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Test Item Selection for the Project UNIQUE Physical Fitness Test

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RESEARCH

Test Item Selection For The Project UNIQUE Physical Fitness Test

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In order to enhance the physical fitness development of individuals with selected handicapping conditions. Winnick and Short (1984b) published a manual which presented the Project UNIQUE Physical Fitness Test and training program. This article presents criteria and supporting technical information pertaining to the selection of test items.

The development of physical fitness is an important objective for individuals with handicapping conditions, and this development may be enhanced if a norm-referenced test is available to help determine unique needs, plan and implement programs, and evaluate physical fitness. The Project UNIQUE Physical Fitness Test (UNIQUE Test) and training program was developed and published in response to this need (Winnick & Short, 1984b). The book was designed primarily for day-to-day use by practitioners, and therefore technical information about test construction was not presented in detail. This article presents criteria and supporting technical information pertaining to the selection of test items in the UNIQUE Test.

Method

Subjects

The UNIQUE Test was established after testing 1,192 normal, 1,468 auditory impaired, 649 visually impaired, and 605 orthopedically impaired males and females ages 10-17. The test may be used with nonhandicapped youngsters as well as for youngsters with visual impairments (VI), auditory impairments (AI), spinal neuromuscular conditions (SN), anomalies/amputations (A/A), or cerebral palsy (CP). Subjects were from schools, agencies, or institutions in 23 states and the District of Columbia.

The Original Battery

The UNIQUE Test was developed as part of Project UNIQUE, a study designed to in-

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vestigate the physical fitness of sensory and orthopedically impaired children and youth (Winnick & Short, 1982). An original battery of 18 field-based items was administered to subjects by competency-trained testers. Items in the test battery were considered to represent a wide range of physical fitness abilities on the basis of logic and validity support in the physical education literature. The original battery, categorized by hypothesized factor structure, included body composition: triceps, abdominal, and subscapular skinfolds; muscular strength/endurance: sit-ups, timed leg raise, timed trunk raise, right hand grip strength, left hand grip strength, flexed arm hang, pull-ups, standing broad jump, and softball throw (distance and velocity); speed: 50-yard dash; agility: rise-to-stand, mat creep, and shuttle run; flexibility: sit-and-reach; and cardiorespiratory endurance: long-distance run (9 minutes or 1 mile for 10- 12-year-olds; 12 minutes or 1.5 miles for 13- 17-year-olds). Specific test procedures and modifications have been described previously (Winnick & Short, 1982, 1984a).

Criteria and Technical Information for Test Item Selection

The final list of test items included in the UNIQUE Test were selected on the basis of both primary and secondary criteria. Primary criteria included a preference for the selection of items which were also included in the AAHPER Youth Fitness Test and the AAHPERD Health Related Test, were appropriate for different classes of individuals, were reliable, were considered valid measurements of physical fitness, and exhibited low intercorrelations. Secondary criteria included a preference for the selection of items which were reasonably familiar to physical educators, were economical, required no elaborate equipment, and could be administered in a reasonable amount of time.

Following the careful consideration of all criteria, a 4- to 6-item battery emerged for each subject group. Table 1 lists the selected items within the components of physical fitness they measure. Items which were selected for each subject group are indicated by an X in the appropriate column of Table 1. It must be emphasized, however, that subject groups are subclassified and specific test items may be modified or eliminated for a specific subclassification. The extent to which each of these items met the primary criteria for selection is the focus of this article.

Items in Related Tests. The first primary criterion was to give preference to items that were included in the AAHPER Youth Fitness Test or the AAHPERD Health Related Fitness Test. This criterion was applied so that comparisons between persons with and without handicapping conditions would be enhanced. In a sense, this resulted in "mainstreaming" test items so that children with handicapping conditions could take the same items as their nonhandicapped peers (although test procedures might be modified and score comparisons might be made with different norms). Thus, participants with handicapping conditions would not have to be separated out of a testing situation or have special test items created for them. Of those items listed in Table 1, five of the recommended items appeared as part of either the Youth Fitness or Health Related tests. Included among the five are the skinfold measures (triceps and subscapular), dash, sit-ups, sit-and-reach, and long-distance run. In addition, two of the substitute items, standing broad jump and flexed arm hang, appeared in the Youth Fitness Test.

