AN ABSTRACT OF THE THESIS OF

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Title: Validation of a Cardiorespiratory Fitness Test for

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The purpose of this study was to validate a field

test of cardiorespiratory fitness for men with mental

retardation. The subjects were 19 healthy men with

moderate mental retardation whose mean age was 26 years

with a mean IQ of 48. Each subject underwent a

maximal treadmill test utilizing a walking protocol after

a three phase familiarization process. Each subject also

completed a one-mile walk test twice.

Descriptive statistics were calculated and a

correlation matrix was generated. Moreover, standard

multiple regression analysis was conducted to evaluate

the relationship between peak $\dot{V}O_2$ and the time of the

distance walk, as well as the ability of the distance

walk to predict peak $\dot{V}O_2$. An alpha level of .05 was used.

The results showed that subjects' mean peak $\dot{V}O_2$ value was 40 ml·kg^{-1}·min^{-1} or 2.59 l·min^{-1} which is considered a below average fitness level compared to non-retarded men of the same age. However, according to the Rockport Fitness Walking Test manual, 79% of the subjects achieved above-average fitness level in the one-mile walk test compared to non-retarded men.

The correlation coefficients between peak $\dot{V}O_2$ and the two one-mile walks varied from .78 to .83. When weight, height, age, heart rates of one-mile walks, and their combinations were held constant, the correlations were strengthened.

Using multiple correlation analysis the best equation for predicting peak $\dot{V}O_2$ was: Peak $\dot{V}O_2$= 101.92 - 2.356(mile 1 time) - 0.42(weight). This model accounted for 85% of total variance. The standard error of estimate was 4.06 ml·kg^{-1}·min^{-1}.

The test-retest reliability of the one-mile walk test was very high (R=.97). This finding suggests that the Rockport Fitness Walking Test is a reliable field test for this population. The developed equation can be used to predict the peak $\dot{V}O_2$ values. Thus, the one-mile walk test (RFWT) would appear to be a valid and reliable measure of cardiorespiratory fitness of men with moderate mental retardation.

VALIDATION OF A CARDIORESPIRATORY FITNESS TEST FOR MEN
WITH MENTAL RETARDATION

by

Pauli Rintala

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CHAPTER 1

INTRODUCTION

The importance of physical fitness, especially good
cardiovascular-respiratory condition, for general health
and well-being is well documented (American Alliance for
Health, Physical Education, Recreation and Dance, 1984).
The benefits of good cardiovascular-respiratory fitness
(CVRF) should not be limited to nonhandicapped persons.
Some have emphasized that the importance of physical
vitality and fitness for persons with mental retardation
supercedes that of the nonhandicapped population due to
the functional vocational needs and mobility requirements
for self sufficiency (Moon & Renzaglia, 1982). Persons
with mental retardation can often succeed or fail in
employment depending upon their ability to efficiently
sustain long periods of moderate physical activity. An
adequate level of cardiovascular-respiratory fitness
could allow such persons to successfully participate in
vigorous leisure activities (Fernhall & Tymeson, 1988).

Numerous health risks are associated with inactive lifestyles. The risks are magnified for persons with mental retardation due to lower levels of physical fitness and a propensity toward obesity. The prevalence of obesity in persons with mental retardation has been documented by numerous researchers (Fox & Rotatori, 1982; Kelly, Rimmer, & Ness, 1986; Polednak & Auliffe, 1976). These findings are distressing when considering the adverse effects of obesity on health and longevity (Buskirk, 1986; Fox, Burkhart, & Rotatori, 1984; Van Itallie, 1979).

Several studies have indicated that, as a group, adults with mental retardation are particularly low in measures of cardiovascular fitness (CVF)(Beasley, 1982; Coleman, Ayoub, & Friedrich, 1976; Schurrer, Weltman, & Brammell, 1985). Although there is evidence that the cardiovascular functioning of this population can be increased, exercise training studies have ignored the important question of reliability and validity of the dependent measures (Seidl, Reid, & Montgomery, 1987). Consequently, when CVF has been tested it has been done so with procedures previously established for use with the general population and administered indiscriminately to persons who are mentally retarded (Reid, Montgomery, & Seidl, 1985).

The cardiorespiratory fitness tests used with persons with mental retardation have ranged from field tests i.e., tests that can be used in mass testing situations, such as the 300-yard walk-run, to maximal treadmill walking and running protocols. However, it is not clear which of the many protocols, if any, are valid. The only field running test that appears to be valid for men with mental retardation is the 1.5-mile run-walk (Fernhall & Tymeson, 1988). Replication and expansion of field study validation is seen as an important research priority (Fernhall & Tymeson, 1988; Seidl et al., 1987).

According to Seidl et al. (1987), there appears to be a need for more investigations using direct measures of oxygen consumption during maximal exercise. Tomporowski & Ellis (1984a, 1985) used a maximal walking protocol developed by Balke & Ware (1959) and Tomporowski & Jameson (1985) employed nonstandardized procedures on the treadmill for adults with severe and profound mental retardation.

In the study by Tomporowski & Jameson (1985), the motorized treadmill and the running program were found to be the most productive exercise activities for persons with mental retardation. Nearly all participants, regardless of their level of retardation, exercised in one program or the other at a level necessary to induce changes in physical fitness. It appears that aerobic exercise, particularly jogging and running activities, can be performed by individuals with mental retardation with minimal prompting or extrinsic rewards. Perhaps the inherently motivating characteristics of exercise may provide educators with a medium through which to teach various skills including generalized communication and social skills to the mentally retarded.

Purpose of the Study

The main purpose of the study was to validate a field test of cardiorespiratory fitness for men with mental retardation. Specifically, the study determined the relationship between a cardiorespiratory laboratory test and a field test for men with moderate mental retardation.

Significance of the Study

Most cardiorespiratory fitness tests are based upon the premise that there is a linear relationship between heart rate, oxygen uptake, workload, and energy expenditure. While this relationship is not based on intellectual level, assessing the cardiorespiratory fitness of people with mental retardation is difficult because of variations in testing methodology, difficulties of test termination, cadence adherence, variable performance by the participant because of learning or motivational changes, and variable efficiency (Seidl et al., 1987). The only field test that has been suggested to be valid for men with mental retardation is the 1.5-mile run-walk (Fernhall & Tymeson, 1988). There is a need to have valid and reliable field tests in order to determine the effectiveness of different exercise programs for this population. The proposed study will add valuable information concerning the validity of one of the field tests for men with moderate mental retardation.

Research Problems

The following research questions were addressed in this study:

1. What is the cardiorespiratory fitness level of men with moderate mental retardation?

2. What is the reliability of the field test of cardiorespiratory fitness?

3. What is the relationship between a laboratory test of peak $\dot{V}O_2$ compared to a field test of cardiorespiratory fitness for men with mental retardation?

Delimitations

The subjects of this study were delimited to nineteen males with mental retardation from group homes and homes in western Oregon. The functioning level of this population was moderate retardation with an age range from 18 to 38 years. The laboratory testing for peak $\dot{V}O_2$ followed the procedures described by Fernhall and Tymeson (1987). The field test used was the 1.0 mile walk (Rockport Fitness Walking Test). The primary investigator, assisted by trained laboratory personnel, administered the treadmill tests and the primary investigator, with the assistance of several exercise and sport science graduate students, administered the field test.

Limitations

The following limitations apply to this study: The results of this study cannot be generalized to other special populations or to other age groups or to women with mental retardation. The motivation of the subjects and their effort to achieve a maximal performance in the one-mile walk test was not controlled.

Definitions of Terms

Cardiovascular-respiratory Fitness. The ability of the lungs and heart to take in and transport adequate amounts of oxygen to the working muscles over long periods of time (Fox & Mathews, 1981). The terms cardiovascular and cardiorespiratory have been used interchangeably in the literature.

Maximal Oxygen Consumption ($\dot{V}O_2$ max). The highest oxygen uptake a subject can obtain during physical work while breathing air at sea level. This is often measured as oxygen consumed in liters per minute ($1 \cdot min^{-1}$) or in milliliters per kilogram of body weight per minute ($ml \cdot kg^{-1} \cdot min^{-1}$).

Peak $\dot{V}O_2$. In this study, the highest attained oxygen consumption achieved during the treadmill tests.

Respiratory Exchange Ratio (RER). The amount of carbon dioxide exhaled, divided by the amount of oxygen consumed. It has also been abbreviated by R.

Mental Retardation. The term as defined by the American Association on Mental Deficiency (AAMD), refers to "significantly subaverage general intellectual

functioning resulting in or associated with impairments in adaptive behavior and manifested during the developmental period" (Grossman, 1983, p. 11).

The AAMD classifies mental retardation according to the following guidelines:

Term	Intelligence Quotient (IQ) range for level
mild	50-55 to approx. 70
moderate	35-40 to 50-55
severe	20-25 to 35-40
profound	Below 20 or 25

(Grossman, 1983, p. 13)

Validation. The 1985 Standards for Educational and Psychological Testing refers to validity as "the appropriateness, meaningfulness, and usefulness of the specific inferences made from the test scores. Test validation is the process of accumulating evidence to support such inferences" (American Psychological Association, 1985, p.9).

Reliability. Test score reliability is the tendency toward consistency exhibited by a person's repeated performance of the behavior. The coefficient of stability refers to scores obtained through a test-retest format.

CHAPTER 2

REVIEW OF LITERATURE

Physical fitness has become more than a passing fad or a slogan. Fitness also has different meanings and interpretations. Physical fitness, and especially a specific form of it known as health-related fitness, deals with the health status of people.

The President's Council on Physical Fitness and Sports defines health-related fitness as "...the ability to carry out daily tasks with vigor, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and to meet unforseen injuries" (McGlynn, 1987, p.4). The components of health-related fitness that are essential to a healthy life are (a) cardiovascular-respiratory efficiency, (b) muscle strength and endurance, (c) appropriate body composition, and (d) flexibility. All individuals must meet a minimum level of fitness to live a healthy and productive life.

Physical Fitness of the Mentally Retarded

Physical fitness is as important for a child or an adult with mental retardation as it is for the non-handicapped (Moon & Renzaglia, 1982). Millions of people with mental retardation perform and compete daily in order to prove their worth and productivity in a society that values excellence. These persons should have adequate levels of physical fitness, not only to complete work tasks but also to enjoy and benefit from active participation in lifetime pursuits (Fernhall, Tymeson, & Webster, 1988). Physical fitness training may be even more important as the severity of retardation increases, since fitness training builds basic skills such as ambulation and fine-motor control (Wehman, 1979). There is also evidence that participation of people with mental retardation in activities that promote physical fitness positively influences cognitive and affective variables such as IQ, academic performance, self-concept, and the ability to interact with peers (Moon & Renzaglia, 1982).

