flexibility/range of motion was domain-referenced (see other chapters in this manual). Domain-referenced validity is a form of logical validity which is frequently used in the development of criterion-referenced tests (Safrit, 1990). For measures of body composition, however, validity was established primarily from the concurrent and predictive properties of the skinfold and BMI tests.

Concurrent validity is claimed for skinfolds in part because of their relationship to percent body fat, which in turn has been found to be related to health problems. Body mass index, although it does not measure percent body fat, has been shown to be directly related to health problems and is also related to skinfolds. Predictive validity of the skinfold tests lies in their ability to reasonably estimate both percent body fat and BMI values through multiple regression techniques.

Although the information presented in this paper is meant to suggest that the measures of body composition included in the BPFT have both sufficient validity and reliability for use with youngsters with disabilities, a number of additional research topics remain. Some ideas for future research in this area include the following:

- Determine the accuracy of body fat prediction equations developed on able-bodied subjects for youngsters with CP or SCI;
- Further investigate the relationship between BMI and skinfolds for boys with CP (i.e., why did twice as many boys with CP from the Project UNIQUE data fall "below zone" on BMI compared to TS skinfolds?);
- Determine pass/fail rates for youngsters with MR on both skinfolds and BMI;

- Determine pass/fail rates for youngsters with VI on TC skinfolds;
- Determine the "decision validity" of the skinfold tests (i.e., can skinfolds accurately classify individuals as obese when the criterion for obesity is established through hydrostatic weighing or other more sophisticated techniques?);
- Determine the "consistency of classification" (a measure of criterion-referenced reliability) for skinfolds and BMI (e.g., if a youngster is classified as "too lean" on one administration of a skinfold test, will he/she be classified the same way on a subsequent administration of the test?).

It is quite possible that future research may eventually alter some of the body composition standards associated with the BPFT. The rationale for the items, however, appears strong and it seems that both skinfolds and body mass index have a role to play in the assessment of health-related physical fitness in youngsters with disabilities.

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Chapter IV
Muscular Strength and Endurance

Muscular strength and endurance (MS/E) is a sub-component of musculoskeletal functioning in the Brockport Physical Fitness Test (Winnick and Short, in press). MS/E was conceptualized as the sub-component 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. 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 summarized in Table 4.1. For a description of test items or more specific information on test item selection, readers are referred to the test manual (Winnick and Short, in press).

Information pertaining to the validity and reliability of the BPFT MS/E test items is discussed below 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.

Table 4.1
MS/E Test Item Selection Guide by Group

	GP	MR	VI	CP	SCI	CA/A
Reverse Curl					R*	
Seated Push-up				R*	R*	R*
40m Push/Walk				R*		
Wheelchair Ramp Test				R*/O*		
Bench Press (35-lb.)		O*			O*	R*
Dumbbell Press (15-lb.)				R*/O*	O*	R*/O*
Extended Arm Hang		R*				
Flexed Arm Hang	O	R*	O			O*
Dominant Grip Strength		O		O*	R*	R*
Isometric Push-up		O*				
Push-up	R		R			
Pull-up	O		O			O*
Modified Pull-up	O		O			
Curl-up	R		R			
Modified Curl-up		R				
Trunk Lift	R	R	R			R

GP = general population
MR = mental retardation
VI = visually impaired (blind)
CP = cerebral palsy
SCI = spinal cord injury
CA/A = congenital anomaly/amputation
R = recommended test item
O = optional test item

* Test item is recommended or optional for some, but not all members of the category; consult BPFT manual for more specific information.

Validity

Measures of MS/E traditionally have been prominent in most physical fitness test batteries. The AAHPER Youth Fitness Test (AAHPER, 1976), the Special Fitness Test for the Mildly Mentally Retarded (AAHPER, 1976), and the Motor Fitness Test Manual for the Moderately Mentally Retarded (Johnson and Londeree, 1976) are examples of physical fitness test batteries that include tests of MS/E. More recently published fitness tests which 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 (AAHPERD, 1980; Cooper Institute for Aerobics Research, 1987; McSwegin, Pemberton, Petray, and 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). Most recently, MS/E items were included in the health-related criterion-referenced Prudential FITNESSGRAM (Cooper Institute for Aerobics Research, 1992) because the ability to exert force (strength) and resist fatigue (endurance) were perceived as important components of maintaining "balanced, healthy functioning of the musculoskeletal system" (Plowman and Corbin, 1994, p. 73).

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 and Short, in press) 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 nondisabled youngsters, 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 and 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 and 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, and 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, and Abel, 1995; Richter, Gaebler-Spira, and Mushett, 1990). 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, 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 posses 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 Prudential FITNESSGRAM test items included in the BPFT were derived from expert opinion (Plowman and 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 percent) when compared to those in the second quintile (Blair, Kohl, Paffenbarger, Clark, Cooper, and Gibbons, 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 and diseased men and women 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 diseased men and women 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 diseased men and women 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 nondisabled children and adolescents. 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 nondisabled subjects aged 10-17 (n=1,162) (Winnick and 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, and 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 and diseased adults 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 which was utilized in the 40m push/walk test and one by Kosiak and Kottke (1990) pertaining to skin pressure 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 Prudential FITNESSGRAM test battery. Effort was made in the development of the BPFT to establish an association with the Prudential FITNESSGRAM so that test-users could switch back-and-forth between the two tests as necessary. The Prudential 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. 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 separately later in the chapter.

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

These six test items are included in the Prudential FITNESSGRAM. Some (or all) of these items are either recommended or optional tests for youngsters who are blind, mentally retarded, or, depending upon the site of the impairment, have anomalies or amputations.

Information on the rationale and validity (as well as reliability) of these test items is already available in the literature (Plowman and 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 and Corbin, 1994, p. 92).

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" (Plowman and 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 subjects with disabilities established that flexed arm hang and pull-ups generally are associated with factors labeled "power-strength," a characterization applied to tests typically lasting less than 30 seconds and involving a "relatively high load" (Winnick and 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 Prudential FITNESSGRAM and appear in Table 4.2. The FITNESSGRAM CR standards for each of these items was based on expert opinion derived, in part, from an analysis of normative data collected in the United States and Canada (Plowman and Corbin, 1994). Where appropriate, FITNESSGRAM standards which 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 4.3). There is a consistent trend in the literature that documents a performance discrepancy between youngsters who are retarded and nonretarded on many measures of MS/E. Factors such as motivation, fewer opportunities to train, fewer opportunities to participate in physical activities,

Table 4.2
General Standards for Measures of MS/E in the BPFT

Age	Flexed Arm Hang (sec.) M	Flexed Arm Hang (sec.) P	Push-up (# Completed) M	Push-up (# Completed) P	Pull-up (# Completed) M	Pull-up (# Completed) P	Modified Pull-up (# Completed) M	Modified Pull-up (# Completed) P	Trunk Lift (in.) L	Trunk Lift (in.) U	Curl-up/ Modified Curl-ups (# Completed) M	Curl-up/ Modified Curl-ups (# Completed) P
Males												
10	**4**	10	**7**	20	**1**	2	**5**	15	9	12	**12**	24
11	**6**	13	**8**	20	**1**	3	**6**	17	9	12	**15**	28
12	**10**	15	**10**	20	**1**	3	**7**	20	9	12	**18**	36
13	**12**	17	**12**	25	**1**	4	**8**	22	9	12	**21**	40
14	**15**	20	**14**	30	**2**	5	**9**	25	9	12	**24**	45
15	**15**	20	**16**	35	**3**	7	**10**	27	9	12	**24**	47
16	**15**	20	**18**	35	**5**	8	**12**	30	9	12	**24**	47
17	**15**	20	**18**	35	**5**	8	**14**	30	9	12	**24**	47
Females												
10	**4**	10	**7**	15	**1**	2	**4**	13	9	12	**12**	26
11	**6**	12	**7**	15	**1**	2	**4**	13	9	12	**15**	29
12	**7**	12	**7**	15	**1**	2	**4**	13	9	12	**18**	32
13	**8**	12	**7**	15	**1**	2	**4**	13	9	12	**18**	32
14	**8**	12	**7**	15	**1**	2	**4**	13	9	12	**18**	32
15	**8**	12	**7**	15	**1**	2	**4**	13	9	12	**18**	35
16	**8**	12	**7**	15	**1**	2	**4**	13	9	12	**18**	35
17	**8**	12	**7**	15	**1**	2	**4**	13	9	12	**18**	35