Different Classes of Persons. The second primary criterion for the selection of test items was the extent to which test items could be used for different classes of persons. In selecting test items, preference was given to those items that could be administered to both males and females with and without handicapping conditions between the ages

Table 1

Project UNIQUE Physical Fitness Test Items According to Major Participant Groups

Test items	Normal, Auditory impaired, Visually impaired[a]	Cerebral Palsy[a]	Wheelchair Paraplegic Spinal neuro-muscular[a]	Congenital anomaly/ amputee[a]
Body composition				
skinfolds	X	X	X	X
Muscular strength/endurance				
grip strength (strength)	X[b]	X[c,f]	X[g,h]	X[b,j]
50-yard dash (power-speed)	X	X[d]	X[d]	X
sit-ups (power-strength)	X	—	—	X[i]
softball throw for distance (power strength)	—	X[e]	—	—
Flexibility				
sit-and-reach	X	X	—	X
Cardiorespiratory endurance				
long-distance run	X	X	X	X

[a]Items may require modification or elimination for selected group subclassifications.
[b]The broad jump may be substituted for grip strength tests as a measure of strength for these groups.
[c]Grip strengths measure power-strength for males with cerebral palsy.
[d]The dash measures power-endurance for individuals in this group.
[e]The softball throw is recommended for females only as a measure of power-strength.
[f]The arm hang may be substituted for grip strength tests for males.
[g]The arm hang or softball throw for distance may be substituted for grip strength measures (strength factor) for males.
[h]The softball throw may be substituted for grip strength measures (strength factor) for female participants.
[i]The softball throw for distance may be substituted for sit-ups (as a power-strength factor) when the sit-up would be considered inappropriate.
[j]Males may substitute the arm hang for grip tests (strength factor).

of 10 and 17. It must be emphasized, however, that no one item could be administered without modification to every group or subclassification of persons. In certain cases items need to be modified for individuals with handicapping conditions, and in other cases, items must be eliminated.

Reliability. The third primary criterion was test reliability. Only items with acceptable reliability were selected for the UNIQUE Test. Data on the reliability of each of the recommended and substitute items listed in Table 1 were found in previous research. In regard to skinfold measures, reliability coefficients tend to be high, exceeding .90 (Col-

Table 2

Means, Standard Errors of Measurement, and Alpha Coefficients of Project UNIQUE Reliability Samples

Test items	No. of trials	Normal				Visual				Auditory				Orthopedic			
		N	*M*	SEM	α	N	*M*	SEM	α	N	*M*	SEM	α	N	*M*	SEM	α
Triceps skinfold (mm)	3	50	12.72	.33	.99	50	13.75	1.04	.97	50	12.49	.78	.98	50	12.70	.85	.97
Subscapular skinfold (mm)	3	50	10.29	.36	.99	50	13.84	.60	.99	50	10.45	.44	.99	50	10.64	.35	.99
Sit-and-reach (cm)	2	50	29.19	.95	.99	50	23.22	1.15	.98	50	22.95	.94	.99	38	20.93	.97	.99
Right grip (kg)	3	50	24.01	1.08	.98	50	23.58	1.14	.99	50	23.42	1.36	.97	50	14.15	1.33	.98
Left grip (kg)	3	50	23.37	1.04	.98	50	21.17	1.69	.97	50	21.01	1.21	.98	50	14.86	1.00	.99
Arm hang (sec)	2	50	8.35	2.88	.93	50	11.48	4.85	.84	50	9.17	3.11	.92	50	2.50	1.08	.96
Broad jump (ft)	3	50	5.27	.18	.96	50	4.96	.29	.94	50	5.08	.16	.98	21	2.04	.16	.99
Softball distance (ft)	3	50	92.39	7.62	.95	50	70.71	4.35	.99	50	84.73	4.11	.99	50	28.91	4.51	.86

N = Number of subjects in analysis; *M* = Mean Score; SEM = Standard Error of Measurement; α = alpha coefficient;
Adapted from Daquila (1982) and used with permission.

Table 3
Means and Alpha Coefficients of Grip Strength Tests With Significant Trend Categorized by Measurement Schedule

Subjects	Trials 1-3		Trials 1-2	
	M	α	*M*	α
Right Grip				
Nonimpaired	24.01	.98	24.28	.96
Auditory impaired	23.42	.97	23.85	.95
Left Grip				
Nonimpaired	22.36	.98	22.76	.98
Auditory impaired	21.01	.98	21.25	.98
Orthopedically impaired	14.86	.99	15.29	.99

Table 4
Factor Structure for Normal Females (N = 336)

Factors	Orthogonal solutions			Oblique solutions		
	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Abdominal skinfold	.89	.88	.89	.91	.90	.92
Triceps skinfold	.89	.88	.89	.88	.87	.89
Subscapular skinfold	.84	.86	.82	.86	.89	.86
Factor 2						
Shuttle run	.74	.76	.40	.76	.78	.56
50-yard dash	.66	.71	—	.72	.75	.48
Broad jump	.59	.61	—	.69	.71	.47
Sit-ups	.59	.56	—	.66	.65	.51
Long-distance run (yds per min)	.49	.44	—	.55	.52	.51
Mat creep	.48	.48	—	.56	.57	.43
Factor 3						
Right grip	.95	.91	.89	.97	.93	.88
Left grip	.85	.89	.81	.88	.92	.82
Softball distance	—	—	.42	.41	.43	.46
Mat creep	—	—	.45	.41	.43	.50
Factor 4						
Arm hang	.67	.63	.71	.74	.71	.74
Pull-ups	.56	.59	.46	.59	.61	.48
Sit-ups	—	—	.54	.50	.51	.63
Broad jump	—	—	.51	.46	.45	.61

