Chapter I

Introduction
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Chapter I

INTRODUCTION

1.1 Introduction

Keeping physically fit is now becoming the highest priority on the agenda of the modern man. Convinces of the 20th century living have brought with it marked reduction in physical activity and the promotion of a sedentary lifestyle. The benefits of regular exercise on psychological health and on people with anxiety and depression have been clearly documented. In fact, it is easy to spot a regular exerciser by one’s improved sense of general well being and enhanced self image.

To develop an understanding of the present paradigm of physical fitness activity/ programme’s structure and management, we need to review the growth and development of modern physical activity for fitness at least since the beginning of 1800 century.

1.2 Growth and Development of Physical Activity for Fitness in 1800’s

Many people might believe that today’s fitness revolution is only about twenty-five years old, but a quick review of physical education texts shows clearly that it started back in the 1880s. Rice, et al.,¹ and Van Dalen et al.,² cite proof that health-related fitness had its start more than one hundred years ago:

1. Educational institutions employed physicians to teach students about the importance of health.
2. Programs of physical training were based on the rigorous gymnastic exercises influenced by the German and Swedish programs.

3. Importance was placed on proper exercise and improved strength, and anthropometric measurements were significant.

1.3 Growth and Development of Physical Activity for Fitness in 1900’s

A shift occurred in the 1900s when teachers became physical educators who emphasized sport participation to promote the critical objectives of education, including physical fitness. Unfortunately, physical fitness was secondary to sport and games.

During the 1940s, 50s, and 60s public schools underwent intense scrutiny. The fitness status of World War II inductees was so poor that the armed forces blamed the schools for emphasizing sports at the expenses of physical fitness. About one-third, or 3 million, of the men examined for the Armed Services failed their examinations because of physical and mental reasons. In 1943, the head of the physical recreation program of the U.S. Army called for sport and play to be deemphasized and replaced with an intense physical training program.

A study of the fitness status of American children as reported by Kraus and Hirschland, who based their results on a series of minimal muscular fitness tests, found that 58 percent of American school children failed these tests, whereas only 9 percent of European children failed the same tests. About the same time, the release of scientific evidence that demonstrate a high degree of atherosclerosis found in autopsy examinations of American soldiers during the Korean conflict sent shock waves through the physical fitness and health professions.

These reports caused President Eisenhower to call for a special White House conference in 1956 to discuss the issue of youth fitness. The result of this meeting was the formation of the President’s Council on Youth Fitness, with Vice President Nixon serving as its first chairperson.

It was during this period, the mid 1950s, that AAPHERD developed the youth Fitness test. Testing began nationwide in 1957 and 1958 resulted in the publishing of manual citing national fitness norms.

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President Kennedy gave even greater visibility and importance to the physical fitness movement not only through his own lifestyle of physical activity but through his popular article titled “The Soft American”.\(^5\) He educated the public about youth fitness and promoted the development of the Governor’s Councils on Physical Fitness. This initiative had a powerful impact. During the period from 1957 to 1965, AAPHERD’s second national testing program showed significant improvement in student performances. A second manual was published with a new set of normative data.

Unfortunately, coronary artery disease was still the number one killer among adult Americans and during this period accounted for about 55 percent of all U.S. death annually. Researches in preventive medicine and degenerative diseases focused on sedentary lifestyles and general lack of exercise as central contributing factors. In fact, obesity became a major health problem, during this period health care costs increased dramatically.

Two significant publications surfaced during the late 1960s that tried to inform the public about the obvious lack of physical activity. Bowerman,\(^6\) a nationally recognized track coach from the University of Oregon, toured New Zealand and discovered jogging. Upon his return to the United States he wrote a book of jogging. His book may have been responsible for the first recognized running boom, since more than 3,00,000 copies were sold.

Many in the health fitness believe that the 1968 book by the Air Force physician Dr. Kenneth Cooper, entitled *Aerobics*,\(^7\) also had a significant impact on the adult fitness craze. The book was intended to quantify exercise and develop a pharmacopeia of fitness activities. It also represented an advanced version exercise prescription, identifying the quantity, kind and frequency of desirable exercise. His text was based on years of research while serving in the U.S. Air Force.

Two years later, in 1970, Cooper\(^8\) published a second book, *The New Aerobics*. He wanted Americans to take physical fitness and exercise more seriously in order to thwart heart disease and obesity. The adult fitness revolution was initiated.

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6 W.J. Bowerman and W.E. Harris; *Jogging* (New York: Grosset and Dunlap, 1967).  
as millions became actively involved in physical exercise for the first time in their lives.