Adults with mental retardation have the right to participate in similar recreational and fitness activities as non-retarded adults, but they are frequently not self-directed enough to learn about these

options (Day & Day, 1977). When preparing adults with mental retardation for deinstitutionalization and normalization, increased attention has been given to the potential value of exercise programs (McCubbin & Jansma, 1987). Two reasons for such increased attention are a trend of the general population to recognize the value of improving health through exercise, and the potential benefits of exercise to various psychological variables (Moon & Renzaglia, 1982).

Most experts agree that the fitness level of individuals with retardation is generally inferior to that of non-handicapped persons. This has been evidenced in studies across the levels of retardation (Campbell, 1973; Coleman, Ayoub, & Friedrich, 1976; Fernhall, Tymeson, Millar, & Burkett, 1989; Reid, Montgomery, & Seidl, 1985; Schurrer, Weltman, & Brammell, 1985). There is also evidence that moderately and severely retarded persons are less fit than the mildly retarded (Londeree & Johnson, 1974; Jansma, Ersing, & McCubbin, 1986).

According to Moon and Renzaglia (1982), it may be difficult to enhance the physical fitness of adults with mental retardation to equal that of the non-retarded population since persons with mental retardation may not be initially motivated by such factors as weight loss,

improved cardiovascular fitness, increased energy levels or other intrinsic benefits that encourage non-handicapped persons to exercise. Systematic intervention programs that include prompts, extrinsic reinforcement and exercises specifically geared to their motor performance capabilities are necessary if adults with mental retardation are to improve their physical fitness (Caouette & Reid, 1985; Montgomery, Reid, & Seidl, 1988).

One of the primary problems of previous research with the mentally retarded is the lack of valid and reliable instruments for assessing the fitness level of this population. Indeed, systematic validity studies are greatly needed, and also, determining a reliability estimate for the selected field measure should become integral to all research studies with this population (Seidl et al., 1987).

Cardiovascular Fitness of the Mentally Retarded

According to Fernhall and Tymeson (1988), persons with mental retardation may be more dependent on their level of cardiovascular fitness than their non-retarded counterparts. For individuals with mental retardation, success or failure in employment can often depend upon

their ability to efficiently sustain long periods of
moderate physical activity. Moreover, an adequate level
of cardiovascular fitness could help vocational
transition and allow these individuals to successfully
participate in vigorous leisure activities.

In the following section, descriptive laboratory and
field studies of cardiovascular fitness for mentally
retarded adults are reviewed.

Laboratory Studies

Several laboratory investigations of cardiovascular
fitness in adults with mental retardation have been
done. However, a variety of testing protocols and
various subjects have been used. Nevertheless, with one
exception (Nordgren, 1970), the results of cardiovascular
fitness studies are uniform (Andrew, Reid, Beck, &
McDonald, 1979; Cressler, Lavay, & Giese, 1988; Fernhall
& Tymeson, 1988; Fernhall, Tymeson, Millar, & Burkett,
1989; Pitetti, Fernandez, Pizarro, & Stubbs, 1988;
Schurrer, Weltman, & Brammell, 1985). The studies show
considerably lower levels of cardiovascular fitness among
adults with mental retardation compared with non-retarded
adults. The $\dot{V}O_2$max values for the mentally retarded
ranged from 25 to 38 $ml \cdot kg^{-1} \cdot min^{-1}$. Only Nordgren (1970)
found no difference in cardiovascular fitness levels

between subjects with and without mental retardation.

Fernhall et al. (1988) observed that Nordgren's (1970) results are probably due to the test used and the population tested. First, the cardiovascular fitness test was a variation of PWC_{150} and PWC_{170}, but without metabolic measurements. This further increases the error inherent in this test. (PWC=physical work capacity i.e., the capacity to perform physical work while at a set heart rate e.g., PWC_{150}.) Second, 25% of Nordgren's sample of 63 subjects was unable to complete the PWC_{170} assessment and was excluded from the analysis. Considering that some reasons for noncompletion were consistent with poor fitness (i.e., leg fatigue, general fatigue), it is possible that only the more fit subjects were included in the sample. Given the possibility of a biased sample, it is not surprising that there were no significant differences in cardiovascular fitness between adults with mental retardation and non-handicapped adults.

According to Fernhall et al. (1988), the cardiovascular levels reported by Fernhall & Tymeson (1988) and Schurrer et al. (1985) are surprisingly low for physically healthy individuals, especially considering that these subjects were relatively young

adults (mean age 23-29 yrs). The obtained values, 25-28 $ml \cdot kg^{-1} \cdot min^{-1}$, are what would be expected for people with heart disease or people 30 years older than these subjects (Åstrand & Rodahl, 1986; Pollock, Wilmore, & Fox, 1984). There would appear to be no appreciable differences between the subject pools, which included subjects who were institutionalized, lived in group homes, or lived at home.

Field Studies

Data from descriptive field studies of adults with mental retardation are almost nonexistent (Fernhall et al., 1988). The largest cardiovascular fitness field study (N=184) was conducted by Reid et al. (1985) (see also Montgomery et al., 1988) with educable mentally retarded (EMR) and trainable mentally retarded (TMR) sheltered workshop employees. The cardiovascular fitness test was a modified step test, with a prediction of maximal capacity based on submaximal results. The results indicated that the subjects exhibited low levels of cardiovascular fitness compared to non-handicapped peers.

Different field tests have been used to assess the effect of training on subjects with mental retardation. In general, field studies with adults with mental retardation indicate these subjects exhibit low levels of

cardiovascular fitness before involvement in a training program (Fernhall et al., 1988).

Beasley (1982), using the Cooper 12 min run-walk test, showed that adults with mental retardation (EMR and TMR, age range 16-50 yrs) exhibited low levels of cardiovascular fitness. Similar results were reported by Corder (1966) and Giles (1968) using the 600-yard run-walk test and Coleman & Whitman (1984) using the 300-yard run test.

Cardiovascular fitness field tests (run-walk) used with persons with mental retardation have ranged in distance from 300 yards to 1.5 miles, and included the 12-minute Cooper run. There appears to be a need for more investigations using direct measures of oxygen consumption during maximal exercise (Seidl et al., 1987). At the same time more valid field tests are needed for practical reasons. However, both types of tests, laboratory and field tests, have their own methodological problems.

Assessing Cardiovascular Fitness

Special physical education instructors are faced

with the dilemma of choosing an effective measure of cardiovascular fitness for individuals with mental retardation (Lavay, Giese, Bussen, & Dart, 1987). Although proper assessment procedures are necessary in order to provide programs of physical activity effectively to persons with mental retardation (Werder & Kalakian, 1985; Wessel & Kelly, 1986), tests of cardiovascular fitness that have established norms, reliability, and validity for the general population have been used indiscriminantly with individuals who are mentally retarded (Bundschuh & Cureton, 1982).

It has been only a few years since important testing issues, such as a lack of validation and poor reliability, came into consideration. Without tests that are reliable and administratively feasible, proper assessment procedures and, consequently, appropriate programs of physical fitness for persons who are mentally retarded cannot be fully achieved (Cressler et al., 1988). In the following section, testing issues such as variation in test methodology, cadence adherence, termination point, efficiency, learning, and motivation are discussed.

Variation in Test Methodology

Seidl et al. (1987) reviewed the cardiovascular

fitness tests used with persons with mental retardation. The tests have ranged from field tests such as the 300-yard walk-run to maximal treadmill walking and running protocols. The variety of tests employed makes comparisons difficult.

With the non-handicapped population, it is widely accepted that cardiovascular fitness is best measured as $\dot{V}O_2$max which is defined as the ability of the body to take in, transport, and utilize oxygen during maximal exercise. Although maximal treadmill protocols have been used in six studies with adults with mental retardation (Andrew et al., 1979; Fernhall & Tymeson, 1988; Fernhall et al., 1989; Schurrer et al., 1985; Tomporowski & Ellis, 1984, 1985), only four of these (Andrew et al., 1979; Fernhall & Tymeson, 1988; Fernhall et al., 1989; Schurrer et al., 1985) included direct measurements of oxygen consumption.

Field tests and submaximal laboratory protocols have been used with the mentally retarded. However, since these methods have been shown to be population-specific, there is a need to establish their validity (Seidl et al., 1987). The 300- and 600-yard walk-run tests have been popular, and have been justified for persons with mental retardation on grounds of subject motivational

status. However, these field measures are not considered to be a valid means for evaluating cardiovascular fitness in non-handicapped persons. Thus, one must question their validity with persons with mental retardation (Seidl et al., 1987).

The only field test that has been validated with a mentally retarded population is the 1.5-mile run-walk (Fernhall & Tymeson, 1988). The test was a valid indicator of cardiovascular fitness for men (r=.88), but not for women (r=.55) (Fernhall et al., 1988).

Kline, Porcari, Hintermeister, Freedson, Ward, McCaron, Ross & Rippe (1987) investigated the potential of walking as an evaluative tool and concluded a one-mile walk test protocol a valid sub-maximum assessment for VO_2max estimation among 30 to 69 years old non-handicapped persons (N=343). This study led to the development of the Rockport Fitness Walking Test (RFWT). After experimenting with the RFWT with adults with mental retardation, DePauw, Goc-Karp, Bolsover, Hiles & Mowatt (1990) recommended the test for the assessment of fitness levels of mentally retarded individuals.

<u>Test Termination and Cadence Adherence</u>

Ten studies listed by Seidl et al. (1987) to predict
the cardiovascular fitness of adults with retardation
used various procedures. Only three of them (Nordgren,
1971; Reid et al., 1985; Tomporowski & Jameson, 1985)
commented on the applicability of the selected mode of
exercise and protocol used. Nordgren (1971) encountered
difficulty with 16 of 63 subjects with mild and moderate
retardation in determining physical work capacity on a
cycle ergometer. Problems included the inability of
subjects to follow the required cadence and difficulty in
completing more than one work load, which made
extrapolation difficult. Lavay et al. (1987) and Cressler
et al. (1988) confronted similar problems.

Bicycle ergometer tests and step tests present a
similar administrative problem in maintaining a steady
cadence. Reid et al. (1985), using a step test, reported
a loss of 36 of 220 subjects with mild and moderate
retardation. Many of them experienced difficulty in
attaining and maintaining required stepping cadences.
Moreover, 45% of the subjects stopped prior to reaching
target heart rate.

Tomporowski and Jameson's (1985) study provides further support for the notion that persons with retardation experience difficulty in maintaining predetermined cadences. Behavioral data on 19 adults with severe and profound retardation revealed that few subjects were able to maintain a regular cadence while exercising with cycling and rowing ergometers.