Table 5

Factor Structure for Normal Males (N = 209)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Abdominal skinfold	.90	.87	.93	.92	.89	.93
Subscapular skinfold	.83	.85	.83	.88	.89	.86
Triceps skinfold	.81	.83	.79	.84	.86	.81
Arm hang	—	—	−.47	−.49	−.45	−.56
Factor 2						
50-yard dash	.83	.80	.85	.87	.86	.89
Shuttle run	.76	.77	.75	.81	.82	.80
Mat creep	.70	.70	.69	.72	.73	.71
Sit-ups	.56	.56	.56	.65	.65	.64
Softball distance	.51	.52	.53	.54	.54	.55
Broad jump	.51	.50	.50	.57	.57	.57
Factor 3						
Left grip	.97	.91	1.00	1.00	.95	1.02
Right grip	.86	.90	.79	.90	.94	.83
Factor 4						
Sit-ups	.60	.48	—	.45	.46	—
Arm hang	.59	.73	.43	.68	.81	.54
Pull-ups	.41	.54	—	.51	.64	—

gan, 1978; Pollock, Laughridge, Coleman, Linnerud, & Jackson, 1975; Pollock, Hickman, Kendrick, Jackson, Linnerud, & Dawson, 1976), with small (less than 2 mm.) measurement errors among trained testers and high (.97) intratester reliability and intertester objectivity (AAHPERD, 1984). Lohman, Wilmore, Friestad, and Slaughter (1983) reported mean differences of 1 to 3 mm. between recently trained educators and an experienced tester.

Reliability coefficients in the .80s and .90s for grip strength have been reported in the literature (Avent, 1963; Fleishman, 1964a; Keogh, 1965; Rarick, Dobbins, & Broadhead, 1976). Jackson and Baumgartner (1969) reported an intraclass reliability coefficient of .95 for the 50-yard dash. Colgan (1978) and Klesius (1968) reported reliability coefficients in the .80s and .90s for the same item. Reliability coefficients ranging from .89 to .99 for sit-ups were reported by Vodola (1978) for the various groups he studied. AAHPERD (1984) concluded that the reliability of the sit-up test has been satisfactory with coefficients generally ranging from .68 to .94. Klesius (1968) reported some of the lowest reliability coefficients in the literature (.55 to .68) for sit-ups.

The softball throw for distance has been found to have good reliability with coefficients in the .80s and .90s reported (Bolonchuk, 1971; Fleishman, 1964a; Keogh, 1965; Klesius, 1968). Except in one study, which reported a test-retest reliability coefficient of .70 using first-grade pupils as subjects, high (range of .84 to .98) reliability coeffi-

Table 6

Factor Structure for Auditory Impaired Females (N = 385)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Abdominal skinfold	.87	.87	.87	.88	.88	.88
Subscapular skinfold	.85	.85	.85	.87	.88	.87
Triceps skinfold	.81	.81	.81	.81	.81	.82
Factor 2						
Shuttle run	.82	.82	.82	.85	.85	.85
Mat creep	.77	.77	.77	.82	.83	.82
50-yard dash	.69	.68	.70	.78	.78	.79
Factor 3						
Right grip	.94	.94	.90	.95	.95	.91
Left grip	.91	.93	.87	.92	.95	.89
Softball distance	.55	.51	.59	.58	.55	.61
Broad jump	.45	.41	.49	.51	.48	.55
Factor 4						
Sit-and-reach	.54	.55	.51	.57	.58	.55
Sit-ups	.54	.55	.52	.66	.67	.65
Leg raise	.47	.44	.49	.52	.49	.55
Trunk raise	.46	.42	.48	.48	.45	.50
Broad jump	.42	.46	—	.55	.58	.51
Factor 5						
Arm hang	.79	.78	.79	.83	.83	.83
Pull-ups	.58	.59	.57	.60	.61	.59
Long-distance run (yds per min)	.46	.45	.47	.53	.53	.53

cients have been reported in the literature for the sit-and-reach test (AAHPERD, 1984). Based on the research of Colgan (1978), Vodola (1978), Doolittle and Bigbee (1968), and Doolittle, Dominic, and Doolittle (1969), the reliability of the long-distance run is high (.80 to .96). The standing broad jump has been studied by several investigators, who have reported very acceptable reliability coefficients (.83 to .99) (Bolonchuk, 1971; Keogh, 1965; Klesius, 1968; Marmis, Montoye, Cunningham, & Rozar, 1969). Finally, the reliability of the flexed arm hang has been found acceptable with reported coefficients of .87 and higher (Avent, 1963; Bolonchuk, 1971; Colgan, 1978; Vodola, 1978).