L = lower boundary of acceptable range
U = upper boundary of acceptable range

Table 4.2 (cont'd)

Age	Dominant Grip Strength (kg.)		Isometric Push-up (sec.)		Bench Press (# Completed)		Extended Arm Hang (sec.)		Dumbbell Press (# Completed)	
	M	P	M	P	M	P	M	P	M	P
Males										
10	**18**	22	**40**	40			**30**	40		
11	**21**	26	**40**	40			**30**	40		
12	**25**	30	**40**	40			**30**	40		
13	**29**	35			**20**	34			**14**	22
14	**33**	42			**33**	43			**19**	28
15	**37**	46			**40**	50			**21**	33
16	**43**	51			**47**	50			**24**	39
17	**49**	57			**50**	50			**27**	45
Females										
10	**17**	20	**25**	40			**20**	40		
11	**19**	22	**25**	40			**20**	40		
12	**22**	24	**25**	40			**20**	40		
13	**24**	28			**10**	23			**5**	12
14	**26**	31			**13**	26			**7**	14
15	**29**	33			**14**	27			**10**	16
16	**29**	33			**14**	27			**11**	16
17	**29**	33			**15**	30			**11**	16

Table 4.3
Specific Standards for Youngsters with MR and Mild Limitations in Physical Fitness

Age	Isometric Push-up (sec.)	Bench Press (# Completed)	Extended Arm Hang (sec.)	Flexed Arm Hang (sec.)	Dominant Grip Strength (kg.)	Modified Curl-ups (# Completed)
Males						
10	**20**		**23**		**12**	**7**
11	**20**		**23**		**14**	**9**
12	**20**		**23**		**16**	**11**
13		**10**		**6**	**19**	**13**
14		**16**		**8**	**22**	**14**
15		**20**		**8**	**24**	**14**
16		**23**		**8**	**28**	**14**
17		**25**		**8**	**32**	**14**
Females						
10	**13**		**15**		**11**	**7**
11	**13**		**15**		**12**	**9**
12	**13**		**15**		**14**	**11**
13		**5**		**4**	**16**	**11**
14		**6**		**4**	**17**	**11**
15		**7**		**4**	**19**	**11**
16		**7**		**4**	**19**	**11**
17		**8**		**4**	**19**	**11**

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 subjects 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 Francis and Rarick (1959), Hayden (1964), Sengstock (1966), Vodola (1978), Rarick, Dobbins, and Broadhead (1976), Johnson and Londeree (1976), Rarick and McQuillan (1977), Findlay (1981), Reid, Montgomery, and Seidl (1985), Roswal, Roswal, and Dunleavy (1986), Montgomery, Reid, and Seidl (1988), Pizzaro (1990), and Eichstaedt, Wang, Polacek, and Dohrmann (1991).

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 (Eichstaedt, et al, 1991; AAHPER, 1976; and Johnson and Londeree, 1976) suggested that a 50% adjustment 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 (no data were collected on modified pull-ups). 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 camp sites in East Lansing and Kalamazoo, Michigan. Number of subjects tested and passing rates for various standards are presented for these and other MS/E items in Table 4.4.

The passing rates shown in Table 4.4 suggest that most youngsters who are visually impaired should find the minimal general standards associated with the trunk items (trunk lift and 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. Most youngsters with mental retardation and mild limitations in fitness will find the minimal general standards for the trunk

Table 4.4
Passing Rates for Subjects with MR and VI for Relevant Tests of MS/E and Available Standards

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

* Ages 13-17
** Ages 10-12

MR = mental retardation
VI = visually impaired
NR = standard is not recommended for that item for specific youngsters

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 subjects tested could achieve the minimal specific standards.

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 Prudential FITNESSGRAM procedures. Youngsters had difficulty dealing with the four inch strip. 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 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 Prudential FITNESSGRAM curl-up were adopted as the general standards for the BPFT modified curl-up (Table 4.2). 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, and Bell, 1989).

Specific standards for youngsters with MR are available for the modified curl-ups (See Table 4.3). Specific standards were developed following an analysis of previously published data (Reid, Montgomery, and Seidl, 1985; Roswal, Roswal, and Dunleavy, 1986; Rarick, Dobbins, and Broadhead, 1976; Vodola, 1978; Pizzaro, 1990; Sengstock, 1966; and Eichstaedt, et al, 1991) 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 4.4. 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 with physical disabilities (Winnick and Short, 1985) as well as with youngsters with MR (Rarick, Dobbins, and Broadhead, 1976; Rarick and McQuillan, 1977). Factor analyses of data collected on subjects 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 and 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 MS/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 with nondisabled subjects yielded Pearson r's of .77 (n=381) and .76 (n=501) between dominant grip strength and 35-lb bench press and 15-lb dumbbell press respectively. 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.

Standards

The general CR standards for grip strength are given in Table 4.2. 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 nondisabled subjects (n=680) tested during Project Target.

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 the grip strength, however, were developed for youngsters with MR (See Table 4.3). An analysis of previously published comparative data (Rarick, Dobbins, and Broadhead, 1976; and Montgomery, Reid, and

Seidl, 1988) as well as data collected as part of Project Target (115 subjects with MR contrasted with 680 nondisabled subjects) suggested that a 35% reduction to the minimal general standards would be an appropriate estimate of the performance discrepancy existing between retarded and nonretarded youngsters on grip strength. 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 are summarized in Table 4.4 for subjects 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 CP subjects met the minimal general standards while four of the 11 (36%) were able to reach the preferred general standards. Of the four SCI subjects, 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 and 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 weight and bar, 35-lbs proved to be too heavy to lift, and equipment requirements were inconvenient for itinerant teachers (Eichstaedt and Lavay, 1992). Furthermore, 35-lbs might constitute a maximum lift for some youngsters, a practice which generally is discouraged for prepubescent individuals (National Strength and Conditioning Association, 1985); 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 found a Pearson r of .55 between the isometric push-up and traditional push-ups for a group of nondisabled subjects (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 4.2). 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 nondisabled subjects during Project Target. A total of 177 10-12-year-old subjects and 322 13-17-year-old subjects 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 4.3). 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. The mean bench press scores of 31 subjects with MR were contrasted to the mean scores of 322 nondisabled subjects by gender and age (13-17). A similar comparison was made between 13 subjects with MR and 177 nondisabled subjects (aged 10-12) on the isometric push-up. For both items the group with MR generally had means less than 50% of the means of their nondisabled counterparts. 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 MR subjects tested during Project Target on isometric push-up and bench press are provided in Table 4.4. 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 and 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 nondisabled subjects (aged 14-17) tested during Project Target. 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 4.2) were developed by testing nondisabled youngsters. The minimal standards approximate the 20th percentile of a distribution of scores obtained by 403 10-12-year-old subjects. 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 subjects reported discomfort in the hands (apparently due to bar friction) during more lengthy hangs.

Specific standards are available for youngsters with MR (Table 4.3). 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 nondisabled subjects were contrasted with P50 values obtained by Hayden (1964) on a sample of severely retarded youngsters. Scores obtained by Hayden's subjects ranged from 82-93% of the Project Target nondisabled scores. 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).

<u>Attainability</u>

Thirty-six subjects (aged 10-12) with MR from Rochester, N.Y. (two studies) and New York City were tested on the extended arm hang. Pass rates for the available standards are provided in Table 4.4. 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 (15-1b) 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 with 490 nondisabled subjects 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 4.2) for youngsters 13-17. Expert opinion was used to determine that the general standards are appropriate for the classes of subjects 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 nondisabled adolescents (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, N.Y. Only one of the nine subjects with CP met the minimal general standard for dumbbell press. This subject also attained the preferred standard. Of the two subjects 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

Specific standards for each of the four tests designed for persons with physical disabilities are given in Table 4.5. Two specific standards 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 advise for reducing the risk of acquiring pressure-induced skin ulcers (p. 977).