Bar-Or, Skinner, Bergsteinova, Shearburn, Royer, Bell, Haas & Buskirk (1971) found that there was a striking relationship between lack of completion and place of residence and that level of IQ may be a contributing factor. Seidl et al. (1987) suggested that researchers should carefully chronicle the characteristics and selection criteria of the subjects as well as the techniques employed to facilitate adjustment to the testing methodology. For example, physical prompting appears to be a useful method to promote test adjustment (Tomporowski & Ellis, 1984b).

Studies using the treadmill with adults with mental retardation have not identified any apparent problems with the protocol, because the cadence is mechanically determined (Seidl et al., 1987). Therefore, it is not surprising that some investigators believe a motor

driven treadmill to be an excellent way to assess cardiovascular fitness (Tomporowski & Jameson, 1985). The treadmill moves at a set speed and allows precise control of pace and ensures continuous exercise. However, previous practice is necessary for this population to feel comfortable while walking/running at different speeds and elevations on the treadmill (Cressler et al., 1988). A common problem with this population during treadmill walking is using the handrails for support (Lavay et al., 1987).

Motivation, Learning and Physiological Efficiency

Reid et al. (1985) noticed that despite individual testing and encouragement, their mentally retarded subjects were not sufficiently motivated to perform the step test to their potential. In contrast, Tomporowski and Jameson (1985) stated that "...perhaps the most important observation made during the course of training was the high level of motivation exhibited by subjects during exercise sessions" (p. 204). The exercise regimen consisted of running, treadmill walking, stationary bicycle riding, rowing, and calisthenics. It appears that aerobic exercise, particularly jogging and running activities, can be performed by individuals with mental retardation with minimal prompting or need for extrinsic reward.

If subjects are familiar with the test apparatus, repeated tests of cardiovascular fitness using a given protocol should result in similar scores (Seidl et al., 1987). However, Andrew et al. (1979) reported $\dot{V}O_2$max values ($ml \cdot kg^{-1} \cdot min^{-1}$) of two control subjects who decreased their cardiovascular functioning over 12 weeks from 43.5 to 25.7, and 50.5 to 40.0. Conversely, Schurrer et al. (1985) indicated that one of their five subjects showed an increase in $\dot{V}O_2$max from 20.6 to 42.3 $ml \cdot kg^{-1} \cdot min^{-1}$ as a function of the exercise program. It is difficult to attribute such changes to physiological mechanisms, and one must question if the tests were providing valid indicators of cardiovascular fitness for these individuals. Such extreme fluctuations in scores may more accurately represent changes in motivation rather than physiological functioning (Fernhall et al., 1988; Seidl et al., 1987).

Learning is undesirable, in the testing context, because it confounds the internal validity of the study. Seidl et al. (1987) recommend that when examining the validity of cardiovascular tests with persons with mental retardation, investigators should assess the extent of learning over several administrations of the test.

Attention has not been directed to physiological efficiency in studies of persons with mental retardation. However, indirect tests which predict oxygen consumption from work performance or heart rate assume a constant efficiency (Seidl et al., 1987). Poor efficiency, or a greater energy expenditure for a given work demand, can be attributed to such factors as poor coordination or lack of experience with a task or piece of equipment. Seidl's (1986) study lends support to previous reports of early test termination with increasing work and suggests that persons with mental retardation are not efficient exercisers compared with non-handicapped persons (Seidl et al., 1987).

The above mentioned aspects (variation in test methodology, test termination, cadence adherence, motivation, learning and physiological efficiency) can undermine the validity of the cardiovascular measures and cast doubt on the studies, which depend on accurate and precise measures to determine the effectiveness of an exercise program (Seidl et al., 1987). Thus, it remains unclear whether the observed scores are entirely due to poor cardiovascular fitness per se or to the inability of subjects to perform optimally on the test. Therefore, it seems that studies investigating the relationship between

a cardiovascular field test and direct measurement of oxygen uptake with adults with mental retardation are warranted.

CHAPTER 3

METHODOLOGY

The main purpose of this study was to validate a field test of cardiorespiratory fitness for men with mental retardation. This chapter is divided into the following sections: selection of tests; selection of subjects; laboratory equipment; testing procedures; and data analysis.

Selection of Tests

Prior to selecting the tests, the investigator conducted a pilot study. Two subjects, one functioning at the lower and the other one at the higher level of moderate mental retardation, were tested. Both the treadmill test and the field test were administered.

The direct measurement of oxygen uptake during a maximal graded exercise test was chosen for the criterion measure. The walking protocol previously used by Fernhall & Tymeson (1987) for individuals with mental retardation was modified for this study (see section "Treadmill

Protocol" later in this chapter). The pilot testing

helped the personnel to become acquainted with

individuals with mental retardation and also to develop

the familiarization process of treadmill testing needed

for the subjects.

The 1.5-mile run/walk was used as a pilot test

because it had been suggested as a valid test for men

with mental retardation. The experiment indicated,

however, that maintaining a constant running pace was

difficult and the distance seemed to be too long to

motivate the subjects to achieve their best possible

effort. Thus, a one-mile walk test (Rockport Fitness

Walking Test, RFWT) was chosen for the field test. It has

been suggested as an appropriate field test for the

mentally retarded by DePauw et al. (1990).

Selection of Subjects

Twenty healthy men with mental retardation were

recruited to participate in this study. Only men were

chosen since using both genders would decrease the power

of the applied statistical tool. Subjects were secured

with the assistance of the local schools, agencies that

operated group homes and vocational training centers. The

subjects lived in Benton and Polk counties in western Oregon. Eight other possible subjects were contacted, but eliminated because of lack of interest, fear or inability to walk on the treadmill.

The State of Oregon Mental Health Division was notified and permission was given to contact local authorities for information on each of the subjects. The IQ and other pertinent information for each subject was provided by either the group home or the county Developmental Disability office. All of the subjects and/or their legal guardians gave informed consent prior to participation in the study.

Appendix A contains the form granting approval for the use of human subjects by the Oregon State University Committee for the Protection of Human Subjects. The form used to obtain written consent of the subjects and their legal guardians for participation in this study is found in Appendix B.

In order to include only physically healthy individuals, the physician for each subject was asked to examine his records for any conditions that would contraindicate participation in this study. Appendix C contains the form used for this purpose.

Laboratory Equipment

Maximal oxygen uptake tests were conducted on each subject in the Human Performance Laboratory at Oregon State University. The equipment used to conduct these tests included the following:

1. Treadmill. A Quinton Clinical Research Treadmill Model Q18-60 was used in the maximal aerobic testing.

2. Electrocardiograph. A Quinton Model Q630A electrocardiograph was used to record the electrocardiogram (ECG) during the treadmill testing. From 5-lead ECG, abnormalities that might have occured during testing could be observed, and heart rate could be extrapolated from the record.

3. Blood pressure (BP). A Quinton Model 410 exercise testing blood pressure monitor was used during the test.

4. Gas analysis. A Parkinson Cowan (PC) dry gas meter was used to measure the volume of inhaled gas. A S-3A oxygen analyzer from Applied

Electrochemistry was used to measure oxygen content of expired air. An LB2 infrared carbon dioxide (CO_2) analyzer from Beckman Instruments was used to measure CO_2 content of expired air.

5. Computer. All assessment instruments were interfaced with an IBM XT computer at the beginning (nine first subjects), and resultant data were accumulated and processed via Vista Turbofit Software (Vacuumetrics). However, the signals from the PC meter were erratically processed causing occasional loss of data points for all calculated variables. To correct this problem, software from Rayfield Instrument (Waitsfield, Vt) with an Apple IIE computer was used to gather data (ten subjects) from the previously cited instrumentation. Procedures in each program used the same equations to calculate peak $\dot{V}O_2$ values.

Testing procedures

The procedures recommended by the American College of Sports Medicine (1986) were followed in the testing. During cardiorespiratory testing, in order to prepare the

individual for optimal performance, a cool room
temperature (20-22 C) was maintained, eating (2 hours)
and smoking (4 hours) were restricted prior to testing.
The subjects were dressed in loose fitting clothes. They
avoided vigorous exercise for several hours prior to
testing but were provided with appropriate warm-up and
cool-down. Also any medication taken by the subjects was
known. None of the subjects were taking medication that
would confound the test results.

The laboratory aspect of the study was divided into
three familiarization sessions prior to the formal
treadmill testing (see Appendix D):

Session 1 consisted of video tape viewing at
subjects' homes. The video showed the procedures
which were to be done in the laboratory. Also some
of the equipment used with treadmill testing was
introduced. The principal investigator was available
to answer any questions. For reinforcing the
subjects to participate and do their best,
different rewards were promised e.g., soft drink and
pizza, or something comparable which was of interest
to the subject.

Session 2 consisted of hands-on practice in the laboratory. Sufficient practice sessions were provided in order to familiarize and accommodate each individual to the test procedures, the laboratory, and the personnel before the actual testing began. As noted by others (Reid, Seidl, & Montgomery, 1989) the mentally retarded must feel comfortable with the testing apparatus being used as well as with the investigators administering the protocols. Therefore, the subjects practiced using a mouthpiece, a noseclip and headgear during this session. Two of the subjects wore a mask because of problems they experienced with a mouthpiece. Also during session 2, a short practice walk on the treadmill was administered.

Session 3 involved subject training in simulation of the walk on the treadmill and use of the respiratory collection system. Moreover, the speed was determined and grade of the treadmill was manipulated so each subject could comfortably maintain pace.

Session 4 was formal treadmill testing and all laboratory data were collected during this phase.

<u>Treadmill protocol</u>

The treadmill protocol, which was modified from Fernhall & Tymeson (1987), required the subjects to walk at 2.5-4.0 mph, depending on the individual; at 0% grade for 2.0 minutes, followed by 2.5-4.0 mph at a 2.5% grade for 2.0 minutes. The grade was then increased 2.5% every minute with a constant speed up to 20% grade[1]. Beyond a grade of 20%, the speed was increased until the subject declared fatigue. If electrocardiographic or blood pressure abnormalities were evidenced, the test was stopped (see Appendix E). Metabolic data were collected each minute. Heart rates were monitored each minute through the ECG record. Blood pressure was taken every other minute[2]. All treadmill tests were administered by the same research team.

One tester was responsible for changing grade and speed while a second operated the electrocardiograph and observed the subject for abnormalities in ECG or BP, and signs of exhaustion. To obtain accurate data, the third worker was positioned in front of the subject to make sure that the mouthpiece or mask remained properly

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1. The exception was Subject 1 whose cardiorespiratory fitness level was so high that he was able to continue to 30%.
2. Occasionally it was not possible to record BP.

placed. The fourth tester stood behind the subject to
prevent falls.

Criteria for terminating the maximal treadmill test
were exhaustion declared by the subject and/or
respiratory exchange ratio (RER) beyond 1.1 and/or heart
rate of at least 90% of subject's predicted HRmax (using
220-age formula).