Considerable analysis pertaining to the reliability of the UNIQUE Test was conducted by Daquila (1982), who investigated the test reliability of skinfold measures, sit-and-reach, grip strength, flexed arm hang, standing broad jump, and softball throw using multiple trial data collected as a part of Project UNIQUE. To analyze these multiple trial items (all trials were administered on the same day), Daquila randomly selected 50 sub-

Table 7

Factor Structure for Auditory Impaired Males (N = 491)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Abdominal skinfold	.90	.90	.87	.92	.92	.89
Subscapular skinfold	.85	.86	.82	.88	.89	.85
Triceps skinfold	.84	.83	.85	.84	.83	.84
Factor 2						
Shuttle run	.85	.85	.84	.88	.88	.88
Mat creep	.79	.80	.79	.81	.82	.81
50-yard dash	.79	.79	.80	.84	.83	.85
Factor 3						
Right grip	.93	.91	.86	.94	.93	.88
Left grip	.85	.90	.77	.86	.91	.80
Softball distance	.43	—	.50	.49	.45	.54
Broad jump	.42	—	.49	.51	.47	.55
Factor 4						
Trunk raise	.61	.63	.54	.61	.63	.54
Sit-ups	.49	.45	.54	.57	.55	.62
Leg raise	.43	—	.48	.49	.47	.53
Factor 5						
Pull-ups	.73	.74	.59	.77	.76	.66
Arm hang	.59	.62	.57	.67	.68	.66

jects from the total Project UNIQUE data pool of each of the subject categories (normal, auditory impaired, visually impaired, and orthopedically impaired). Daquila computed repeated measures analysis of variance (for analysis of trend among trials), Cronbach's alpha coefficient (for reliability), and the standard error of measurement (for variability) for each item in each subject group. In some instances, especially in the orthopedic group, it was necessary to compute these analyses with a sample size of less than 50. The results of these analyses are presented in Table 2.

Table 2 presents data pertaining to the number of trials associated with each item analyzed, the number of subjects in the sample, the mean, the standard error of measurement, and Cronbach's alpha coefficient for each item in each subject group. Generally the alpha coefficients are high. The majority of the alphas are above .90 and none are lower than .84.

It should be noted that use of the Cronbach alpha is most appropriate when the data are trend free, that is, when performance does not differ significantly from trial to trial. To a large extent the data were trend free; but a significant trend emerged for sit-and-reach (all groups), standing broad jump (visually impaired group), right and left grip strength (normal and auditory impaired groups), and left grip strength (orthopedically im-

Table 8

Factor Structure for Visually Impaired Females (N = 167)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Abdominal skinfold	.88	.88	.87	.89	.89	.88
Subscapular skinfold	.87	.88	.87	.89	.89	.89
Triceps skinfold	.86	.86	.86	.86	.87	.86
Factor 2						
50-yard dash	.77	.77	.75	.80	.81	.79
Broad jump	.72	.72	.70	.78	.78	.76
Softball distance	.60	.64	.56	.62	.65	.58
Mat creep	.58	.60	.56	.63	.65	.61
Long-distance run (yds per min)	.53	.50	.55	.56	.53	.57
Shuttle run	.52	.50	.54	.51	.49	.53
Sit-ups	.47	.45	.47	.51	.50	.50
Factor 3						
Right grip	.90	.87	.84	.96	.93	.90
Left grip	.84	.86	.85	.91	.93	.92
Factor 4						
Leg raise	.69	.62	.70	.70	.63	.72
Trunk raise	.61	.65	.64	.63	.66	.66
Sit-and-reach	.46	.42	.46	.50	.46	.50
Factor 5						
Pull-ups	.80	.79	.74	.82	.81	.76
Arm hang	—	.40	.43	.50	.51	.53

paired group). Subjects' performance improved on consecutive trials for the sit-and-reach and the standing broad jump (visually impaired subjects only). Effects of learning and/or warm-up may have influenced performance on these items. Since only a limited number of trials were used in the present study, additional research is necessary to determine a trend-free measurement schedule for these items. In those instances in which grip strength evidenced a significant trend, performance generally declined on the third trial. Fatigue was apparently a factor during grip strength in most but not all subject categories. A second set of means and alphas was calculated using trials 1 and 2 only; trial 3 was eliminated because it differed significantly from the other two trials in each instance. Table 3 contrasts the means and alpha coefficients for the two-trial schedule with the means and alpha coefficients for the three-trial schedule originally employed.