In addition to Cooper Fitness books, such as Joan Ullyot’s *Women’s Running* in 1976, George Sheehan’s *Dr. Sheehan on Running* in 1976 and Jim Fixx’s *The Complete Book on Running* in 1977 sold in record numbers.

A series of events e.g. Olympic Games, World Championships, Asian Games, National games etc. helped to push people into the fitness and jogging craze. Contribution of Jackie Sorensen in the field of fitness is remarkable as she created aerobic dance in 1973 by setting exercises to music. Classes in aerobic fitness numbered in hundreds of thousands; people were exercising and sweating to music and enjoying it.

A series of events helped to push people into the fitness and jogging craze. Some experts claim that the fitness boom has peaked. It is possible that fitness activity has begun to flatten out. Consumer sales still rise each year, but the percent growth has declined steadily.

### 1.4 World of Fitness in 21st Century

At the beginning of twenty first century, the fitness world reached to its maximum spectrum of practices using programmatic application of pedagogy, sciences and technology. But worldwide there has been a large shift towards less physically demanding work. This has been accompanied by increasing use of mechanized transportation, a greater prevalence of labour saving technology in the home, and less active recreational pursuits. At least 60% of the world's population does not get sufficient exercise. This is true in almost all developed and developing countries, and among children.\(^9\)

These exercise trends are contributing to the rising rates of chronic diseases including: obesity, heart disease, stroke and high cholesterol. Active transport (walking, bicycling, etc.) has been found to be inversely related to obesity in Europe,

North America, and Australia. Thus exercise has been associated with a decrease in mortality.\(^\text{10}\)

One of the causes most prevalent in the developing world is urbanization. As more of the population moves to cities, population over-crowding, increased poverty, increased levels of crime, high-density traffic, low air quality and lack of parks, sidewalks and recreational sports facilities leads to a less active lifestyle.\(^\text{11}\)

Physical inactivity is increasing or high among many groups in the population including: young people, women, and the elderly. A number of factors has been associated with physical inactivity at a population level including: female gender, older age, smoking, little schooling and poverty.\(^\text{12}\)

Studies in children and adults have found an association between the number of hours of television watched and the prevalence of obesity. A 2008 meta analysis found that 63 of 73 studies (86%) showed an increased rate of childhood obesity with increased media exposure, and rates increasing proportionally to time spent watching television.\(^\text{13}\)

1.5 Summary of the Fitness Surveys/ Studies

Numerous scientific surveys/studies have been conducted to understand fitness practices. Some important have been emphasized in the preceding parts.

Neiman\(^\text{14}\), provides an excellent summary of the findings of national fitness surveys.

1. Only 20 percent of the population exercises at the level suggested by the American College of Sports Medicine; another 40 percent exercises at a level less than that recommended by ACSM, with at least 40 percent of the people classified as sedentary.

2. Upper socioeconomic groups are more physically active than lower socioeconomic groups; this factor presents a challenge to education and industry.

\(^{10}\)http://en.wikipedia.org/wiki/exercise_trends#cite_note_WHO2009-0
\(^{11}\)http://www.who.int/dietphysicalactivity/factsheet_inactivity/en/index.html
\(^{13}\)http://www.commonsensemedia.org/sites/default/files/esm_media+health_v2c11708.pdf
3. Among all groups, as people increase in age, their level of activity decreases.
4. The five fitness activities cited as being consistently popular by virtue of the largest number of participants are: (i) walking, (ii) swimming, (iii) calisthenics, (iv) bicycling, and (v) jogging or running.
5. Males and females participate equally in fitness activities such as those cited in 4 above; male are more involved in sport-related activities.
6. A large proportion of the population are more physically active now than they once were according to studies done by the Harvard Alumni group, Gallup, and Public health agencies.
7. Unfortunately, studies have shown a significant reduction in fitness participation by children and adolescents. This is consistent with what has been found in recent youth fitness studies.

*The AAU/ Nabisco Physical Fitness Study (1984):* Updyke,

15 found that about 74 percent of the youth tested were not able to meet the Amateur Athletic Union’s performance standards set for age and sex; this figure is up from 58 percent in AAU’s 1979 study.

*National Children and Youth Fitness Study I (1985):* Ross and Gilbert,

16 showed that a one third of youth were not physically active enough for aerobic benefit; only 50 percent get the required twenty-minute minimum for aerobic sessions. According to their study, children have become fatter. Better scores seemed to be correlated with greater activity. Over 80 percent of the youth tested get their activity outside the regular physical education setting. The tests used were triceps and subscapular skinfolds, sit and reach exercises, bent-leg sit ups, pull ups, and a one mile walk/ run. Approximately 8800 children between ages 10 and 18 were tested. The results demonstrated that there is a crisis in youth fitness in the country.