Table 4.5
Specific Standards for Youngsters with Physical Disabilities on Reverse Curl, Seated Push-up, 40-meter Push/Walk, and Ramp Test

Males and Females				
Age	Reverse Curl # Completed	Seated Push-up[2] (sec.)	40-meter Push/Walk[1] (sec.)	Wheelchair Ramp Test[2] (ft.)
10-17	**1**	**5/20**	**Pass**	**8/≥15**

[1] Youngsters pass when they cover the distance within 60 s of the acceptable heart rate intensity.
[2] Scored as pass/fail based upon either standard.

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, six (75%) were able to exceed 10s; 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 subjects 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 30s 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

As shown in Table 4.5, a single specific standard 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/minute to 100 meters/minute" (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 CP subjects 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 an adult.

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 subjects 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 minutes 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 (ACSM, 1995); 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 minute 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 minute, 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 subjects as part of Project Target. Useable data were collected on just five subjects with CP, two from class C3 and three from class C6. All five subjects 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 provided in Table 4.5. The conditions for attaining the first standard require youngsters to propel 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 (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 subjects attempted the test during Project Target testing 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 one-pound weight one time (Table 4.5). 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 nondisabled subjects. Most of the studies reviewed 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 looked at 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 and Magnusdottir, 1987) and the interclass coefficient (r) reported for the modified curl-up was .88 (Jette, Sidney, and Cicutti, 1984).

Additional reliability studies have been conducted on tests of abdominal strength and endurance using subjects with disabilities. Some of these studies are summarized in Table 4.6. 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 (1996) tested 64 nondisabled youngsters 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 subjects. A number of reliability studies employing subjects with disabilities are summarized in Table 4.7. Although some of the studies have small sample sizes, the coefficients reported in Table 4.7 for a variety of upper arm and shoulder tests suggest good test-retest score consistency.

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 disabilities also has resulted in acceptable coefficients as shown in Table 4.8. These coefficients suggest a high degree of score consistency for the grip strength test.

Table 4.6
Reliability of Field Tests for Abdominal Strength/Endurance for Individuals with Disabilities

Author	Disability	N	Gender	Age	Field Test	Reliability Coefficient
Londeree & Johnson (1974)	Moderately MR	1105	M/F	6-21	30s sit-ups	spring and fall test-retest r = .78 -.99
Reid, Montgomery, & Seidl (1985)	MR	20	M/F	20-39	60s sit-ups	test-retest R = .63
Pizzaro (1990)	EMR	44	M/F	12-15	modified sit-ups	test-retest r = .83
	TMR	37	M/F	12-15	modified sit-ups	test-retest r = .94
Eichstaedt & Lavay (1992)	Unclassified	209	M/F	unspecified school-aged	modified sit-ups	R =.92 one week test-retest r = .96
Winnick & Short (1997)	MR	25	M/F	11-17	modified curl-ups	one week test-retest a = .82

r = interclass coefficient
R = intraclass coefficient
a = alpha coefficient

EMR = educable mentally retarded
TMR = trainable mentally retarded

Table 4.7
Reliability of Field Tests of Upper Arm and Shoulder Girdle Strength for Individuals with Disabilities

Author	Disability	N	Gender	Age	Field Test	Reliability Coefficient
Londeree & Johnson (1974)	Moderately MR	1105	M/F	6-21	flexed arm hang	spring and fall test-retest r = .48
Daquila (1982)						same day test-retest
	visually impaired	50	M/F	10-17		a = .84
	auditory impaired	50	M/F	10-17	flexed arm hang	a = .92
	orthopedically impaired	50	M/F	10-17		a = .96
Reid, Montgomery, & Seidl (1985)	MR	20	M/F	20-39	push-ups	one month test-retest R = .62
Eichstaedt & Lavay (1992)	Unclassified	189	M/F	unspecified school-aged	isometric push-up	R =.83 one week test-retest r = .88
Winnick & Short (1996)	MR	38	M/F	10-17	isometric push-up	test-retest a = .83
	MR	12	M/F	13-17	15-lb dumbbell press	test-retest a = .98
Winnick & Short (1997)	MR	11	M/F	11-17	extended arm hang	one week test-retest a = .85
	MR	17	M/F	11-17	flexed arm hang	one week test-retest a = .93
	MR	23	M/F	11-17	35-lb bench press	one week test-retest a = .91

r = interclass coefficient
R = intraclass coefficient
a = alpha coefficient

Table 4.8
Reliability of Grip Strength Measures for Individuals with Disabilities

Author	Disability	N	Gender	Age	Field Test	Reliability Coefficient
Rarick, Dobbins & Broadhead (1976)	EMR	261	M/F	6-13	left grip right grip	test-retest r = .90 -.96 test-retest r = .88 -.98
Rarick & Quillan (1977)	TMR	69	M/F	6-9	left grip right grip	test-retest r = .89 -.99 test-retest r = .84 -.90
Daquila (1982)						same day test-retest
	visually impaired	50	M/F	10-17	grip strength	a = .97 -.99
	auditory impaired	50	M/F	10-17	grip strength	a = .97 -.98
	orthopedically impaired	50	M/F	10-17	grip strength	a = .98 -.99
Reid, Montgomery & Seidl (1985)	MR	20	M/F	20-39	grip strength	test-retest R = .88
Winnick & Short (1997)	MR	36	M/F	11-17	dominant grip	one week test-retest a =.96

r = interclass coefficient
R = intraclass coefficient
a = alpha coefficient

EMR = educable mentally retarded
TMR = trainable mentally retarded

Much less reliability data are available for the trunk lift; in fact besides one investigation conducted during Project Target, no other studies were found using the Prudential FITNESSGRAM protocol. Plowman and Corbin (1994) summarized two trunk extension studies which employed different procedures and reported interclass r's ranging from .74-.96. Rarick, Dobbins, and Broadhead (1976) reported test-retest coefficients for a spinal extension test given to educable mentally retarded subjects. 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 subjects with MR. In the Project Target study, a proportion of agreement of .89 was calculated for the trunk lift across two administrations (14 days apart) using youngsters with MR as subjects (n = 36). More reliability data is needed for the trunk lift.

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 and is presented in Table 4.9. Each of these MS/E items was taken by subjects with MR who were classified in accord with the specific standards presented in Table 4.3.

Table 4.9
Consistency of Classification for Selected MS/E Test Items for Subjects with MR

Test Item	n	P
Dominant Grip Strength	36	.92
Bench Press	23	.82
Extended Arm Hang	11	.72
Flexed Arm Hang	17	.82
Modified Curl-up	25	.72

The number of subjects used in the calculation of the P coefficients in Table 4.9 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.

Discussion

As with the flexibility and range of motion tests associated with the BPFT and discussed in the following chapter, the rationale and validity of the muscular strength and endurance tests 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 has been described previously (Winnick and Short, in press).

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 and Warren, 1990; Looney and 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 Prudential FITNESSGRAM (Plowman and 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 subjects, 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 subjects 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 their nondisabled counterparts on measures of fitness (Eichstaedt and 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 paper 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 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. Clearly research has established that subjects with CP typically make inferior scores on measures of strength and endurance compared to nondisabled counterparts and, in some cases, the differences are vast (Winnick and Short, 1982). It is also 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., 40m push, wheelchair ramp test) are not germaine to nondisabled individuals and, therefore, are not associated with general standards per se.

Consequently the approach taken in the BPFT for MS/E items was to attempt 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 (See Table 4.1) 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 on-going 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.

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Chapter V
Flexibility/Range of Motion

Flexibility and range of motion are sub-components of musculoskeletal functioning in the Brockport Physical Fitness Test (Winnick and Short, in press). For the purposes of the BPFT, range of motion (ROM) was defined as the extent of movement possible in a single joint, where traditional tests might include goniometry techniques typically measured in angular units. Flexibility was conceptualized as the extent of movement possible in multiple joints represented by one's ability to perform a functional movement. Traditional tests of flexibility might include field tests that typically measure how far one can reach. The BPFT flexibility items include the back saver sit and reach (BSSR), the Apley test (modified), the shoulder stretch, and the Thomas test (modified). The only test of ROM is the Target Stretch Test (TST).