The data presented in Table 3 demonstrate that modifying the measurement schedule does not appreciably affect the reliability of the test. The grip strength test can be considered very reliable for each subject category regardless of the measurement schedule

Table 9

Factor Structure for Visually Impaired Males (N = 244)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Abdominal skinfold	.95	.93	.93	.96	.95	.93
Subscapular skinfold	.89	.91	.87	.90	.92	.88
Triceps skinfold	.84	.84	.85	.87	.87	.86
Factor 2						
50-yard dash	.71	.69	.74	.75	.73	.77
Broad jump	.69	.70	.69	.80	.81	.81
Softball distance	.63	.65	.61	.67	.69	.66
Mat creep	.62	.64	.59	.67	.68	.65
Long-distance run (yds per min)	.53	.53	.54	.66	.65	.65
Shuttle run	.46	.45	.46	.46	.45	.46
Factor 3						
Left grip	.91	.88	.84	.97	.94	.89
Right grip	.84	.88	.79	.90	.94	.85
Factor 4						
Pull-ups	.64	.73	.44	.70	.78	.54
Arm hang	.56	.65	.43	.62	.70	.51
Sit-ups	.54	.47	.45	.62	.59	.56
Long-distance run (yds per min)	.52	.46	.41	.64	.61	.55
Leg raise	.47	—	.55	.47	—	.55

employed. The UNIQUE Test employs a three-trial schedule so that test procedures are consistent for all subject classifications.

Validity. The fourth primary criterion in the selection of the items was validity. The justification of test items for the UNIQUE Test was determined on the basis of construct, criterion, and logical validity. Construct validity was primarily established as a part of Project UNIQUE and consisted of a factor analysis of the original battery of test items in consideration of the various groups involved in the project. The results of this study are presented first in this subsection. Criterion related validity, logical validity, and additional construct validity were determined on the basis of related literature and research and are discussed in the second portion of this subsection.

Of the original 18-item battery, only items that were reliable and appropriate for specific subject groups were factor analyzed. Rise-to-stand was eliminated due to questionable reliability. The total number of items factor analyzed for normal, AI, and VI subjects, therefore, was 17. Trunk raise, sit-and-reach, and standing broad jump were inappropriate for many CP and SN subjects and were eliminated from their factor analyses. Similarly, sit-ups, leg raise, and mat creep were also eliminated for SN subjects. Therefore,

Table 10

Factor Structure for Cerebral Palsied Females (N = 42)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Triceps skinfold	.94	.94	.93	.92	.92	.91
Abdominal skinfold	.92	.93	.91	.92	.93	.91
Subscapular skinfold	.88	.87	.90	.89	.88	.90
Mat creep	−.54	−.52	−.54	−.59	−.57	−.58
Shuttle run	−.40	—	−.44	−.49	−.48	−.52
Factor 2						
Long-distance run (yds per min)	.72	.74	.76	.73	.77	.76
50-yard dash	.68	.64	.70	.68	.62	.70
Shuttle run	.63	.56	.63	.68	.60	.69
Sit-ups	.56	.61	.53	.57	.63	.55
Factor 3						
Right grip	.82	.78	.93	.84	.79	.95
Left grip	.74	.77	.66	.72	.79	.67
Factor 4						
Pull-ups	.75	.61	.77	.74	.61	.76
Softball distance	.69	.80	.66	.73	.84	.70
Arm hang	.49	—	.51	.55	.47	.57

14 items were factor analyzed for CP subjects and 11 for SN subjects. Items for A/A subjects were not factor analyzed due to insufficient subject numbers. With the exception of the SN group in which subject numbers were relatively low, test items were analyzed separately for males and females. Only data from subjects who completed all items appropriate for them were entered into the analyses.

For the purposes of Project UNIQUE, a variable from the total battery was considered to belong to a factor if it had a factor loading of .40 or greater on four of six derived solutions. The six derived solutions were obtained from three types of factor analysis: incomplete principal components analysis (Harmon, 1967), canonical component analysis (Rao, 1955), and alpha factor analysis (Kaiser & Caffrey, 1965), and two types of rotation: orthogonal and oblique.

Factor structures were derived from both raw score correlation coefficient matrices and partial correlation coefficient matrices (age controlled). All factor structures were considered in the selection of test items, but because of limited space only the age-controlled factor structures are presented here. In general, the age-controlled factor structures tended to be more resolute than the raw score structures. The age-controlled factor structures are presented in Tables 4 through 12.