Field test

The one-mile walk (RFWT) was conducted twice,
approximately a week apart, in an indoor facility on a
measured 1/8 of a mile course which was marked with
cones. The surface of the course was partially concrete
and partially astroturf. The test was administered inside
to standardize weather conditions. Temperature and
humidity were comparable to the laboratory conditions.

Following instructions "walk eight laps as fast as
you can as if you were in a hurry to go somewhere", the
subjects walked the distance, in groups of 2-4 subjects.
Each subject was assisted by a tester who walked with the
subject. Assisting testers were graduate students in
Movement Studies for the Disabled and Exercise
Physiology. The tester walked slightly ahead of the
subject and verbally encouraged him to keep moving (Koh &

Watkinson, 1988; Watkinson & Koh, 1988). Every subject
wore a heart rate monitor (either Vantage Sport Tester,
Finland or Pulse Monitor PU-801, Japan) and the tester
recorded the elapsed time and heart rate after each lap.
Also the time of walk completion was recorded to the
nearest second and heart rate was recorded immediately
upon crossing the finish line. A minimum of two days rest
was allowed between the treadmill and field test.

Data analysis

Statistical analyses of the data were performed
using the STATGRAPHICS package for the IBM compatible
personal computer. Descriptive statistics were
calculated for peak $\dot{V}O_2$, maximal heart rate, maximal RER
(=respiratory exchange ratio), and the time of completion
of the one-mile walk. A correlation matrix was generated
between these and the descriptive variables. Standard
multiple regression analysis was conducted to evaluate
the relationship between peak $\dot{V}O_2$ and the time of the
distance walk, as well as the ability of the distance
walk to predict peak $\dot{V}O_2$. An alpha level of .05 was
accepted to indicate statistical significance.

CHAPTER 4

RESULTS AND DISCUSSION

The purpose of this study was to validate a field
test of cardiorespiratory fitness for men with mental
retardation. Specifically, the study analysed the
relationship between a cardiorespiratory laboratory test
and a field test for men with moderate mental
retardation. In addition, the cardiorespiratory fitness
level of the subjects was determined. This chapter
outlines the description of the subjects, their
cardiorespiratory fitness level, the reliability of the
one-mile-walk test, and the relationship between peak VO_2
and other variables.

Description of Subjects

Twenty male subjects participated in this study.
Nineteen subjects' scores were accepted for data
analysis. One subject was excluded because of his high
Intelligence Quotient (IQ=82) which differentiated him
from the others and was discovered after testing. The
mean age was 26 with a range of 18 to 38 years,
and the mean IQ was 48 with a range of 21 to 68. Five of
the subjects lived at home, while the rest of the

subjects lived in group homes. Five of the subjects were in school; most of the remaining subjects worked in sheltered workshops, but some had jobs in the community. The physical characteristics of the subjects are presented in Table 4.1. Other information concerning the subjects e.g., exercise patterns, is presented in Appendix F.

Table 4.1

Physical Characteristics of the Subjects

Subject #	Age (yrs)	Weight (kg)	Height (cm)	IQ	
1	18	60.0	170	53	ws
2	20	50.0	165	53	wr
3	20	63.6	147	49	ld
4	19	52.0	175	61	ws
5	38	67.0	167	44	w
6	30	58.0	175	43	ws
7	38	68.0	172	64	ws
8	28	60.0	170	55	w
9	20	62.0	171	42	sb
10	27	58.5	152	45	*
11	27	68.9	178	46	ws
12	29	87.5	171	68	wr
13	23	73.9	164	49	p
14	24	94.3	180	55	p
15	26	67.3	146	32	sb
16	23	90.9	162	54	ws
17	27	65.8	172	43	sb
18	27	62.1	160	21	sb
19	28	58.2	162	41	sb
M	26	66.7	166	48	
SD	5.6	12.2	9.7	11	

ws=WAIS; wr=WISC-R; w=WISC; ld=Leiter-
  Devereux; sb=Stanford-Binet; p=Peabody
* Score is estimated from information provided
  by a county agency: low moderate range

Cardiorespiratory Fitness Level

The mean peak $\dot{V}O_2$ value, for the 19 subjects, was 40 $ml \cdot kg^{-1} \cdot min^{-1}$ with a range of 23.76 to 60.50. Moreover, the mean maximal heart rate was 182 and the mean respiratory exchange ratio was 1.15. The descriptive, physiological data obtained in this study are presented in Tables 4.2 and 4.3.

Treadmill Test Results

The results of peak oxygen uptake ($\dot{V}O_2$peak), peak heart rate (HRpeak), and peak respiratory exchange ratio (RERpeak) were obtained during the treadmill test.

Table 4.2.

Treadmill Test Data

Subj #	$\dot{V}O_2peak$ $(ml \cdot kg^{-1} \cdot min^{-1})$	$\dot{V}O_2peak$ $(l \cdot min^{-1})$	HRpeak (bpm)	RERpeak
1	60.50	3.63	182	1.16
2	59.16	2.96	186	1.11
3	27.20	1.73	173	1.23
4	48.52	2.52	187	1.19
5	35.13	2.35	183	1.23
6	49.33	2.86	180	1.26
7	38.07	2.59	180	1.10
8	42.96	2.58	178	1.26
9	41.99	2.60	189	1.08
10	43.58	2.54	188	1.06
11	47.60	3.28	185	1.14
12	34.35	3.00	182	1.25
13	30.85	2.28	184	1.05
14	27.14	2.55	178	1.09
15	37.29	2.50	170	1.10
16	23.76	2.16	167	1.17
17	39.05	2.57	214	1.19
18	39.15	2.42	167	1.05
19	34.48	2.00	178	1.11
M	40.01	2.59	182	1.15
SD	10.0	0.44	10.3	0.07

Criteria for terminating the maximal treadmill test were exhaustion declared by the subject and/or respiratory exchange ratio (RER) beyond 1.1 and/or heart rate of at least 90% of subject's predicted maximum heart rate (220 bpm - age). Fourteen of the 19 subjects achieved RERpeak values of 1.1 or above, and fifteen out of 19 reached HRpeak of at least 90% of their predicted maximum heart rate.

The most commonly used criterion for determining whether or not a maximal effort has been obtained is the documentation of a 'leveling off or plateauing' of $\dot{V}O_2$ in spite of an increase in exercise intensity (McConnell, 1988). Taylor, Buskirk, & Henschel (1955) established their test termination point when $\dot{V}O_2$ increased by less than 150 ml·min^{-1} (2.1 ml·kg^{-1}·min^{-1}) with an increase in elevation of 2.5% at a constant speed. Eleven subjects in this study were able to fulfill this criterion.

Of these three criteria, (1) plateauing of $\dot{V}O_2$, (2) RERpeak of at least 1.1, and (3) HRpeak of at least 90% predicted maximun heart rate, four subjects obtained all criteria, and 17 obtained at least two out of three criteria. When considering plateauing as the best criterion, eleven subjects reached $\dot{V}O_2$max. Consequently, the remaining eight subjects are considered to have attained peak $\dot{V}O_2$.

The two highest values of peak $\dot{V}O_2$ were 60.50 and 59.16 ml·kg^{-1}·min^{-1} which is considered very high compared to non-retarded men of the same age (Åstrand, 1960). On the average, the mean was 40 which is below average compared to values of non-retarded men of the same age.

One-mile Walk Test Results

The finishing times (MILE 1 and MILE 2) and the finishing heart rates (HR 1 and HR 2) were obtained from the two one-mile walks.

Table 4.3.

One-mile Walk Data

Subj #	MILE 1 (min)	MILE 2 (min)	HR 1 bpm	HR 2 bpm
1	9.93	10.02	169	168
2	10.68	10.43	175	167
3	21.33	20.75	148	145
4	12.27	12.55	176	151
5	14.25	14.00	153	157
6	13.73	12.93	133	147
7	14.40	14.13	163	165
8	14.07	15.86	168	155
9	13.18	13.23	148	162
10	15.38	15.17	141	163
11	11.62	11.87	147	148
12	12.78	13.18	187	184
13	15.50	15.92	164	145
14	15.08	15.50	137	134
15	16.95	16.30	149	154
16	18.22	19.13	150	137
17	12.68	12.53	201	208
18	16.07	16.17	114	122
19	14.92	14.15	159	156
M	14.37	14.41	157	156
SD	2.67	2.68	20.2	18.8

The results of the paired t-test showed that there was no significant difference in the means of the two one-mile-walks using the finishing times and the finishing heart rates as variables.

The fitness level of the subjects was determined according to the procedures and charts from the Rockport Fitness Walking Test (RFWT) manual (1986/1987). For the RFWT, the time it took to walk one mile and the heartrate immediately at the end of the test were utilized as predictor variables. The majority of subjects (79%) were assessed at the above average fitness level compared to non-retarded men of the same age. Only one subject's fitness level was below average.

Reliability of One-mile Walk Test

The appropriate statistical technique for estimating reliability of repeated measures is the intraclass correlation coefficient (R) (Baumgartner, 1989). Table 4.3. describes the subject data in terms of individual scores for each one-mile-walk. The repeated measures ANOVA (Appendix G) revealed a non-significant F-value; therefore, mean squares for treatments and error were pooled to obtain a mean square within value. The coefficient for stability or consistency (R) was calculated as follows:

$$R = \frac{MS(subj) - MS(within)}{MS(subj) + (k/k'-1)MS(within)}$$

where k= number of trials actually
administered

k'= prophesied number of trials
for which reliability
cofficient is estimated

$$R = \frac{14.13-.18}{14.13+(2/1-1)(.18)} = .9748$$

Relationship Between Peak $\dot{V}O_2$ and Other Variables

The relationship between peak $\dot{V}O_2$ and other variables was assessed by calculating single and partial correlations (Pearson product moment) and utilizing a regression analysis.

Correlational analysis

The correlations between measured variables were calculated and a correlation matrix of the selected variables was developed (Appendix H). Both one-mile walk times demonstrated a significant negative correlation (approximately -.80) with peak $\dot{V}O_2$ values ($l \cdot min^{-1}$ and $ml \cdot kg^{-1} \cdot min^{-1}$). Significant positive correlation was found

between height and peak $\dot{V}O_2$ ($l \cdot min^{-1}$) and significant

negative correlation between height and times for both

one-mile walks. Walking heart rate after 1/4 mile of the

first one-mile walk (mileHR4) and peak heart rate on the

treadmill (HRpeak) correlated significantly (positive)

with each other and both correlated significantly

(positive) with the heart rate after the first one-mile

walk. Moreover, peak heart rate on the treadmill (HRpeak)

correlated significantly (negative) with times for both

one-mile walks. Finally, IQ correlated significantly

(positive) with the heart rate after the first one-mile

walk.