In the BPFT certain flexibility/ROM tests are recommended (R) or optional (O) for specific groups of youngsters. Both recommended and optional items generally are deemed appropriate for youngsters with particular disabilities, but recommended items are preferred. A guide for test item selection appears in Table 5.1.

Validity

Tests of flexibility have been used in physical fitness test batteries for many years. Fleishman (1964), for example, included measures of dynamic and extent (static) flexibility in his Basic Fitness Tests and Johnson and Londeree (1976) incorporated a bob and reach test in the Motor Fitness Test Manual for the Moderately Mentally Retarded. No attempt was made by the authors of these earlier tests to justify the inclusion of a flexibility item on a health-related basis.

In fact, most of the fitness tests published prior to 1980 now are considered more appropriately to be tests of skill-related fitness rather than measures of health-related fitness.

When flexibility tests are used as measures of health-related physical fitness, the rationale is usually based on a presumed relationship between flexibility and low back pain. One of the components of the Health Related Physical Fitness Test (AAHPERD, 1980), for instance, was abdominal and low back-hamstring musculoskeletal function measured by modified sit-ups and sit and reach tests. The Prudential FITNESSGRAM (Cooper Institute for Aerobics Research, 1992), a health-related criterion-referenced fitness test currently endorsed by AAHPERD, included the BSSR and shoulder stretch tests as measures of musculoskeletal functioning because the upper body and abdominal/trunk regions were deemed important for "maintaining functional health and correct posture, thereby reducing possibilities of future low back pain and restrictions in independent living" (p.17).

The rationale for the inclusion of flexibility or range of motion test items in a fitness battery for students with disabilities is linked to the health-related needs typically associated with a specific impairment. While the health-related flexibility needs of individuals with either MR or VI might not differ significantly from those of the general population (i.e., neither MR or VI is associated inherently with restrictions in flexibility), they often do for those with physical disabilities. People with physical disabilities are at greater risk for restrictions in functional health, posture, and independent living due to reduced flexibility than are members of the general population. In fact these elements, which may present current challenges to many youngsters with physical disabilities, probably are more important health-related criteria than the possibility of developing future low back pain. According to Surburg (1995) flexibility is important to people with physical disabilities for a number of health-related reasons including enhanced performance of activities of daily living, improved mobility and independence, improved posture and muscle balance, prevention of injury, and reduction in postexercise muscle soreness. Restrictions in flexibility are commonly associated with cerebral palsy, especially when spasticity is prevalent. Hypertonicity of the muscles restricts range of motion in the joints. The flexors, adductors, and internal rotators tend to dominate their antagonists resulting in many of the health-related problems noted by Surburg (1995). Furthermore, when these muscle imbalances are severe, contractures can result. For these reasons Sherrill (1998) considered improved flexibility to be the most important fitness goal for youngsters with CP.

Maintenance of flexibility also is critical for youngsters with SCI. It is especially important to maintain appropriate levels of flexibility in those joints surrounded by active muscle because the mobility of those joints is critical to the youngster's independence. The ability to transfer, propel a wheelchair, or perform other activities of daily living is influenced by flexibility. Youngsters with SCI also are susceptible to muscle imbalance resulting from heavy reliance on specific muscle groups required in wheelchair use, including the anterior shoulder muscles (DiRocco, 1995). Muscle imbalances around a joint will serve to limit the range of motion for certain joint actions, reduce the functional ability of the joint, and increase the likelihood of muscular injury. As with cerebral palsy, contractures are also possible in persons with SCI.

Clearly certain amounts of flexibility and range of motion are necessary for good health, but how much? As with muscular strength and endurance, there is no universally acceptable criterion for health-related flexibility/range of motion. Although criterion levels of maximum oxygen intake and percent body fat have provided references for aerobic capacity and body composition, no such index currently is available for any measure of musculoskeletal functioning (including measures of flexibility). Criterion levels of flexibility/ROM, therefore, generally are established through expert opinion. In the development of the BPFT, expert opinion was provided by the Project Target Advisory Committee and the authors. Depending upon the test item, expert opinion often was informed by reviewing norm-referenced data sets, by considering values used in clinical settings, and/or by consulting recommendations or research results found in the literature. The specific approach utilized is discussed in the following sections for each of the five test items.

Back Saver Sit and Reach

The BSSR is included in the Brockport Physical Fitness Test battery in response to the health-related concern of low back pain (or the risk of developing low back pain in the future). The BSSR has been shown to validly measure hamstring flexibility, but research has failed to confirm a relationship between the test and indices of low back pain despite the fact that the anatomical logic for such a relationship is strong (Plowman and Corbin, 1994). The BSSR is a recommended test item for the general population, as well as for youngsters with MR, VI, and CA/A (for use with unaffected limbs only).

Table 5.1
Flexibility/ROM Test Item Selection
Guide for the BPFT

	BSSR	Shoulder Stretch	Apley (mod.)	Thomas (mod.)	TST
GP	R	O			
MR	R	O			
VI	R	O			
CP					
C1			R		R
C2U			R		R
C2L					R
C3			R		R
C4			R		R
C5			R	R	O
C6			R	R	O
C7			R	R	O
C8			R	R	O
SCI					
LLQ					R
PW			R		R
PA			R	R	
CA/A*	R	R	R	R	R

GP = general population
VI = visual impairment (blindness)
C1-C8 = CP-ISRA sport classifications
LLQ = low level quadriplegia
PA = paraplegia ambulatory
MR = mental retardation with mild limitations in fitness
CP = cerebral palsy
SCI = spinal cord injuries
PW = paraplegia wheelchair
CA/A = congenital anomalies/amputation

*Items are recommended depending on the site of the amputation/anomaly

Table 5.2
General CR Standards for Flexibility/ROM Tests

	BSSR (in.)	Shoulder Stretch (P/F)	Apley (mod.)	Thomas (mod.)	TST Min.	TST Pref.
Males						
10	8	Pass	3	3	1	2
11	8	Pass	3	3	1	2
12	8	Pass	3	3	1	2
13	8	Pass	3	3	1	2
14	8	Pass	3	3	1	2
15	8	Pass	3	3	1	2
16	8	Pass	3	3	1	2
17	8	Pass	3	3	1	2
Females						
10	9	Pass	3	3	1	2
11	10	Pass	3	3	1	2
12	10	Pass	3	3	1	2
13	10	Pass	3	3	1	2
14	10	Pass	3	3	1	2
15	12	Pass	3	3	1	2
16	12	Pass	3	3	1	2
17	12	Pass	3	3	1	2

Min. = minimal
Pref. = preferred

BSSR = back saver sit and reach
TST = Target Stretch Test

Standards

The general CR standards for the BSSR, as well as the other measures of flexibility, are provided in Table 5.2. These are the same standards associated with the Prudential FITNESSGRAM. The FITNESSGRAM standards were based on expert opinion formed as a result of an analysis of existing norm-referenced data sets (Plowman and Corbin, 1994). No specific CR standards are recommended for the BSSR in the BPFT for youngsters with CA/A (unaffected limbs only), VI or MR. For youngsters with CA/A it is assumed that unaffected areas should demonstrate the same level of flexibility as is expected in the corresponding areas of nondisabled youngsters; hence, no specific standards are required.

In the case of youngsters with VI, Winnick and Short (1982) reported significant differences on sit and reach performance between nondisabled and visually impaired girls (the difference between the boys was nonsignificant). Although statistically different, the difference in the means between the nondisabled and visually impaired girls was not very large in a practical sense. The mean difference was 4 cm which was approximately .5 standard deviations below the mean score for the nondisabled girls. Winnick and Short (1982) reported that one-third of their sample of visually impaired girls was able to reach or surpass the median score obtained by their sample of nondisabled girls. Consequently, it was decided that youngsters with VI should be expected to attain the BSSR standards recommended for the general population.