Any comparison of the factor structures across subject groups must be done cautiously, especially with the CP and SN groups, since those structures were derived from

Table 11

Factor Structure for Cerebral Palsied Males (N = 55)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Triceps skinfold	.96	.94	.93	.96	.94	.94
Abdominal skinfold	.87	.88	.86	.88	.90	.87
Subscapular skinfold	.84	.84	.84	.84	.84	.83
Factor 2						
50-yard dash	.90	.90	.90	.91	.91	.90
Shuttle run	.82	.84	.83	.83	.84	.83
Long-distance run (yds per min)	.79	.76	.83	.80	.77	.83
Softball distance	.67	.68	.65	.67	.68	.65
Mat creep	.58	.58	.58	.60	.60	.60
Sit-ups	.57	.57	.56	.56	.56	.55
Factor 3						
Pull-ups	.87	.85	.83	.88	.85	.84
Arm hang	.77	.82	.69	.78	.83	.70
Left grip	.49	.46	.58	.49	.46	.58
Factor 4						
Leg raise	.73	.71	.76	.74	.72	.77

a somewhat different battery of tests. Within this limitation, however, there appeared to be some commonalities among the factor structures. For instance, without exception factor 1 consisted primarily of the skinfold measures; it was considered to be a body composition component for each subject group. Factor 2, although somewhat different for each group, seemed to be best defined by measures of power. The predominance of the 50-yard dash and shuttle run in factor 2 suggested a power-speed label for normal, AI, and VI subjects and a power-endurance label for CP and SN subjects.[1] Factor 3 was always

[1]To help explain factors pertaining to strength, power, and endurance, the time-duration classification schema presented by Edington and Edgerton (1976) was consulted and modified. In essence, test items characterized by maximum or near maximum effort of an activity and/or which were performed in 1 second or less were labeled as strength. Factors in which average performance lasted from 1 second to 2 minutes were labeled as power. The emergence of three power items in Project UNIQUE data necessitated a further distinction. A power-speed label was applied to factors characterized by the predominance of movement for the purpose of speed and moderate load involvement. A power-strength label was applied to a power factor in which the continued exertion of a relatively high load predominated. These power items were performed within a 30-second interval or represent items within the factor structures which require near maximum contraction. A power-endurance label was applied to power factors performed within a 30-second to 2-minute interval. These items were characterized by lighter load. Since this model did not exclusively categorize items, factors were designated in terms of the closest or most logical factor when there was an overlapping time duration.

Table 12

Factor Structure for Subjects With Spinal-Neuromuscular Conditions (N = 61)

Factors	Orthogonal solutions PC	RAO	Alpha	Oblique solutions PC	RAO	Alpha
Factor 1						
Subscapular skinfold	.89	.88	.90	.89	.88	.90
Triceps skinfold	.80	.83	.79	.80	.83	.79
Abdominal skinfold	.76	.75	.76	.75	.75	.75
Factor 2						
Shuttle run	.83	.83	.84	.88	.88	.87
50-yard dash	.83	.82	.81	.82	.83	.80
Long-distance run (yds per min)	.65	.64	.67	.71	.70	.72
Factor 3						
Right grip	.83	.90	.75	.87	.93	.81
Left grip	.79	.88	.72	.84	.91	.78
Arm hang	.65	.53	.71	.66	.55	.72
Softball distance	.63	.61	.60	.68	.66	.66
Pull-ups	.53	.43	.57	.53	.43	.57

defined by at least one of the grip strength measures, and occasionally by other items requiring a brief but all-out muscular effort such as the standing broad jump. Although not quite as resolute for the CP and SN groups, factor 3 was considered either a strength or power-strength component for all groups. Wherever they emerged, factors 4 and 5 did not appear to be as clearly defined as the first three. Generally speaking, however, the items associated with these factors (most notably sit-ups, pull-ups, and flexed arm hang) required repetitive muscular contractions against a submaximal resistance. Factors 4 and 5 were considered to represent power-strength or power-endurance components.[2]

Although test items were selected to measure flexibility (sit-and-reach) and cardiorespiratory endurance (long-distance run), the factor analysis did not identify these components as separate factors. This was attributed at least partially to the fact that only one test item was originally selected to define each of these hypothesized factors. The fact that flexibility and cardiorespiratory endurance did not clearly emerge, therefore, was evidently due to the absence of other items which may have helped to better define these constructs. The items that comprise flexibility and cardiorespiratory endurance did load to some extent on other factors. The sit-and-reach test emerged for normal, AI, and VI

[2]For a more detailed discussion of the factor analytic procedures, consult Winnick and Short (1982) or contact the authors.

females on factors that included the trunk raise and leg raise. The long-distance run item loaded either on the power-speed or power-strength factors. In addition to the cardiorespiratory demands of the test, the long-distance run makes demands on the muscular system as well. This apparently is why the long-distance run loaded on power-related factors, particularly in the absence of other cardiorespiratory items in the design.