The partial correlation coefficients between the

first one-mile walk time and peak $\dot{V}O_2$, holding weight,

height, age, and heart rate of the first one-mile walk

constant, are presented in Table 4.4. The first one-mile

walk time was chosen over the second mile walk because of

the similar magnitude of their relationship to peak $\dot{V}O_2$.

When weight, height, age, heart rate, or their

combinations were controlled, the correlation between

walking time and peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$) was strengthened.

These results suggest that the walking time was a

relatively independent predictor of peak $\dot{V}O_2$.

Table 4.4.

Partial Correlation Coefficients Between Peak $\dot{V}O_2$ and the First One-mile Walk Time*

Constant	Peak $\dot{V}O_2$ $(ml \cdot kg^{-1} \cdot min^{-1})$	Peak $\dot{V}O_2$ $(l \cdot min^{-1})$
Weight	-.84	-.85
Height	-.85	-.76
Age	-.80	-.83
Weight, Height	-.79	-.80
Weight, Height, Age	-.79	-.79
Mile Heart Rate	-.80	-.84

* Pearson product moment correlations

Regression analysis

In regression analysis, statistical power of the study is related to the number of independent variables (IVs) in the equation. In order to keep power relatively high (approximately .80) with a limited sample size of 19, the number of IVs in the equation was limited to two (Sharp & Gahlinger, 1988). Tabachnick & Fidell (1989) recommend having 20 times more cases than IVs, but acknowledge having a minimum requirement of at least 5 times more cases than IVs. In this case, the sample size should have been at least 10.

The correlation matrix (Appendix H) revealed that the only variables that correlated significantly with peak $\dot{V}O_2$ values were one-mile walk time, weight and

height. Because the correlation coefficents of two one-mile walks were high, and they accounted for the same aspect of the peak $\dot{V}O_2$, the first one-mile walk time was used in the regression analysis. The scattergrams, with the line of best fit, of peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$ and $l \cdot min^{-1}$) and the time of completion of the first one-mile walk are presented in Appendices I and J.

Examination of residuals scatterplots and a normal probability plot of residuals revealed that the assumptions of normality and linearity were adequately met. The assumption of homoscedasticity may have been affected by the sample size. Moreover, the residuals plot did not reveal any possible outliers.

When standard multiple regression procedure was used for predicting peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$) using the first one-mile walk time and weight as independent variables, an R^2 of .85 was obtained (adjusted .84). Adding other variables such as height, age, and one-mile walk heart rate did not increase the shared variance significantly. However, for predicting peak $\dot{V}O_2$ ($l \cdot min^{-1}$) involving the same IVs, an R^2 of .72 was obtained (adjusted .68). In other words, adding weight to the equation for predicting

peak $\dot{V}O_2$ ($l \cdot min^{-1}$) did not increase the predictability.
Table 4.5. displays the regression coefficients with
their standard errors.

Table 4.5.

Regression Model for Estimating Peak $\dot{V}O_2$

	Peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$)			Peak $\dot{V}O_2$ ($l \cdot min)^2$		
	Coeff.	SE	Sig.	Coeff.	SE	Sig.
Constant	101.92	6.50	*	4.25	.39	*
Mile 1	-2.356	.38	*	-0.144	.02	*
Weight	-0.420	.08	*	0.006	.005	
R^2	.85			.72		
R^2(Adj.)	.84			.68		
SEE	4.06			.24		
n	19			19		

*P is less than or equal to .05

The scattergram between the observed and predicted
peak $\dot{V}O_2$ in $ml \cdot kg^{-1} \cdot min^{-1}$ is shown in Figure 4.1., according
to the model in Table 4.5.

Plot of peakV̇O2
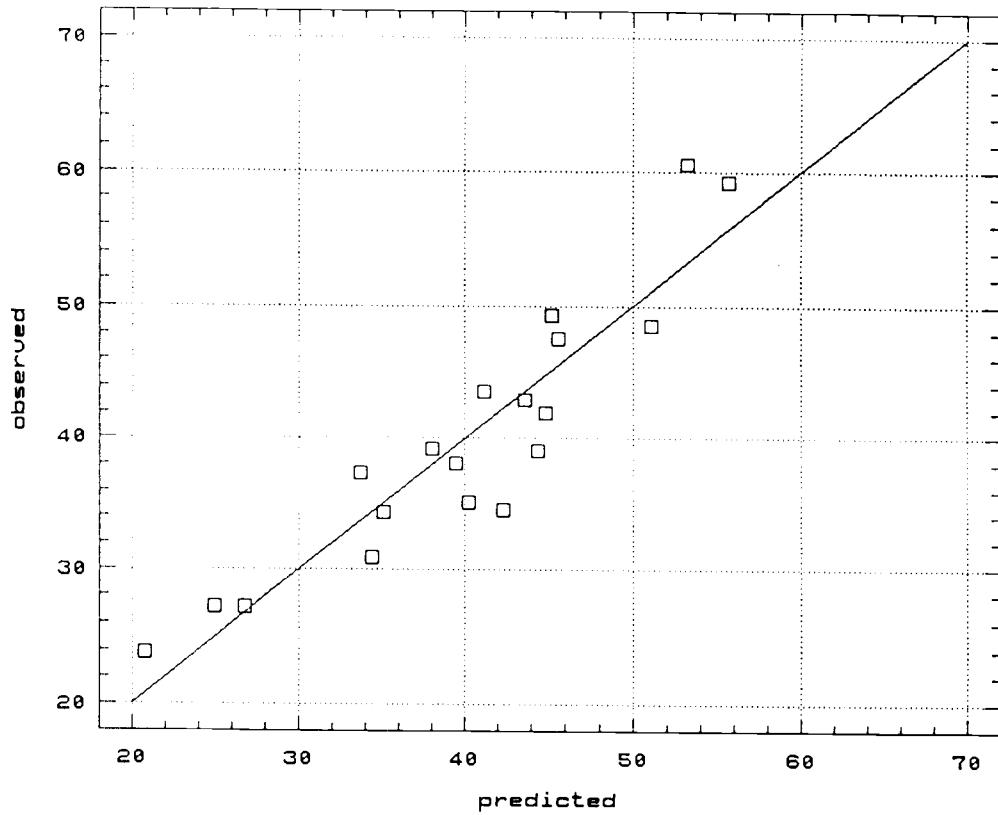
Figure 4.1. Scattergram for the Predicted and Observed Peak $\dot{V}O_2$ in ml $\cdot$ kg^{-1} $\cdot$ min^{-1} (n=19)

<u>Summary of Findings and Their Discussion</u>

<u>Summary of Findings</u>

The subjects were 19 men with moderate
mental retardation with a mean age of 26 years (mean
IQ=48). Their mean peak $\dot{V}O_2$ value was 40 ml·kg^{-1}·min^{-1} or
2.59 l·min^{-1} which is considered a below average fitness
level compared to non-retarded men of the same age.
However, according to the Rockport Fitness Walking Test
manual, 79% of the subjects achieved above average
fitness level in the one-mile walking test compared to
non-retarded men.

The repeated measures ANOVA was used to assess test-
retest reliability of the one-mile walk test. The
reliability coefficient was .97.

The correlation coefficients between peak $\dot{V}O_2$ and
the two one-mile walks varied from .78 to .83. When
weight, height, age, heart rates of one-mile walks, and
their combinations were held constant, the correlations
were strengthened.

Using multiple correlation analysis the best
equation predicting peak $\dot{V}O_2$ in $ml \cdot kg^{-1} \cdot min^{-1}$ was found;
Peak $\dot{V}O_2$= 101.92 - 2.356(mile 1 time) - 0.42(weight).
This model accounted for 85% of total variance. The
standard error of estimate was 4.06 $ml \cdot kg^{-1} \cdot min^{-1}$.

Discussion

The findings of this study suggest that the
cardiovascular-respiratory fitness level of men with
mental retardation may not be as low as earlier studies
indicate. The mean peak $\dot{V}O_2$ (mean max $\dot{V}O_2$ in most other
studies) obtained in this study was 40 $ml \cdot kg^{-1} \cdot min^{-1}$. This is
considerably different from 29 $ml \cdot kg^{-1} \cdot min^{-1}$ reported by
Fernhall & Tymeson (1987) (n=8, similar IQ's and ages),
and 28 $ml \cdot kg^{-1} \cdot min^{-1}$ in the study of Fernhall et al.
(1989)(n=19). Schurrer et al. (1985) in their study of
two men with mental retardation found higher max $\dot{V}O_2$
values (42 and 49 $ml \cdot kg^{-1} \cdot min^{-1}$) than the mean value of this
study. Their values were obtained after 23 weeks of
aerobic training. However, their pre-training values were
21 and 34 $ml \cdot kg^{-1} \cdot min^{-1}$. In each of these studies maximum
oxygen uptake was determined using continuous walking
protocol on the treadmill.

The possible explanation for the higher cardio-respiratory fitness levels of the subjects in this study, compared to previous studies of the mentally retarded, can be attributed to their exercise habits (see Appendix F). Sixteen out of 19 subjects did some aerobic activities, mostly walking, at least three times a week. Also according to a staff person, teacher or parent, twelve out of 19 subjects were classified either 'above average' or 'high' in their activity level compared to others of this population. Only two subjects were classified 'low' or 'below average' in this respect. The majority of the subjects attended different Special Olympics programs which may have improved their cardiorespiratory fitness level. However, Pitetti et al. (1989) concluded that the level of activity of the Special Olympic participants falls below that which is required for improving physical fitness.

Subjects 1 and 2 had peak $\dot{V}O_2$ values of 60.5 and 59.2 $ml \cdot kg^{-1} \cdot min^{-1}$, respectively. In order to test the accuracy of the equipment and the test-retest reliability of the laboratory procedure, the maximal treadmill test was administered again using the same equipment almost six months later. Subject 1 reached his peak $\dot{V}O_2$ at 59.4 $ml \cdot kg^{-1} \cdot min^{-1}$ and weighed one kilogram more the second time.

Subject 2 reached his peak $\dot{V}O_2$ at 53.4 ml·kg^{-1}·min^{-1} and weighed four kilograms more. Considering their weight increase at the second measurement, the obtained peak $\dot{V}O_2$ values were not different from those at initial assessment.

Using a plateau in $\dot{V}O_2$ in the face of increased workload as the best criterion for determining if $\dot{V}O_2$ max was obtained, the majority of the subjects (11 out of 19) reached $\dot{V}O_2$ max. Nevertheless, the term peak $\dot{V}O_2$ was used because not all of the subjects attained true, objective maximum.