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15 W.F. Updyke; AAU/NABISCO Physical Fitness Program: Annual Report of Results (Bloomington, IN: Nabisco Brands, USA, October 1984)
President’s Council on Physical Fitness Study (1986): After collecting data on 18,857 public school children age ranging 6 to 17 years, Reiff,\(^{17}\) reported the following results: Children performed poorly on the cardiovascular test, pull-up test, sit and reach test; girls declined or stayed at the same level in six of the nine items after age 14; and boys outperformed girls in every test except flexibility. Reiff’s results support the existing literature that increased physical activity is needed. Unbelievably, only eleven boys out of nearly ten thousand (0.1 percent) scored in the 85\(^{th}\) percentile on any six of the nine items.

National Children and Youth Fitness Study II (1987): The NCYFS-II,\(^ {18}\) study was launched to investigate the physical fitness and physical activity habits of 4,700 children ages six to nine. The tests included triceps and calf skinfolds, sit and reach exercises, bent leg sit ups, modified pull-ups, and a half-mile walk/run for ages six and a one-mile walk/run for eight and nine. Their conclusions were: Children carry more body fat than their counterparts did twenty or more years ago; there is a dramatic shift toward team sports as early as grades three and four; physical activity patterns are significantly related to physical fitness; and school factors tend to be significantly related to the body composition of children.

The publication in 1996 of the Surgeon General’s Landmark Report\(^ {19}\) signaled a major shift in the way physical fitness was viewed and discussed by the general public as well as health and fitness professionals. Now “physical activity” joined “physical fitness” as a recognized essential for good health. Among the findings reported in “Physical Activity and Health” are:

- People of all ages, both male and female, benefit from regular physical activity.
- Significant health benefits can be obtained by including a moderate amount of physical activity (e.g. 30 minutes of brisk walking or raking leaves, 15 minutes of running, or 45 minutes of playing volleyball) on most, if not all,

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\(^{19}\) http://www.fitness.gov/50thanniversary/toolkit-firstfiftyyears.htm
days of the week. Through a modest increase in daily activity, most people can improve their health and quality of life.

- Additional health benefits can be gained through greater amounts of physical activity. People who can maintain a regular regimen of activity that is of longer duration or of more vigorous intensity are likely to derive greater benefit.

- Physical activity reduces the risk of premature mortality in general and of coronary heart disease, hypertension, colon cancer, and type 2 diabetes in particular. Physical activity also improves mental health and is important for the health of muscles, bones, and joints.

- Research on understanding and promoting physical activity is at an early stage, but some interventions to promote physical activity through schools, worksites, and healthcare settings have been evaluated and found to be successful.

*Physical Activity and Sport in the Lives of Girls (1997)*: the council published a report, “Physical Activity and Sport in the Lives of Girls,” under the direction of the Center for Research on Girls and Women in Sport, University of Minnesota. The report described the status of physical activity and sports for women and girls in athletics, discussed the impact of Physical activity, and recommended further ways to promote physical activity and sports opportunities for women and girls, noting that young females were twice as likely to be inactive as young males.

### 1.6 Predicted Trends of Fitness

An interesting look into what the future holds for the adult fitness was provided by Murray and Jarman, who asked fifty fitness experts (ACSM fellows) their opinion on what is probable and what is desirable for the next twenty-five years. The experts were asked what they believe will occur in the fitness area and what they believe should occur to advance fitness. Each expert listed five or more events, trends, or development. A final questionnaire focused on the following seven categories: (i)
fitness in sports and recreation, (ii) fitness and wellness, (iii) fitness in industry, (iv) fitness in education, (v) fitness in business, (vi) research in fitness, and (vii) fitness equipment and facilities.

The expert’s conclusions, based on the questionnaire, were as follows: In the category of sports and recreation, the elderly need greater attention. In fitness and wellness, more hospital programs are needed, smoking cessation programs should increase, and people should take more responsibility for their own fitness. In fitness in industry, more companies should begin worksite fitness and health promotion programs. In fitness in education, more physicians need to understand better principles of exercise science. In fitness in business, more fitness counseling, cardiac rehabilitation, and health care centers are needed. Research should focus on the psychological benefits of fitness. In fitness equipment and facilities more public areas must be used and more equipments is needed in the home.