Given the lack of related test items, therefore, the existence of flexibility and cardiorespiratory components could neither be conclusively confirmed nor rejected by the factor analysis conducted in Project UNIQUE. Instead, each was selected and justified on the basis of related literature and logical considerations. Flexibility and cardiorespiratory endurance are generally included in definitions of physical fitness. Support for the inclusion of the sit-and-reach test as a measure of flexibility, and long-distance run as a measure of cardiorespiratory endurance, is provided by AAHPERD (1984).

Other test items supported in the literature include the grip strength (Fleishman, 1964a, 1964b; Rarick, Dobbins, & Broadhead, 1976); sit-up (Flint, 1965); standing broad jump (Safrit, 1981); and skinfolds (AAHPERD, 1984). The 50-yard dash has often been selected as a speed item in notable tests of physical fitness. In regard to the flexed arm hang, Cotton and Marwitz (1969) found a correlation coefficient of .72 between the flexed arm hang and the pull-up test. Disadvantages of the flexed arm hang are that it is affected by one's weight, it yields extremely low scores for females, and it is inappropriate in cases of upper arm impairment. For these reasons, it is only suggested as a substitute item for certain subject groups.

In regard to the softball throw for distance, the literature is less supportive. Rarick, Dobbins, and Broadhead (1976) found that softball velocity was correlated moderately with the standing broad jump (.54 to .71) and the vertical jump (.51 to .62). Rarick, Dobbins, and Broadhead (1976) also indicated that the time dimension more accurately reflected the actual force applied to the ball than using distance information only. In collecting Project UNIQUE data, however, it was extremely difficult to measure the time of the throw and to determine the height of release which are necessary for calculating velocity. In addition, computation of velocity in a field setting is much more laborious than simply recording distance. Since a reasonably high correlation was found between softball throw for distance and softball throw for velocity using Project UNIQUE data, the softball throw for distance was selected in preference to softball throw for velocity. Other investigators have warned about the importance of learning on performance of the softball throw. In view of this, the softball throw for distance is generally not recommended for groups as a test item. However, it is a recommended item for females with cerebral palsy because it was felt to be the best of the power-strength items which defined factor 4 for this group of subjects. It is also a substitute item for certain subject groups.

Intercorrelations. The final criterion of primary importance in the selection of test items was to select items with low intercorrelations. This criterion was employed so that each item in the test added new information about the ability of the participant. Intercorrelation data are presented in Table 13, but because of limited space only data pertaining to the final battery of items for each subject group are presented.

Generally speaking, little relationship was found among test items measuring body composition (skinfolds), flexibility (sit-and-reach), and muscular strength/endurance (grip strength, arm hang, standing broad jump, softball throw, sit-ups, and dash). Intercorrelations between cardiorespiratory endurance (long-distance run) and muscular strength/endurance items were generally moderate.

Table 13

Intercorrelations of the Test Items by Major Subject Groups*

Test item and group	Triceps skinfold	Subscapular skinfold	Right grip	Left grip	Arm hang	Broad jump	Softball distance	Sit-ups	50-yard dash	Sit and reach	Long distance run
Triceps skinfold											
Normal	—	.75	−.15	−.14	−.32	−.26	—	−.24	−.25	.00	−.37
AI	—	.73	−.11	−.12	−.25	−.30	—	−.24	−.23	.08	−.30
VI	—	.75	.00	−.00	−.32	−.30	—	−.18	−.24	.02	−.25
CP	—	.77	−.06	−.15	−.29	—	−.15	—	−.08	—	.01
SN	—	.71	.11	.11	−.14	—	−.02	—	−.01	—	−.02
Subscapular skinfold											
Normal	.75	—	−.02	−.04	−.35	−.27	—	−.27	−.31	−.03	.30
AI	.73	—	.06	.06	−.29	−.22	—	−.25	−.22	.07	−.26
VI	.75	—	.15	.15	−.29	−.18	—	−.16	−.12	.01	−.22
CP	.77	—	.11	.08	−.20	—	−.06	—	−.11	—	−.19
SN	.71	—	.38	.38	.03	—	.16	—	−.04	—	−.05
Right grip											
Normal	−.15	−.02	—	.95	.38	.66	—	.46	.60	.04	.47
AI	−.11	.06	—	.94	.31	.69	—	.37	.52	.18	.36
VI	.00	.15	—	.93	.32	.64	—	.45	.49	.14	.37
CP	−.06	.11	—	.64	.35	—	.20	—	−.07	—	−.03
SN	.11	.38	—	.94	.36	—	.57	—	.28	—	.43