Previous research has reported hamstring flexibility differences between nondisabled subjects and their peers with mental retardation. Rarick Dobbins, and Broadhead (1976), for instance, reported differences ranging from approximately 4 cm for boys to approximately 7 cm for girls in the 6-9 age range. Furthermore, they reported that the means for educable mentally retarded subjects ranged from between .65 (boys) to 1.19 (girls) standard deviations below the means obtained for nondisabled subjects and that although one-third of the mentally retarded boys could achieve or surpass the median performance of the nondisabled boys, only 8% of the retarded girls could reach the same level of achievement when compared to the nondisabled girls. Pizzaro (1990) reported sit and reach performance differences of approximately 8 cm between educable mentally handicapped and nonhandicapped subjects.

While these statistics might suggest the need to offer specific CR standards for youngsters with MR on the BSSR, two other considerations argued against it. First, the general CR standards for the BSSR are at or below the 25th percentile for nondisabled youngsters, when compared to the Health Related Test sit and reach norms (AAHPERD, 1980). Over one-half of the Rarick, Dobbins, and Broadhead (1976) sample of mentally retarded boys and 27% of the mentally retarded girls were able to achieve the 25th percentile of their nondisabled counterparts.

The second consideration deals with the fitness level of subjects tested. It is generally agreed that youngsters with mental retardation tend to be less active and less fit than nondisabled youngsters of similar age. Standards should be adjusted as necessary for youngsters with disabilities, but those adjustments should be based on the influence of impairment not on the influence of a sedentary lifestyle or poor fitness. If it can be assumed that Special Olympians can be considered more active and more fit than other mentally retarded youngsters, data provided by Roswal, Roswal, and Dunleavy (1984) are instructive in this regard. They provided sit and reach norms for Special Olympians with mild and moderate levels of retardation. Median values for male subjects (aged 8-19) with MR ranged from 5 cm below to 9 cm above the median values for nondisabled boys on the sit and reach test associated with the Health Related Test. Females with

MR had median values ranging from 3 to 8 cm below the median values for nondisabled females. In only one of eight gender by age (8-15 and 16-19) by level of retardation (mild and moderate) categories presented by Roswal, et al did the median value obtained by Special Olympians with mild and moderate levels of retardation fall below the general CR standard in the BPFT. These data were interpreted to suggest that, with training, the general CR standards associated with the BSSR are within reach of, and appropriate for, youngsters with MR.

Attainability

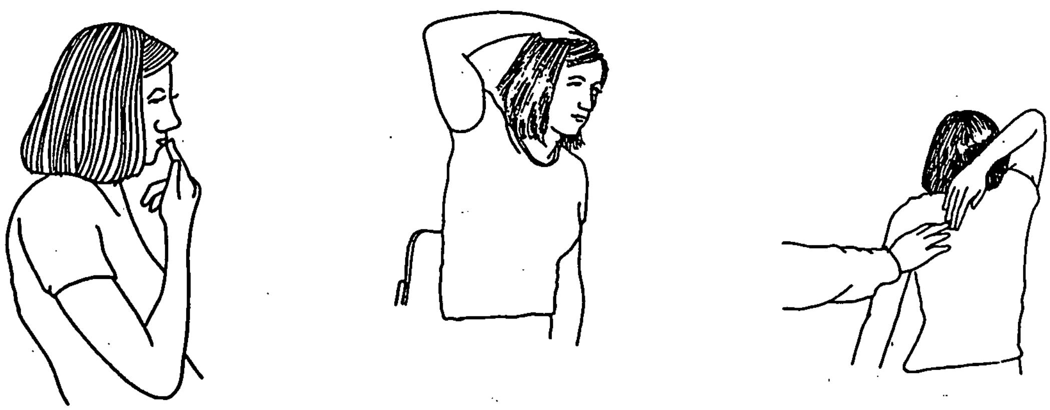
As part of Project Target, the BSSR was administered to 135 boys and girls with MR aged 10-17. The test was administered twice to each subject, once with the right leg forward and once with the left, for a total of 270 measures. Subjects were designated as individuals with mental retardation and mild limitations in physical fitness. In regard to traditional classifications, the subjects would be identified primarily as youngsters with moderate mental retardation. Fifty percent (60 of 120) of the scores obtained by the girls and 63% (94 of 150) of those made by the boys met or exceeded the general CR standard for the BSSR.

Similarly, 96 subjects with VI took the BSSR. Both right and left legs were tested bringing the total number of scores to 192. The large majority of subjects were classified as at least legally blind although 21 of the subjects were partially sighted. Seventy-one percent (57 of 80) of the scores attained by the girls and 70% (78 of 112) of the scores made by the boys reached or surpassed the general CR standard.

Shoulder Stretch and Apley Tests

The shoulder stretch test and a modified version of the Apley test are included in the BPFT battery as measures of shoulder flexibility. The shoulder stretch is an item that also is associated with the Prudential FITNESSGRAM. "The shoulder stretch has been added as an option [for the FITNESSGRAM] to try and illustrate that flexibility is important throughout the body-- not just the hamstrings, and that flexibility is very specific to each joint" (Plowman and Corbin, 1994, p. 87). The shoulder stretch is simply scored pass/fail; a "pass" requires the ability to touch the fingers of the opposite hands behind the back in a particular way.

The Apley test was included as an alternative measure of shoulder flexibility in the BPFT for two reasons. First, it was more easily administered to youngsters in wheelchairs than the shoulder stretch and, second, it lent itself to the development of a modified scoring system that would reduce the number of zero scores made by youngsters known to have restrictions in flexibility (i.e., those with CP) and, instead, increase the chances that those youngsters would score somewhere on an achievement continuum. In addition to retaining the traditional object of the Apley test (touching the superior medial angle of the opposite scapula) and assigning it a "3", the modified scoring system also includes intermediate scores logically associated with certain activities of daily living. The ability to touch the top of the head provides the requisite shoulder flexibility for certain grooming functions (e.g., shampooing or combing the hair) and scores a "2", while the ability to touch the mouth is indicative of the flexibility necessary to perform other important tasks (e.g., eating, drinking, brushing teeth) and scores a "1". Inability to touch the mouth scores a "0" (See Figure 5.1). The shoulder stretch or the Apley test is either a recommended or optional test item for every group covered by the BPFT. The shoulder stretch is optional for youngsters with MR or VI and for youngsters in the general population. The Apley is recommended for most youngsters with CP or SCI. Both tests are recommended for youngsters with C/A depending on the nature of impairment (See Table 5.1).



(a) (b) (c)

Figure 5.1 Scoring the Modified Apley Test
(a) Mouth
(b) Top of Head
(c) Scapula

Both the shoulder stretch and Apley tests require shoulder flexion in combination with external rotation and shoulder abduction, an action believed to be critical for many activities of daily living and, therefore, functional health (Advisory Committee, 1995). A preliminary study of the relationship between the Apley test and subjective measures of functional independence on selected activities of daily living (ADLs) was conducted as part of Project Target. Thirty-eight subjects with CP took a battery of tests, including the modified Apley test, and completed a modification of the Functional Independence Measure (Keith, Granger, Hamilton, and Sherwin, 1987). Data analysis included the construction of 2 X 2 contingency tables between the Apley (pass vs. fail) and the measure of functional independence (independent vs. dependent) for eight ADLs. Significant and moderate phi coefficients between the Apley and functional independence were found for two of the ADLs, eating (.52) and toileting (.60). The coefficients for three of the other ADLs were lower and nonsignificant. (Coefficients for the remaining ADLs could not be determined due to empty cells in the contingency tables.) The moderate coefficients obtained for two of the ADLs indicates that some relationship exists between the modified Apley and functional independence, but the magnitude of the coefficients is insufficient to claim acceptable evidence of statistical validity. Still, the logic for such a relationship remains strong.

Standards

As shown in Table 5.2, the general CR standards for the shoulder stretch and the modified Apley tests are the same for all gender and age combinations; a "pass" for the shoulder stretch and a "3" for the modified Apley. The standards for both of these items were determined solely by expert opinion (Plowman and Corbin, 1994; Advisory Committee, 1995) and are believed to reflect optimal levels of shoulder flexibility (Advisory Committee, 1995). Most youngsters taking the BPFT, regardless of disability classification, are expected to be able to meet the general standards for the item that is recommended for them (See Table 5.1).