1.7 Summary of the Fitness Trends Witnessed in Different Countries

1.7.1 Australia

Australian children between 1961 and 2002 have had a marked decline in their aerobic fitness.

1.7.2 Canada

Obese people are less active than their normal weight counterparts. In Canada, 27.0% of sedentary men are obese as opposed to 19.6% of active men. Lean people are more fidgety than their obese counterparts; this relationship is maintained even if normal weight people eat more or the obese person loses weight.

National data indicates that only 10% of Canadian youth are meeting the guideline for screen time of less than 2 hours per day. As well, although 2/3 of families live close enough for their children to bike or walk to school, only 1/3 report actually walking to school and 80% report never having cycled to school.

1.7.3 Asia and China

A study from China found urbanization reduces daily energy expenditure by about 300–400 kcal and going to work by car or bus reduced it by a further 200 kcal.

A rapid decline in physical activity has occurred between the 1980s and the 2000s. The decline in physical activity is attributed to increasing technology in the workplace and changing leisure activities. In 1989 65% of Chinese had jobs that required heavy labour. This decreased to 51% in the year 2000.

Among Asian children between 1917 and 2003 little change has been seen in power and speed however endurance has decreased substantially in the last 10–15 years.

1.7.4 Denmark

Between 1986 and 1998 school boys in Denmark have become less fit and fatter. This change was not observed among the girls.

1.7.5 Finland

In Finland leisure-time physical activity has increased, while occupational and commuting physical activity has decreased from 1972 to 2002. Leisure-time physical activity increased from 66% (1972) to 77% (2002) in men and from 49% (1972) to 76% (2002) in women. Physical demanding work decreased from 60% (1972) to 38% (2002) in men and from 47% (1972) to 25% (2002) in women. Daily commuting activity decreased from 30% (1972) to 10% (2002) in men and from 34% (1972) to 22% (2002) in women.

1.7.6 The Netherlands

In The Netherlands, walking and cycling as a means of transport is stable since 1994. The average Dutch citizen in the year 2007 walks 240 kilometers (150 miles) and cycles 908 kilometers (564 miles) per year.

1.7.7 South America

Over 60% of the population of Brazil, Chile, and Peru do not meet the recommended levels of physical activity needed to maintain health. A study of a
southern Brazilian population found that >80% of the population was physically inactive.

1.7.8 Sweden

A study of Swedish males found a significant decrease in total physical exercise even though recreational exercise has increased. This was due to a decrease in work place exercise and physical exercise in transportation.

1.8 Physical Activity, Exercise and Physical Fitness

Casper, Powell and Christensen\textsuperscript{23} provide us with an excellent overview of the interrelationships among physical activity, exercise and physical fitness. They offer the following definitions.

*Physical activity* is defined as “any bodily movement produced by the skeletal muscle resulting in energy expenditure. Depending upon the amount of muscle mass and intensity, frequency and duration of muscle contraction, the energy expended (kilocalories) can range from low to high.” *Exercise* is defined as “physical activity that is planned, structured, repetitive and purposeful in the improvement or maintenance of one or more components of physical fitness as an objective.” *Physical fitness* defined by the President’s Council on Physical Fitness and Sports “is the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure time pursuits and to meet unforeseen emergencies”.\textsuperscript{24}

According to Cooper,\textsuperscript{25} physical fitness means “an enhanced cardiorespiratory status.” He incorporates two additional components into his total well-being concept: a positive eating plan (PEP) and emotional equilibrium.

Neiman\textsuperscript{26} defines physical fitness as “a dynamic state of energy and vitality that enables one not only to carry out daily tasks, active leisure-time pursuits, and to


\textsuperscript{24} President’s Council on Physical Fitness and Sports, *Physical Fitness Research Digest 1.1* (Washington, DC: President’s Council on Physical Fitness and Sports, 1971), p.3


meet unforeseen emergencies without undue fatigue,” but also to avoid hypokinetic
diseases, while functioning at an optimal level of intellectual capacity and
experiencing the joy of life.

1.9 Health Related Physical Fitness

Pate, 27 clearly states that physical fitness is a combination of very specific
components that compose health-related physical fitness. These are (1) cardiovascular
endurance, (2) muscular fitness (strength and endurance), (3) flexibility and (4) body
composition.

*Cardiovascular endurance* is described as the ability of cardiopulmonary
systems to deliver oxygen to the working tissues (usually muscles) as well as deliver
important nutrients and carry away their waste products: it is usually associated with
aerobic capacity, which is the ability of muscles to maximally use oxygen during
muscular or exhaustive work.