Fernhall & Tymeson (1987) and Fernhall et al. (1989) have suggested that adults with mental retardation have lower than expected maximal heart rates, thus limiting their maximal cardiac output and $\dot{V}O_2$ max. The subjects in the above mentioned studies exhibited maximal heart rates 8-17% lower than predicted; whereas, the percentage in this study was only 6.2%. Therefore, in this regard the present study does not support previous investigations.

Most of the subjects walked on a regular basis which might have had an effect on the large number of subjects (79%) who achieved an above average fitness level using norms found in the RFWT manual. Similarly, eight out of

ten subjects in the study of DePauw et al. (1990) were assessed at the above level fitness compared to non-retarded individuals on the one-mile walk (RFWT) test.

Information on a reliability estimate for the selected measures should be integral to all research studies (Seidl et al., 1987), and researchers should not publish their work without providing such information (Lavay, Reid, & Cressler-Chaviz, 1990). Nevertheless, there is a lack of reliability information in cardiorespiratory fitness studies of individuals with mental retardation. The only published study on mentally retarded adults which reported reliability scores was done by Cressler et al. (1988). They obtained the test-retest reliability score of R=.81 for the Cooper twelve-minute run/walk test, whereas the reliability score for the one-mile walk test (RFWT) in this study was R=.97. It seems that a walk test compared to a run/walk test might give more consistent results because it is easier for subjects with mental retardation to perform at a constant pace as suggested by DePauw et al. (1990).

Fernhall, Tymeson, & Webster (1988) recommended the 1.5-mile run/walk test as a valid indicator of cardiovascular fitness for men with mental retardation. Based on the experience from the pilot test of the

present study, the one-mile walk test was chosen over the 1.5-mile walk/run test because it is:

1) easier to perform with a constant pace

2) requires less familiarization with concepts such as pacing

3) compatible with subjects who cannot or do not want to run

4) easier to motivate subjects to do fast walking than running

Fernhall & Tymeson (1988) found the correlation coefficient to be r=.88 between $\overset{\bullet}{V}O_2$ max and the 1.5-mile walk/run test. Although the correlation coefficient (r=.78) between peak $\overset{\bullet}{V}O_2$ and the one-mile walk test obtained in this study was lower than in Fernhall & Tymeson's (1988) study, it can be considered sufficiently high for predictive purposes. Furthermore, when subjects' weight was taken into consideration, the predictive value of the one-mile walk test accounted for 85% of the variance. The standard error of estimate was low (SEE=4.06 $ml \cdot kg^{-1} \cdot min^{-1}$).

Dicussion of Procedures

Assessing the cardiorespiratory fitness of people with mental retardation is a difficult task for several

reasons e.g., variations in existing testing methodology, difficulties in test termination and cadence adherence, and learning, motivational, and physiological efficiency problems of the subjects. Therefore, it is critical to familiarize persons with mental retardation with the testing protocol (Lavay et al., 1990). A number of suggestions, provided by Reid et al. (1989), were applied to the procedures used in this study as described in subsequent passages.

Test Selection

The direct measurement of oxygen consumption during a maximal graded exercise test is a widely accepted means of accurately assessing cardiorespiratory fitness with non-handicapped populations (Åstrand & Rodahl, 1986). The results of the Fernhall & Tymeson (1987) study indicated that graded exercise testing can yield valid maximal exercise data in terms of max $\dot{V}O_2$ values, with mildly and moderately mentally retarded individuals. Furthermore, even severely and profoundly mentally retarded individuals have been able to learn how to walk on the treadmill (Tomporowski & Ellis, 1984a, 1985; Tomporowski & Jameson, 1985). Thus, the maximal graded exercise treadmill test was selected for the criterion measure.

After pilot testing, the treadmill protocol was modified from Fernhall & Tymeson (1987) to allow more variety in speed. The treadmill speeds used in this study ranged from 2.5 to 4.0 mph, depending on the individual; in some cases the speed was increased in the final stages (no greater than 4.0 mph) enabling the subject to reach maximum effort faster and avoiding grades that were too steep. When the grade went beyond 15%, the resulting body position created lower back fatique which might lead to premature stoppage of the test.

Although the 1.5-mile run/walk test had been suggested as a valid test for men with mental retardation (Fernhall & Tymeson, 1988), the one-mile walk test was chosen for the field test for this study. The significance of the pilot test for choosing the field test was obvious. During the pilot test, one person displayed faster bursts of running and slower walking periods, and thus, failed to maintain a consistent pace in order to achieve the best possible finishing time. Moreover, in the second test trial his finishing time was 4 minutes and 30 seconds slower than in the first attempt.

Problems individuals with mental retardation may experience with running tests include: 1) Difficulty in

understanding the concept of pace. 2) Variability in
motivation and perseverance. 3) Inability to cope with
breathlessness and fatigue. On the other hand, for some
of the fittest subjects, who were used to running, the
running test might have been a better indicator of their
cardiorespiratory fitness than the walking test. In the
future, when a number of field tests have been validated
for different subgroups, an individually suited field
test may be deemed plausible for different persons.

Pre-test Familiarization

In order to familiarize the subjects to the
laboratory and the treadmill test, three pre-test
sessions and criteria for advancing to the next session
were developed (see Appendix D). For the <u>first session</u> a
10 minute laboratory test orientation VHS videotape was
made. The tape began with depiction of the pre-testing
procedures (weighing, electrode placement, cable
attachment and positioning of the headgear, mouthpiece
and noseclip). Then the actual maximal oxygen uptake test
with staff conducting the test was seen in a shortened
form. The tape was not edited and natural sounds could be
heard. The investigator narrated along with the viewing.

After viewing the tape, some of the portable
equipment used in the treadmill test was introduced and

the subjects were allowed to manipulate them. The
subjects were encouraged to ask questions during and
after the session. The criterion was passed if the
subject was willing to come to the lab for the following
session. The next session was held following an interval
of at least one day.

For most of the subjects, the video was well
received e.g., the headgear was said to be for astronauts
and the mouthpiece for divers. One subject, however,
refused to watch the video because it interfered with his
normal television viewing. Another subject had already
signed a consent form to participate, but after seeing
the videotape he decided to not participate.

Although the videotape was not professionally
developed, it fulfilled its purpose of introducing the
treadmill test to the subjects. The one-mile walk test
was not seen on the videotape because it was assumed that
walking was a familiar activity for all of the subjects.

The second session, held in the laboratory, was a
hands-on practice session. Generally, several subjects
attended at the same time. The equipment was reintroduced
along with the research personnel. The subjects practiced
walking on the treadmill for the first time, starting

with a slow speed and holding the handrails. The criterion was passed when they were able to walk without holding the handrail. Four of the subjects did not pass this stage and were eliminated from the study.

The third session was administered with the subject wearing all necessary equipment. The appropriate speed was ascertained for each subject, and the grade was increased to 5-10%. The criterion was passed when the subject was able to walk on the treadmill for five minutes allowing grade changes. This phase was repeated for two of the subjects. No subjects were eliminated in this phase of familiarization.

Familiarization took at least three days to complete, but most of the cases took even longer depending on the subjects' capabilities to perform, and practical scheduling problems. The criteria for advancement to the next phase were a necessary addition to the familiarization process as suggested by Lavay et al. (1990). The criteria helped to recognize how much familiarization was needed to prepare the subject for the treadmill test.

Test administration

The treadmill forced the subjects to move at a certain speed and grade. All of the subjects learned to walk without holding the handrail. The subjects were taught to show thumbs up if everything was alright, and thumbs down if something was wrong. In most of the cases, the subjects reported for the treadmill test in pairs which served as an effective motivator. The test examiners provided encouragement to the subjects during the test. The amount of encouragement increased towards the end of the test in order to stimulate best performance.

One of the most difficult things to determine was when to stop the test, if the subject did not voluntarily stop. The primary investigator was responsible for deciding when to stop the test after seeing the $\dot{V}O_2$ value, heart rate, and blood pressure at the end of each minute. The spotter standing behind the subject was necessary in order to make the subject feel secure and prevent falls, especially at near maximal stages. An interesting picture was posted on the wall in front of the subject to encourage him to keep his head up.

Two of the subjects were equipped with the Hans Rudolf Exercise Testing Face Mask 7910 (medium) in the maximal test because of the apprehension experienced when they used the mouthpiece. The mask is apt to leak so it was monitored closely. Vaseline was used to help in adherence to the face. In many cases, the mask would be preferred to the mouthpiece because it creates less dryness and salivation in the throat.

The one-mile walk test was short enough that the subjects stayed relatively motivated to continue walking, but it was long enough to tax the subjects aerobically. The assisting tester walking with each subject was necessary to keep the subjects' motivation high. Moreover, subjects walking 2-4 people in the group were more motivated than if they walked alone. Wearing heart rate monitors and the constant monitoring by the testers did not seem to bother the subjects.

Different rewards were used to reinforce participation and to achieve best possible performance. The most common reward was a soft drink or a soft drink and pizza. One subject was motivated with a small amount of money, and another, with the opportunity to do the oil change for the investigator's car. One person did not

receive any reward. The staff people of the group homes were the crucial source of information to determine the best possible rewards for different subjects.

CHAPTER 5

SUMMARY AND CONCLUSIONS

The purpose of this study was to validate a field test of cardiorespiratory fitness for men with mental retardation. Specifically, answers to the following research problems were sought: (1) What is the cardiorespiratory fitness level of men with moderate mental retardation? (2) What is the reliability of the field test of cardiorespiratory fitness? (3) What is the relationship between a laboratory test of peak VO_2 compared to a field test of cardiorespiratory fitness for men with mental retardation? This chapter outlines the summary of procedures, the summary of findings, implications, and the recommendations for future studies.

Summary of Procedures

The subjects were nineteen healthy men with moderate mental retardation. The mean age was 26 with a range of 18 to 38 years. They lived in private homes or group homes in western Oregon. Each subject performed a maximal oxygen uptake test on the treadmill using a walking

protocol, and a one-mile walk field test.

The treadmill test required a three phase familiarization process in order to prepare the subjects for the maximal test. The treadmill protocol was modified from Fernhall & Tymeson's (1987) study to meet the needs of the subjects in this study. The field test was the one-mile Rockport Fitness Walking Test which was conducted twice.

A correlation matrix was generated to demonstrate relationships among the variables. Standard multiple regression analysis was conducted to evaluate the relationship between peak $\dot{V}O_2$ and the time of the one-mile walk test, as well as the ability of the distance walk to predict peak $\dot{V}O_2$. An alpha level of .05 was accepted as an indicator of statistical significance.

<u>Summary of Findings</u>

The mean peak $\dot{V}O_2$ values for 19 subjects, using the maximal oxygen uptake test, was 40 ml$\cdot$kg$^{-1}\cdot$min^{-1} or 2.59 l$\cdot$min^{-1}. These values are considered a below average fitness level compared to non-retarded men of the same age. According to the RFWT manual, 79% of the subjects,

however, achieved an above average fitness level in the one-mile walk test compared to non-retarded men.