Specific standards are recommended for the modified Apley test only for youngsters with more severe forms of CP (See Table 5.3). Youngsters in CP classes C1 and C2L are expected to score at least a "2" on the Apley. A "2" requires youngsters to touch the top of their heads (rather than the opposite scapula). Again, this standard was determined through expert opinion (Advisory Committee, 1997). No specific standards are available for the shoulder stretch, however the shoulder stretch is not an item that is recommended for youngsters with physical disabilities.

Table 5.3
Specific CR Standards for Flexibility/ROM Tests

		Apley (modified) CP Class C1 & C2L	Thomas (modified) CP Class C5-C7 (affected side)
Males			
	10-17	2	2
Females			
	10-17	2	2

Attainability

Subjects (n=124) with MR were tested on the shoulder stretch in conjunction with Project Target. Subjects were tested on both right and left shoulders bringing the total number of scores to 248. Of the 114 attempts made by the girls with MR, 40, or 35%, were successful. The boys were successful 46% (61 of 134) of the time.

Subjects (n=103) with VI were also tested on the shoulder stretch. Again, both shoulders were tested bringing to 206 the total number of scores. Attempts made by the girls with VI were successful 63% (57 of 90) of the time. Boys passed the test 51% (59 of 116) of the time. Although subjects with cerebral palsy (n=18) had difficulty with the shoulder stretch (6% passing rate for 36 tests), they were more successful on the modified Apley test, the recommended item for this group. Forty-three subjects in CP classes C2U-C8 were tested on a few different occasions during Project Target. Two slightly different protocols were used with the Apley. In the first, subjects (n=13) attempted the Apley once with each shoulder. Of the 26 attempts made, 18, or 69%, were successful. In the second protocol, subjects (n=30) were asked to attempt the Apley with their preferred arm only. (The preferred-arm protocol was field-tested to account for differences in how the condition might affect different sides of the body, such as in hemiplegia.) Twenty-one of the 30 subjects, 70%, met the criterion (a score of "3") using their preferred arm.

Thomas Test (modified)

The modified Thomas Test is included in the BPFT battery only for selected ambulatory youngsters with physical disabilities. Specifically, it is recommended for CP classes C5-C8, ambulatory youngsters with SCI, and, depending upon the site of an anomaly/amputation, certain youngsters with CA/A. The Thomas test traditionally has been used in clinical settings to test for length of the hip flexor muscles (Kendall, Kendall, and Wadsworth, 1971). It is included in the BPFT as a test of hip extension in response to the observation that many youngsters with physical disabilities experience shortening of the hip flexors (Advisory Committee, 1995). Although some youngsters experience this shortening as the result of the immobilization and/or inactivity of the hip joint associated with habitual sitting (Kottke, 1990), the rationale for the inclusion of this item in the battery is based on its relationship to posture and ambulation. When a hip flexion contracture is present, additional strain is placed on the back and hip extensor muscles (Perry, 1992). Furthermore, a hip flexion contracture frequently requires postural compensation to maintain the center of gravity over the feet. Common compensatory mechanisms include lumbar lordosis or knee flexion resulting in a crouched posture (Perry, 1992). Youngsters with cerebral palsy often are unable to fully extend the hips and knees and this posture requires "considerable muscular effort by the antigravity muscles to prevent collapse" when walking even at slow speeds (Waters, 1992, p. 487).

The traditional Thomas test requires subjects to lie supine on a table and to bring one leg toward their chest until the lower back is flat while the tested leg (i.e., the opposite leg) stays in contact with the table (0 degrees of hip flexion). As with the Apley test, however, a modified scoring system was developed for use with the BPFT modified version of the Thomas test. In this modification, youngsters are positioned on the table so that the greater trochanters are on a line 11" from the edge of the table. Youngsters who are able to successfully execute the Thomas in the traditional way score a "3" on the test. Other scores are derived by using simple trigonometry to calculate leg elevations for 15 and 30 degrees of hip flexion. Fifteen degrees of hip flexion results in approximately three inches of leg elevation measured 11" from the greater trochanter (i.e., at the edge of the table). Similarly, 30 degrees of hip flexion results in approximately six inches of leg elevation measured at the edge of the table.

The selection of 15 and 30 degrees of hip flexion as important points in the modified scoring system was linked to the notion that contractures could be described as mild, moderate, or severe. In the BPFT version of the Thomas test, a hip flexion contracture of 15 degrees or less is considered mild and scores a "2" on the test. Perry (1992) indicated that increased lumbar lordosis is the least stressful way of reducing hip flexion leverage and that a hip flexion contracture of 15 degrees is easily compensated by lumbar lordosis. Hip flexion contractures greater than 15 degrees are more serious especially when knee flexion of equal degree is used as compensation. "The biomechanical requirements of flexed-knee stance are greater than normal and are associated with increased quadriceps, tibio-femoral, and patello-femoral forces. The most significant increases occur at angles of knee flexion beyond 15 degrees" (Waters, 1992, p. 483). Hip flexion contractures ranging from 15 to 30 degrees are considered moderate in the modified Thomas test and score a "1". In the BPFT, contractures greater than 30 degrees are considered severe, a characterization consistent with the description used by the American Medical Association (1995). Severe contractures score a "0" on the modified Thomas (See Figure 5.2).

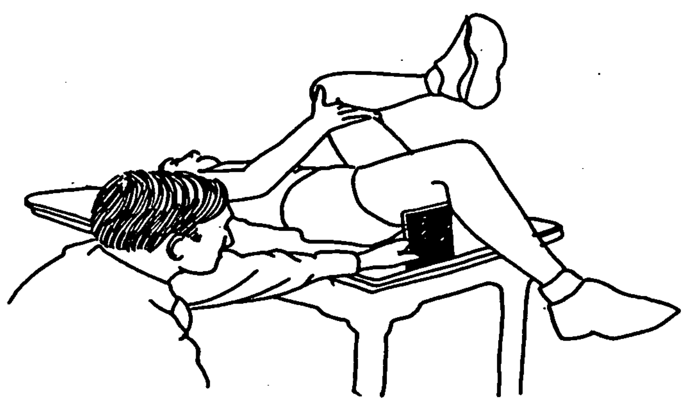


Figure 5.2 Measuring Leg Elevation on the Modified Thomas Test

Standards

General standards for the Thomas test are given in Table 5.2. As with the shoulder stretch and Apley tests, the general standard is the same regardless of age or gender, a "3". The ability to score a "3" on the modified Thomas is indicative of a hip flexor muscle that has "normal length" (Kendall, Kendall, and Wadsworth, 1971).

Specific standards (See Table 5.3) are provided for CP classes C5-C7 (affected limbs only). The C5 youngster has moderate to severe diplegia or hemiplegia (Peacock, 1988). Youngsters with spastic diplegia typically have a flexed hip and knee posture (Waters, 1992). The Project Target Advisory Committee (Advisory Committee, 1997) agreed that it was unrealistic to expect C5 youngsters to score a "3" on the modified Thomas test given the nature of the condition. Instead the Committee approved a score of "2" as the specific standard which represents a realistic goal of minimizing the effects of shortened hip flexor muscles among youngsters with spastic diplegia. Similarly, the C6 participant has "functional involvement" in all four limbs (Peacock, 1988) that may limit the potential for hip extension, hence a score of "2" is the recommended CR standard. Class C7 is appropriate for persons with hemiplegia (Peacock, 1988). Consequently it is anticipated that youngsters should be able to achieve the general standard "3" for the unaffected leg, but the specific standard "2" would be appropriate for the affected leg.

Attainability

A total of 23 ambulatory subjects with CP (aged 10-47) were tested on the modified Thomas test as part of Project Target. Each subject was tested on both legs bringing the total number of tests to 46. Subject performance was compared to established standards to determine success rates (a score of "2" for C5, C6, and the affected side for C7; a score of "3" for the unaffected side for C7 and C8). A total of 31 of the 46 (67%) tests had passing scores. Classes C6-C8 had passing rates ranging from 67-93%, but C5 had a passing rate of just 44% (8 of 18). It appears that the standards for C5 might be the most difficult to attain.