Left grip											
Normal	−.14	−.04	.95	—	.40	.67	—	.48	.60	.04	.48
AI	−.12	.06	.94	—	.30	.66	—	.35	.51	.16	.33
VI	−.00	.15	.93	—	.34	.63	—	.44	.51	.15	.38
CP	−.15	.08	.64	—	.46	—	.33	—	−.02	—	.09
SN	.11	.38	.94	—	.39	—	.59	—	.32	—	.44
Arm hang											
Normal	−.32	−.35	.38	.40	—	.51	—	.50	.47	.02	.52
AI	−.25	−.29	.31	.30	—	.52	—	.46	.37	.13	.49
VI	−.32	−.29	.32	.34	—	.50	—	.41	.33	.14	.44
CP	−.29	−.20	.35	.46	—	—	.25	—	−.25	—	.10
SN	−.14	.03	.36	.39	—	—	.50	—	.15	—	.32
Broad jump											
Normal	−.26	−.27	.66	.67	.51	—	—	.57	.71	.07	.55
AI	−.30	−.22	.69	.66	.52	—	—	.52	.59	.26	.52
VI	−.30	−.18	.64	.63	.50	—	—	.59	.70	.20	.58
CP	—	—	—	—	—	—	—	—	—	—	—
SN	—	—	—	—	—	—	—	—	—	—	—
Softall distance											
Normal	—	—	—	—	—	—	—	—	—	—	—
AI	—	—	—	—	—	—	—	—	—	—	—
VI	—	—	—	—	—	—	—	—	—	—	—
CP	−.15	−.06	.20	.33	.25	—	—	—	.42	—	.49
SN	−.02	.16	.57	.59	.50	—	—	—	.35	—	.44
Sit-ups											
Normal	−.24	−.27	.46	.48	.50	.57	—	—	.63	.07	.55
AI	−.24	−.25	.37	.35	.46	.52	—	—	.51	.22	.48
VI	−.18	−.16	.45	.44	.41	.59	—	—	.43	.20	.56
CP	—	—	—	—	—	—	—	—	—	—	—
SN	—	—	—	—	—	—	—	—	—	—	—

Table 13 (cont.)

Test item and group	Triceps skin-fold	Subscapular skin-fold	Right grip	Left grip	Arm hang	Broad jump	Softball distance	Sit-ups	50-yard dash	Sit and reach	Long distance run
50-yard dash											
Normal	−.25	−.31	.60	.60	.47	.71	—	.63	—	.08	.58
AI	−.23	−.22	.52	.51	.37	.59	—	.51	—	.21	.34
VI	−.24	−.12	.49	.51	.33	.70	—	.43	—	.16	.49
CP	−.08	−.11	−.07	−.02	−.25	—	.42	—	—	—	.50
SN	−.01	−.04	.28	.32	.15	—	.35	—	—	—	.57
Sit-and-reach											
Normal	.00	−.03	.04	.04	.02	.07	—	.07	.08	—	.04
AI	.08	.07	.18	.16	.13	.26	—	.22	.21	—	.05
VI	.02	.01	.14	.15	.14	.20	—	.20	.16	—	.11
CP	—	—	—	—	—	—	—	—	—	—	—
SN	—	—	—	—	—	—	—	—	—	—	—
Long-distance run (yds/min)											
Normal	−.37	.30	.47	.48	.52	.55	—	.55	.58	.04	—
AI	−.30	−.26	.36	.33	.49	.52	—	.48	.34	.05	—
VI	−.25	−.22	.37	.38	.44	.58	—	.56	.49	.11	—
CP	−.01	−.19	−.03	.09	.10	—	.49	—	.50	—	—
SN	−.02	−.05	.43	.44	.32	—	.44	—	.57	—	—

*The signs of the coefficients associated with the 50-yd. dash have been changed to reflect the fact that lower scores are indicative of higher levels of achievement.

Summary

Depending upon the subject group and subclassification of the youngster, the UNIQUE Test is a 4- to 6-item battery that measures four components of fitnesss (three for SN youngsters): body composition, muscular strength/endurance, flexibility, and cardiorespiratory endurance. As indicated by factor analytic data, the muscular strength/endurance component is subcategorized into the related components of strength, power-speed, power-strength, and power-endurance.

Where appropriate, separate norms are provided for normal, AI, VI, CP, and SN youngsters for each item in the test battery. The four test items recommended for all subject groups are 50-yard dash, long-distance run, sum of the triceps and subscapular skinfolds, and sum of the right and left hand grip strengths. (Summing the skinfolds is consistent with health related procedures, while summing the grips controls for differences due to hand preference.) Sit-ups and sit-and-reach are recommended items for most but not all subject groups. Instead of sit-ups, the softball throw is recommended for CP females. In addition, the standing broad jump, softball throw, or flexed arm hang can serve for specific subject groups as a substitute for the grip strength test when testers do not have access to a hand dynamometer or when the administration of the grip strength test is inappropriate.

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