The repeated measures ANOVA was used to assess test-retest reliability of the one-mile walk test. The reliability coefficient was .97.

The correlation coefficients between peak $\dot{V}O_2$ and two different one-mile walks varied from .78 to .83. When weight, height, age and heart rates of one-mile walks and their combinations were held constant, the correlations were strengthened.

Using multiple correlation analysis the best equation for predicting peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$) was found; Peak VO_2= 101.92 - 2.356(mile 1 time) - 0.42(weight). This model accounted for 85% of total variance. The standard errror of estimate was 4.06 $ml \cdot kg^{-1} \cdot min^{-1}$.

Implications

The results of this study suggest that the cardiorespiratory fitness level of men with moderate mental retardation is below average compared to non-retarded men of the same age. However, the fitness level

is not as low as previous studies have indicated. The findings of the maximal oxygen uptake test revealed near average scores and the one-mile walk test revealed above average scores of cardiorespiratory fitness compared to non-retarded men.

The test-retest reliability of the one-mile walk test was very high. This finding suggests that the Rockport Fitness Walking Test is a reliable field test for this population. The developed equation (Peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$) = 101.92 - 2.256 x mile 1 time - 0.42 x weight) can be used to predict the peak $\dot{V}O_2$ values. Thus, the one-mile walk test (RFWT) would appear to be a valid and reliable measure of cardiorespiratory fitness of men with moderate mental retardation.

Testing individuals with mental retardation requires a careful test selection, pre-test familiarization, and test administration. Pre-test familiarization must include several different sessions which gradually familiarizes the person to final testing, in order to obtain near maximal effort and accurate data.

Recommendations for Future Studies

The findings of this study create a basis for the following recommendations for future studies:

1. Research should be conducted using RFWT with both genders, different levels of retardation, and different age groups in order to develop norms for individuals with mental retardation. A representative sample could be selected for a cross-validation study to determine the appropriateness of the regression equation generated from this study.

2. Research should be conducted comparing different field tests (one-mile walk test, 1.5-mile run/walk, and the Cooper run) and their relationship to maximal oxygen uptake in order to find the most appropriate field test for persons with mental retardation of varying fitness levels.

3. Research should be conducted using maximal oxygen uptake testing with both genders, different levels of retardation, and different age groups of mentally retarded individuals in order to re-examine their cardiorespiratory fitness level compared to that of non-retarded individuals. The same testing would prove conclusively whether individuals with mental retardation have lower than expected maximal heart rates.

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APPENDICES

APPENDIX A

Approval from Human Subjects Committee

OREGON STATE UNIVERSITY

Committee for the Protection of Human Subjects

Chairman's Summary of Review

Title: Validation of a cardiovascular fitness test for mentally retarded adults

Program Director: __John M. Dunn__

Recommendation:

__XX__ Approval*

_____ Provisional Approval

_____ Disapproval

_____ No action

*The informed consent forms obtained from each subject need to be retained for the long term. Archives Division of the OSU Department of Budgets and Personnel Service is willing to receive and archive these on microfilm. At present at least, this can be done without charge to the research project. Please have the forms retained in archives as well as in your files.

Remarks: _Revised proposal_

Date: __May 1, 1989__   Signature __

If the recommendation of the committee is for provisional approval or disapproval, the program director should resubmit the application with the necessary corrections within one month.

APPENDIX B

Informed Consent Form

INFORMED CONSENT FORM

The purpose of this study is to attempt to establish the
one-mile walk as an accurate test of cardiovascular
fitness for adults with moderate mental retardation. The
subject will be asked to report to the Human Performance
Laboratory in the Women's Building at Oregon State
Universty three times: during the first visit, the
subject will be shown the equipment and all testing
procedures will be demonstrated for him. During the
second visit, the subject will practice walking on the
treadmill and breathing through the expired air
collection system. During the third visit, formal
treadmill testing will take place.

Formal treadmill testing will require the subject to walk
on the treadmill, at a constant speed of 2.5 mph. This
represents a brisk walk. For the first two minutes the
subject will exercise on a level surface, followed by a
modest increase in treadmill grade for an additional two
minutes. Following these initial stages, the treadmill
grade will be raised modestly (2.5%) every minute until
the subject declares exhaustion, or sooner. Every
laboratory visits will take less than one hour, or, less
than three hours altogether.

On two other days, about one week apart, the subject will
be required to walk the one-mile test on an indoor track.
Each subject will walk in the company of a research
worker. The one-mile tests will take less than one hour
per session (a total of two hours).

All participants are subject to the discomfort of
exertion during the treadmill test and the normal risk of
such activity. However, the possibility of injury is very
slight, since the test will be administered by trained
research and medical personnel who will monitor
electrocardiographic and other physiological responses to
the test. A critical care nurse will be present during
the treadmill testing.

Benefits to the subjects and their guardians are that
they will receive knowledge concerning the subject's
cardiovascular fitness. This knowledge will be useful in
establishing baseline information related to functional
health and work capacity.

The results of the study will be confidential. The sub-
jects will not be identified in any way in publications
and/or presentations arising from this project.

Further information and responses to concerns related to this study will be provided by Pauli Rintala, 737-3221, or 757-1192 and/or Dr. John M.Dunn, 737-3257.

Participation is voluntary and refusal to participate or decision to withdraw will provoke no penalty or loss of benefits to which the subject is otherwise entitled. Subjects may discontinue participation at any time, including during the assessment sessions, without penalty. The testing sessions will be conducted in a positive, reinforcing environment.

I have read the above information and give my consent to the participation of the study.

Subject's signature	Date

Guardian's signature	Date

Investigator's signature	Date

- -

RELEASE FORM:

Permission is granted for the release of confidential information, including medical, educational, and psychological reports, to/from Devolepmental Disability office of Linn County Mental Health Division and the physician named by the guardian.

Subject's or guardian's signature	Date

Doctor's name:_____

address:_____

phone:_____

APPENDIX C

Subject Screening Form

Dr. who it may concern

Re: Subject A's health status

Dear Dr.

My name is Pauli Rintala. I am working towards my
Doctorate degree in Special Physical Education in the
Department of Exercise and Sport Science at Oregon State
University under the guidance of Dr. John M. Dunn. My
dissertation, "Validation of a cardiovascular fitness
test for adults with mental retardation", is a study to
investigate maximal aerobic capacity ($\dot{V}O2max$) of adults
with moderate mental retardation.

The purpose of this letter is to enlist your assistance
in screening the subjects. Our intent is to include only
physically healthy subjects.

The study comprises two parts: (1) The laboratory
treadmill test requires the subject to walk until
exhaustion or to a point where he wishes to stop. The
speed will be held constant (2.5 mph) and the grade will
be increased 2.5% every minute, beginning after 4
minutes, until exhaustion; (2) A one-mile walk test will
be conducted in an indoor track. The subject will be
expected to cover the distance as fast as possible.

The risk in maximal exercise testing of normal healthy
subjects is one death per 10,000 tests in large, varied
populations. In this study, the risk of falling on the
treadmill will be minimized by having one person behind
the walking subject ready to aid if needed. The walking
protocol used in this study offers fewer risks than the
running protocols, and the speeds are considerably lower.

Both tests (treadmill test and walk test) will be
appropriately supervised and a protocol has been
established to quickly summon emergency help if needed.
Emergency equipment (a crash cart and defibrillator) are
on hand. Trained laboratory personnel, including a
registered nurse with critical care experience and a
master's degree in exercise science, certified in
cardiopulmonary resuscitation, will be present in all
testing situations.

Would you please help us to screen your patient,_____by
answering the following questions based on your knowledge
and information regarding the subject in question? This
is not a consent form and does not make you responsible
for any subjects' health status. All of the subjects and
their legal guardians will be given a written informed
consent form to sign.

Sincerely,   Pauli Rintala, M.S.

SUBJECT SCREENING

The purpose of this survey is to determine whether

_____ is a healthy individual.
According to the American College of Sports Medicine
apparently healthy individuals are defined as "those who
are apparently healthy and have no major coronary risk
factors".

Would you, please, answer the following questions
regarding potential risk factors for _____.
Indicate whether he does, does not, or you do not know
for each of the following risk factors:

	No	Yes	Don't know
1. history of high blood pressure (above 145/95)	( )	( )	( )
2. elevated total cholesterol/ high density lipoprotein cholesterol ratio (above 5)	( )	( )	( )
3. cigarette smoking	( )	( )	( )
4. abnormal resting ECG	( )	( )	( )
5. family history of coronary or other atherosclerotic disease prior to age 50	( )	( )	( )
6. diabetes mellitus	( )	( )	( )

The person is on the following medication:_____

_____

Does the person have any other medical conditions which
would prevent him from participating in the study?_____

_____

_____   _____   _____
Physicians signature   Phone number   Date

Please, send this questionnaire to:

Pauli Rintala, Oregon State University, Langton Hall 214,
            Corvallis, Oregon 97331-3302

APPENDIX D

Familiarization Sessions and Criteria

FAMILIARIZATION SESSIONS AND CRITERIA

I   Video tape session at homes

* 10 min video watching
* Answering questions
* Introducing some of the equipment

Criterion: Willingness to come to the lab next time

II Hands-on practice in the lab (2-3 subjects at a time)

* Introducing personnel
* Blood pressure measurement
* One electrode on the chest
* Trying a headgear and a mouthpiece
* Attaching cables
* Walking on the treadmill

Criterion: Capable of walking on the treadmill
          without using supporting handrails

This phase will be repeated if necessary.

III As if "testing situation"

* Blood pressure cuff
* Electrodes (5) on the chest attached to the cables
* Walking on the treadmill with mouthpiece and headgear
* Changing grade

Criterion: Capable of walking on the treadmill with
          all equipment for 5 minutes

This phase will be repeated if necessary.