Target Stretch Test

The TST is an original test of range of motion associated with the BPFT. The intent of the test is to provide testers with easily administered alternatives when more traditional tests of flexibility/range of motion prove inappropriate for youngsters with physical disabilities. The TST provides subtests to measure wrist extension, elbow extension, shoulder extension, shoulder abduction, shoulder external rotation, forearm supination, forearm pronation, and knee extension. With the exception of forearm pronation which was included specifically for use with youngsters with SCI quadriplegia, the subtests of the TST were selected with CP youngsters in mind. As noted earlier, the flexors, adductors, and internal rotators tend to dominate especially when spasticity is prevalent. The TST subtests, therefore, were selected to address some of the stereotypical postural and movement patterns associated with spastic CP. In the BPFT, the TST is a recommended or optional test item for all CP classes and, under certain circumstances, for youngsters with SCI and CA/A.

The TST scoring system requires that testers estimate the extent of movement in a particular joint by superimposing a theoretical clock around the joint and using the tested limb to "read" the clock to the nearest half-hour. The estimated time on the clock is then translated to a test score ranging from 0-2 based upon visual criteria provided by a series of sketches (See Figure 5.3. Due to the subjective nature of the TST, some preliminary criterion-related validity work was conducted during Project Target. Twenty (20) TST subtests were administered to three subjects and videotaped from a tester's perspective. Three graduate students were given a five-minute training session on scoring the TST, were shown the videos of the 20 TST subtests, and scored them. The project coordinator served as a fourth tester. Criterion scores were established later by taking goniometry readings of the 20 joint actions from the videotape. TST scores ranging from 0-2 were given for each of the 20 subtests based on the obtained goniometry values. The scores assigned by the four testers were then compared to the criterion scores determined from goniometry (a total of 80 comparisons). The testers correctly scored the tests 85% of the time. Individual accuracy scores ranged from 75% to 95% among the four testers. When the goniometry determined values were rounded to the "nearest half-hour" (the protocol required of the tester on the TST), the testers' accuracy improved to 90%. Safrit (1990) indicated that validity coefficients determined in this manner should exceed 80%.

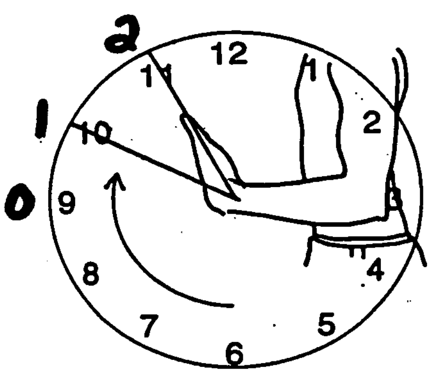


Figure 5.3 - Left Wrist Extension on the TST

<u>Standards</u>

The TST is the only test of flexibility or range of motion in the BPFT battery that has both minimal and preferred CR standards. Most youngsters, regardless of disability, are expected to meet at least the minimal general standards; no specific CR standards are associated with the test. (Due to the variable nature of range of motion for those with more severe forms of CP, however, testers are encouraged to develop individualized standards for youngsters in C1 and C2.) As shown in Table 5.2, the minimal and preferred general standards are constant for all gender and age combinations. For each subtest, a test score of "2" is meant to convey that the youngster is able to approximate optimal range of motion for a particular joint action. A score of "1" is indicative of a somewhat reduced, but nevertheless functional, range of motion.

The preferred standards approximate the optimal range of motion typically found in the human body for a particular joint. Values reported in the literature for "normal" ranges of motion in various joints vary somewhat from source to source. The preferred standards for the TST are based primarily on the "normal limits" reported by Cole (1990). In some cases, Cole's values were adjusted down "to the nearest half-hour" on the theoretical clock used in TST scoring in an effort to improve objectivity. In the case of shoulder external rotation, the preferred standards are based on values reported by the American Academy of Orthopaedic Surgeons (1965) since the TST protocol for this subtest differs from that used by Cole (1990). Table 5.4 provides goniometry values for the normal limits for each joint action as well as for preferred and minimal standards.

Table 5.4
Goniometry Values Associated with TST Scores

	Normal Limits[1]	Preferred/ Optimal	Minimal/ Functional
Wrist Extension	70^{0}	60^{0}	30^{0}
Elbow Extension	0^{0}	0^{0}	-15^{0}
Shoulder Extension	60^{0}	60^{0}	30^{0}
Shoulder Abduction	170^{0}	165^{0}	120^{0}
Shoulder External Rotation	$40\text{-}90^{0}$	75^{0}	30^{0}
Supination/Pronation	90^{0}	90^{0}	45^{0}
Knee Extension	0^{0}	0^{0}	-15^{0}

[1] Values come from Cole (1990) except for shoulder external rotation which came from the American Academy of Orthopedic Surgeons (1965).

While the preferred general standards approximate optimal range of motion, the minimal general standards purport to reflect functional range of motion. Surburg (1995) distinguished optimal and functional range of motion. He considered optimal to be full range of motion, but acknowledged that for some people with disabilities the pursuit of functional range of motion might be more appropriate. "The limits of the disabling condition and the ROM needed to permit adequate functioning, mobility, and independence define the functional range of motion" (Surburg, 1995, p.102). Other researchers (for example, Ryu, Cooney, Askew, An, and Chao, 1991; Vasen, Lacey, Keith, and Shaffer, 1995; Cunningham, Paterson, Himann, and Rechnitzer,

1993) have attempted to more precisely define functional range of motion by determining the ROM necessary to perform specific activities of daily living.

Since range of motion requirements will vary from task to task, the selection of a single CR standard to reflect functional ROM in a generic sense can provide only an estimate of the demands of function. Still, the establishment of functional ROM standards has merit in conveying the notion that some health-related benefits can be derived from the pursuit of greater range of motion even when the limits of range of motion are restricted by impairment. The minimal standards associated with each of the subtests of the TST were adopted by the Advisory Committee (1997) for use with the BPFT. These values have been used as "functional" standards in hospital settings in the state of Michigan for many years, lending some practical credence to their adoption. Unfortunately, there is little documentation on the derivation of these values and, instead, they seem to be part of an "oral tradition" among those who use them (K.J. Richter, personal communication, March 18, 1997). The Advisory Committee (1997) preferred the Michigan standards to other sets of values which were considered including versions related to the AMA's system for the evaluation of permanent impairment (American Medical Association, 1995).

Research that has attempted to establish functional ROM values for activities of daily living has identified values similar or identical to the TST minimal general CR standards. Ryu, et al (1991) found that the majority of their hand placement and range of motion tasks could be accomplished with 40 degrees of wrist extension. The TST minimal standard for wrist extension by comparison is 30 degrees. Cunningham, et al (1993) found that 120 degrees of shoulder abduction is an acceptable threshold for adequate function and were able to use this criterion to distinguish between independent and dependent elderly subjects. The TST functional standard for shoulder abduction also is 120 degrees. Functional ROM of the elbow joint was studied by Vasen, et al (1995). They concluded that all 12 ADLs investigated in their study could be accomplished with a 15 degree loss from optimal elbow extension. This is the same value used as a functional standard in the TST. Again, the required ROM will vary from task to task, but the fact that some of the functional ROM values found in the research literature are close to, or identical to, those adopted for use with the TST provides a modicum of support for these functional standards.

Attainability

The TST was field-tested and modified a number of times over the life of Project Target. Protocols and standards changed during the evolution of the test. When the final version of the TST, including standards, was adopted by the Advisory Committee (1997) consideration was given to data generated as the result of previous field-tests. In the most recent of the previous versions, the protocol was the same, but the minimal standards were different. Compared to the current minimal standards, the previous standards were more difficult for four of the eight subtests and the difference between the standards ranged from 8-18 degrees depending on the subtest. Using the previous version, 130 of the TST subtests were administered to subjects from CP classes C3-C8. Subjects met at least the minimal standard on 122 of the subtests for a 94% pass rate.

Limited attainability data exist for the current version of the test. Fifteen subjects with CP (C3 and higher) took a total of 45 of the various TST subtests. A score of "2", the preferred standard, was obtained on 32 (71%) of the subtests. The minimal standard, a score of "1", was given for 12 (27%) of the subtests. A total of 98% of the tests, therefore, were passed using the minimal CR standards.

Reliability

Although the Apley and Thomas tests have been used in clinical settings (Advisory Committee, 1995) and have been recommended for use in adapted physical education programs (Lasko-McCarthey and Knopf, 1992), and although the shoulder stretch is a recommended item in the FITNESSGRAM (Cooper Institute for Aerobics Research, 1992), a review of literature failed to uncover any research on the reliability of these items. No reliability data on the Apley and Thomas tests were collected as part of Project Target, in part because it proved difficult to identify a large enough sample of subjects with physical disabilities from a particular sub-classification to obtain any meaningful results. Shoulder stretch reliability was estimated during one Project Target study using youngsters with MR as subjects (n = 35). Depending on the side of the body tested, both alpha coefficients and P values ranged from .83-.94 where subjects were tested twice, 14 days apart.

Only one study was found that investigated the reliability of the BSSR. Patterson, Wiksten, Ray, Flanders, and Sanphy (1996) tested 84 boys and girls aged 11-15 and reported intraclass reliability coefficients of .99 for both genders using the mean of four trials as the criterion score. They also found R's ranging from .95-.97 when reliability was determined for a single reach (the fourth), as required in the BPFT protocol. Project Target staff tested 33 youngsters with MR on the BSSR on two occasions spaced 14 days apart. Depending on the leg tested, alpha coefficients ranged from .95-.96 and proportions of agreement (P) ranged from .89-.92.

The reliability of other forms of the sit and reach test is fairly well-established. Plowman and Corbin (1994) summarized some of the reliability research conducted on two versions of the sit and reach with nondisabled subjects and concluded that scores obtained by subjects on these tests are highly consistent. Both interclass and intraclass reliability coefficients typically associated with versions of the sit and reach test are very high (often above .95). The reliability of the sit and reach and related tests also has been investigated using subjects with disabilities. Results of these investigations are summarized in Table 5.5. As with those studies conducted with nondisabled subjects, the reliability coefficients for tests related to the BSSR conducted with subjects with disabilities tend to be high.

Table 5.5
Reliability of Sit and Reach and Related Field Tests

Author	Subjects	N	Age	Field Test	Reliability Coefficient
Johnson & Londeree (1976)	mod. MR	1105	6-21	bob & reach	r = .80-.99
Daquila (1982)	visually imp.	50	10-17	sit & reach	a = .98
	auditory imp.	50	10-17	sit & reach	a = .99
	ortho. imp.	50	10-17	sit & reach	a = .80
Reid, Montgomery, & Seidl (1985)	trainable/ educable MR	20	20-39	trunk forward flexion	R = .94
Pizzaro (1980)	educable MR	44	12-15	sit & reach	R = .90
	trainable MR	37	12-15	sit & reach	R = .97

r = interclass coefficient; a = alpha coefficient; R = intraclass coefficient

Data supporting the reliability of the Target Stretch Test also is yet to be collected. Some preliminary work on objectivity, however, was conducted as part of Project Target. While working from an earlier version of the TST, two testers independently scored 175 of the various TST subtests taken by 38 subjects with CP. The alpha coefficient calculated for the combined 175 paired observations was .92 which represents an acceptable level of inter-rater reliability (Safrit, 1990). Although the scoring of the TST has been modified from this earlier version and additional objectivity work is required, the results of this preliminary study suggest the probability that testers can score performance on a fairly consistent basis using the criteria associated with the TST protocol.

Discussion

As described in the BPFT test manual, and as implied in this paper, the development of domain-referenced validity for the test items and CR standards is based on a five-step "personalized approach" to fitness testing. The approach is considered personalized because testers have the latitude to modify the selection of items and standards as necessary to better meet the needs of a particular youngster. The items and standards recommended in the BPFT, however, are believed to be appropriate for most youngsters with a specific disability. The first step in the personalized approach is to identify the health-related physical fitness needs of a youngster or a group of youngsters with a specific disability. For the recommended BPFT items and standards the health-related needs were identified as a result of a review of the literature and discussions with experts in the field.

Step 2 is to develop a desired profile. In essence the profile sets forth the health-related fitness goals for the youngster (or youngsters) which reflect the health-related needs and consider the nature of the disability. (No profiles have been included in this chapter, but readers can find recommended profiles for each of the disability groups in the BPFT test manual.) Next, components (e.g., musculoskeletal functioning) and subcomponents (e.g., flexibility, range of motion) of health-related fitness are selected in accord with the profile. In the BPFT it is recommended that measures of flexibility be included in the fitness testing of all youngsters although measures of range of motion are included for those whose flexibility is more seriously restricted by impairment.

The fourth step is to select test items from the components and subcomponents of fitness which pertain to the health-related needs. The rationales for the selection of all recommended flexibility and range of motion test items were described earlier in this paper and attempt to reflect some health-related fitness need for a specific disability group (or groups). Finally, CR standards are selected to operationalize the desired profile; that is, the standards attempt to identify test scores which reflect levels of fitness believed to be sufficient to attain the goals cited in the profile. Since specific test scores on any measure of flexibility or range of motion have yet to be linked to specific health-related concerns for either disabled or nondisabled individuals, the CR standards provided by the BPFT were derived primarily from expert opinion.

A future goal in the on-going validation of the battery is to determine decision validity (Safrit, 1990). Decision validity refers to the accuracy of classification into some health-related category provided by the CR standard (e.g., healthy vs diseased, high risk vs low risk, independent vs dependent, etc.). It should be noted that as with the youngsters with disabilities included in the BPFT, decision validity has yet to be determined for nondisabled youngsters on measures of flexibility. Standards for the BSSR and shoulder stretch tests included in the FITNESSGRAM battery were determined through expert opinion and have not yet been statistically related to health status. Some preliminary work attempting to determine decision validity on the TST, Apley, and Thomas tests was conducted as part of Project Target, but these efforts did not link specific test scores to the ability to independently perform certain ADLs. Additional work is required.

The attainability data reported here are encouraging. The passing rates for youngsters with disabilities generally ranged between 35-70% for most items recommended for specific groups (and higher for the TST). These passing rates seem to suggest that the standards will be within reach for many youngsters with the disabilities covered by the BPFT (although some training may be necessary). Practitioners, in fact, may experience higher passing rates among youngsters with CP than reported in this manuscript for the Apley and the TST. Although these tests are designed to be administered to limbs on both sides of the body, youngsters with CP need to attain the CR standard only on one side of the body in order to "pass" the test. The attainability data reported in this chapter considered tests administered to both sides of the body for all groups (including those with CP). The fact that the standards appear attainable by many youngsters from a particular category provides an indication that the protocols associated with the tests also are appropriate.

Reliability data currently available for the flexibility and range of motion tests is insufficient. In addition to the need to conduct more test-retest studies on each of these items it also is necessary to determine the consistency of classification (i.e., fit vs unfit) provided by the standards (Safrit, 1990). Do subjects who pass the test on day 1 also pass it on day 2?

The validation of the flexibility and range of motion tests associated with the BPFT is a significant and on-going endeavor. The area of criterion-referenced health-related physical fitness is fertile ground for research by interested professionals and graduate students. Based on the information presented in this paper the following suggestions are made for future research:

- determine the degree of statistical relationships between measures of flexibility and range of motion and indices of physiological and functional health

- determine the decision validity of the CR standards for all items and for all disability groups;

- correlate TST scores with goniometry values to determine criterion-related validity;

- use goniometry values to determine if scores obtained on the Thomas test accurately reflect the degree of contracture implied in the scoring system (is accuracy a function of body composition or type?);

- determine or confirm the attainability of the Apley standards for youngsters in CP classes C1 and C2L;

- confirm the attainability of the Thomas test for youngsters with CP, especially those in class C5;

- confirm the attainability of both the minimal (functional) and preferred (optimal) standards of the TST for youngsters with CP;

- determine or confirm the consistency of classification for all test items and all disability groups;

- confirm the objectivity of the TST.

Although some significant work remains to be done on the validation of the BPFT, currently available information on the flexibility and range of motion items suggests that these tests and their standards are sufficiently valid and reliable for use with youngsters with selected disabilities. Future research may result in alterations to some of the items or standards, but this is considered a natural part of the evolution of the test.

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EFF-089 (9/97)