IV Formal testing

APPENDIX E

Criteria for Discontinuing an Exercise Test

CRITERIA FOR DISCONTINUING AN EXERCISE TEST

Guidelines established by the American College of Sports Medicine will be followed regarding signs and symptoms that dictate that an exercise test be stopped. These are:

1. subject requests to stop
2. failure of the monitoring system
3. progressive angina (chest pains)
4. two millimeters horizontal or downsloping ST-depression or elevation observed in the electrocardiogram
5. sustained supraventricular tachycardia observed in the electrocardiogram
6. ventricular tachycardia observed in the electrocardiogram
7. exercise-induced left or right bundle branch block
8. any significant drop (10 mmHg) of systolic blood pressure, or failure of the systolic blood pressure to rise with an increase in exercise load
9. lightheadedness, confusion, pallor, nausea
10. excessive blood pressure rise: systolic greater than 250 mmHg; diastolic greater than 120 mmHg
11. R on T premature ventricular complexes as observed via EKG
12. unexplained inappropriate bradycardia
13. onset of second or third degree heart block as indicated by EKG
14. multifocal PVCs as observed on the EKG
15. increasing ventricular ectopy as observed on the EKG

APPENDIX F

Subjects' Background Information

SUBJECTS' BACKGROUND INFORMATION

#1	DD		H	SOP	A5; a-7/wk; ot-2/wk
#2	DD		GH	SOP	A5; s-1/wk; a-2/day; ot-1/wk
#3	DS		H	–	A1; almost nothing
#4	DD		H	SOP	A4; a-2/wk; ot-2/wk
#5	DD		GH	SOP	A3; st-5/wk; ls-1/wk
#6	DD,BD		GH	SOP	A4; st-5/wk; a-6/wk; ot-2/wk; ls-1/wk
#7	DD		GH	SOP	A4; st-4/wk; a-5/wk; ot-1/wk; ls-1/wk
#8	DD,	E	GH	SOP	A3; a-1/mo; ot-2/mo; ls-1/mo
#9	DD,	A	GH	SOP	A5; a-5/wk
#10	DS		GH	SOP	A3; a-7/wk; ot-1/wk
#11	DD		GH	SOP	A5; s-7/wk; a-7/wk; ot-1/wk
#12	BD		GH	SOP	A3; a-7/wk; ot-1/wk
#13	BD		H	SOP	A3; a-3/wk; ot-2/wk
#14	DD,	Hy	GH	–	A4; a-3/wk; ot-1/wk
#15	DS,E		GH	SOP	A2; a-4/wk; ot-1/wk
#16	DS		GH	SOP	A4: s-1/mo; a-3/wk; ot-1/mo: ls-1/wk
#17	DD		GH	SOP	A5; a-3/day; ls-1/wk
#18	DS		GH	SOP	A4; s-5/wk; a-6/wk; ot-2/wk; ls-1/wk
#19	DD,	Hy	H	SOP	A4; a-3/wk; ls-1/wk

DD= Developmental Delay

BD= Brain Damage

DS= Down Syndrome

E = Epilepsy

A = Autism

H = Living at home

GH= Living at group home

Hy= Hyperactivity

SOP=Special Olympic
      Participant

Activity level compared
to other MR's:

A1=low; A2=below average;
A3=average; A4=above
average; A5=high

Exercise patterns and
frequency:

s =strength activities
a =aerobic (walk,run,cycle)
ot=organized team sports
ls=leisure sports (bowling)

wk=week   (e.g., a-5/wk
mo=month   =aerobic
                  activities
                  5 times a
                  week)

APPENDIX G

Repeated Measures ANOVA

Table A.1.   Repeated Measures ANOVA

Source	Sum of Sqr.	DF	Var.Est.	F	P
Betw.Subj.	254.33	18	14.13	77.11	.0001
Within Subj.	3.48	19	0.18		
Treatments	0.02	1	0.02	0.08	.7764*
Error	3.47	18	0.19		
Total	257.81	37	6.97		

* not significant at .05 level

APPENDIX H

Correlation Matrix of Selected Variables

Table A.2. Correlation Matrix of Selected Variables

(N=19)	Peak $\dot{V}O_2$ $(ml \cdot kg^{-1} \cdot min^{-1})$	Peak $\dot{V}O_2$ $(1 \cdot min^{-1})$	MILE1	MILE2	Weight	Height	MileHR[a]	MileHR4[b]	Peak HR	Age	IQ
Peak $\dot{V}O_2$ $(ml \cdot kg^{-1} \cdot min^{-1})$	1.00										
Peak $\dot{V}O_2$ $(1 \cdot min^{-1})$	.76*	1.00									
MILE1	-.78*	-.83*	1.00								
MILE2	-.81*	-.80*	.97*	1.00							
Weight	-.70*	-.10	.30	.38	1.00						
Height	.27	.52*	-.68*	-.60*	.17	1.00					
MileHR[a]	.19	.22	-.45	-.41	-.06	.25	1.00				
MileHR4[b]	.17	.20	-.44	-.42	-.07	.24	.85*	1.00			
Peak HR	.31	.26	-.54*	-.56*	-.24	.39	.64*	.76*	1.00		
Age	-.23	-.09	.04	.01	.13	.12	.08	-.21	-.01	1.00	
IQ	.01	.22	-.25	-.16	.29	.43	.58*	.37	.14	-.01	1.00

1 Pearson product moment correlations
* P is less than .05
a Heart rate at the end of the first one-mile walk
b Heart rate after 1/4 mile of the first one-mile walk

APPENDIX I
Relationship Between the First One-mile Walk Times
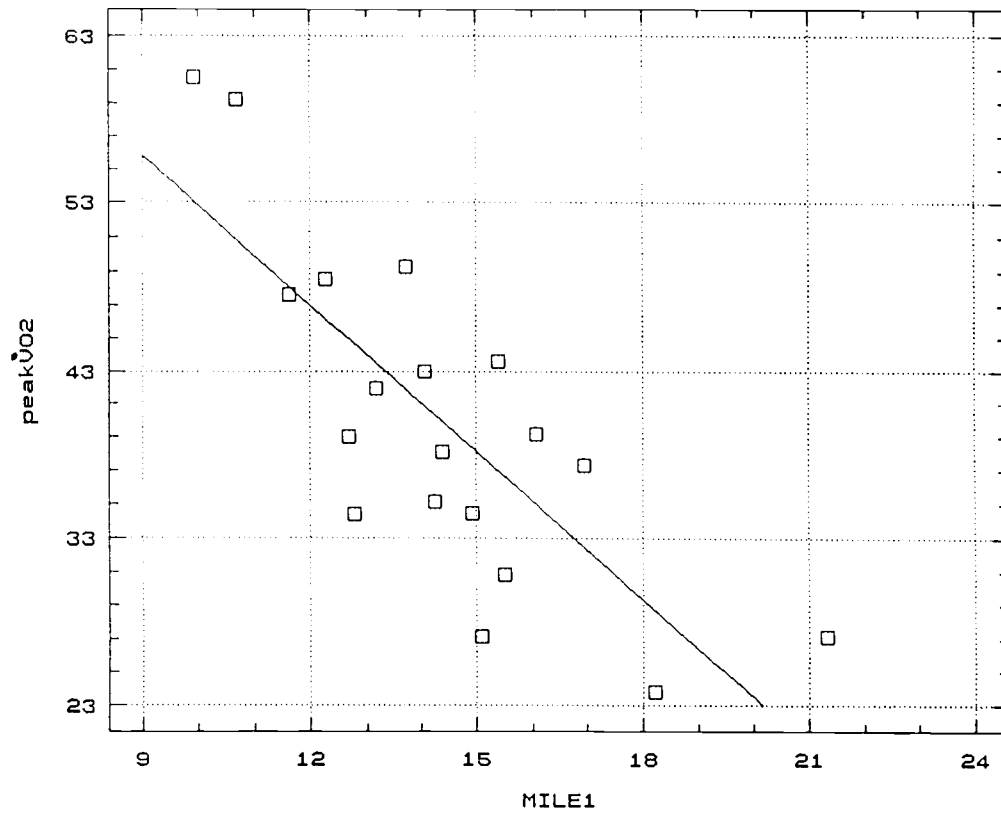and Peak $\dot{V}O_2$ ($ml \cdot kg^{-1} \cdot min^{-1}$)

Regression of peakV̇O2 on MILE1

Figure A.3. Scattergram of Peak $\dot{V}O_2$ $(ml \cdot kg^{-1} \cdot min^{-1})$ and the
Time of Completion of the First One-mile Walk

APPENDIX J

Relationship Between the First One-mile Walk Times
and Peak $\dot{V}O_2$ ($l \cdot min^{-1}$)

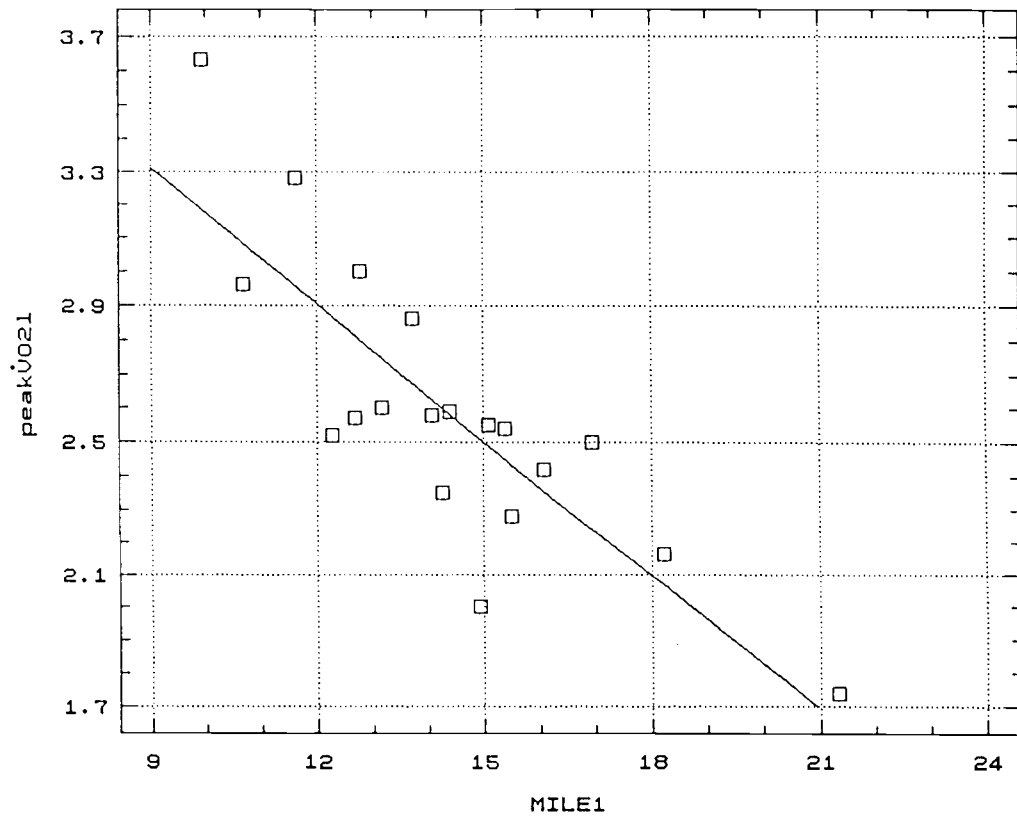# Regression of peakV̇O2l on MILE1

Figure A.4. Scattergram of Peak $\dot{V}O_2$ ($1 \cdot min^{-1}$) and the Time of Completion of the First One-mile Walk