*Muscular fitness* is the important aspect of muscular strength and endurance,
defined as the ability of the musculoskeletal system to develop maximal one-time
effort against a resistance (strength), or to manifest submaximal effort repeatedly or to
sustain an effort for given periods of time (endurance).

*Flexibility* is simply defined as the ability of a body or body parts to move
through an optimal range of motion about a joint or articulation or series of joints,
restricted in part due to bony contours of tissues, and their innate resistance to stretch.

*Body composition* is defined as the ratio of fat to the body’s lean mass (bones,
muscles and other connective tissues).

It is termed “health related” because there is an implied relationship between
one’s level of fitness and one’s health status. Research has demonstrated that
individuals with high levels of physical fitness also possess good health.

The term fitness has been applied to many different goals of life like the
avoidance of disease, efficiency in every day to day life, the ability to perform in
different activities at desired levels and healthy mental and social behaviors. Total

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77-82.
fitness is the capacity to combine all these aspects to achieve the optimal quality of life. The state of total fitness results in positive health that exceeds the state of simply being free from disease. The fully fit person has high level of cardio respiratory function and mental alertness, meaningful social relationship, the ability to cope with problems, desirable fat, sufficient level of flexibility, muscular strength and endurance and healthy low back if one is fit, one’s life includes regular exercise and a healthy diet and one is able to cope with stress without substance abuse. Being fit means being able to enjoy a full life without a low risk of developing major health problems, the quality of life continuum including stages from known illness to absence of disease, to live in the fullest sense of the world.28

M. Barrett mentioned that “Evidence is mounting that physically fit person lead longer lives, better performance record and participate more fully in life than those who are unfit”……. Regular physical activity is to create “whole” man.29

1.10 Regular Physical Activity and Physical/Physiological Well Being

In 21st century people are facing some of the common problems such as obesity, cardio respiratory problems, anemia, ageing, diabetes, autonomic dysfunction, raised blood cholesterol, anxiety, hypertension, structural deformity, occupational hazards, acclimatization with the pollution, low immunity, organic handicapped, organic dysfunction like vision acuity, balance loss, spondylitis etc. There are different types of physical activities to defend against these kinds of diseases/health problems. Physical activity stimulate growth, maturity, neurological development, anatomical development, muscular development, development of different reflexes, proprioreceptors, better autonomic and voluntary network etc. Hence, physical activity is the most accepted mean to achieve these educational as well as life objectives.30

Acute adaptations to exercise are the immediate, temporary physiological changes that return to near resting values when exercise has ceased. Table -1 lists a number of acute changes.

29 M. Barrett; Health Education Guide: A Design for Teaching (Lea and Febiger, 1975), p.2
Table-1
Acute Changes to Exercise $^{31}$

<table>
<thead>
<tr>
<th>Increase</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sympathetic outflow</td>
<td>Parasympathetic outflow</td>
</tr>
<tr>
<td>Heart rate response</td>
<td>Peripheral resistance</td>
</tr>
<tr>
<td>Breathing Rate</td>
<td>Vasoconstriction (working tissue)</td>
</tr>
<tr>
<td>Stokes volume</td>
<td>Kidney function</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Gastrointestinal activity</td>
</tr>
<tr>
<td>Myocardial contractility</td>
<td></td>
</tr>
<tr>
<td>Plasma epinephrine/ norepinephrine</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td></td>
</tr>
<tr>
<td>Vasodilation (working tissue)</td>
<td></td>
</tr>
<tr>
<td>Core temperature</td>
<td></td>
</tr>
<tr>
<td>Sweating</td>
<td></td>
</tr>
</tbody>
</table>

Table -2 cites the more common adaptations in the exercise physiology research.

Table-2
Chronic Adaptations to Exercise $^{32}$

<table>
<thead>
<tr>
<th>Increase</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxidative capacity of muscles</td>
<td>Heart rate- Submax work</td>
</tr>
<tr>
<td>Muscle capillary density</td>
<td>Resting heart rate</td>
</tr>
<tr>
<td>A-VO$_2$ differential</td>
<td>Sympathetic outflow</td>
</tr>
<tr>
<td>Blood volume</td>
<td>Triglyceride levels</td>
</tr>
<tr>
<td>Anaerobic threshold</td>
<td>Total cholesterol</td>
</tr>
<tr>
<td>Submax cardiac output</td>
<td>Low density lipoproteins</td>
</tr>
<tr>
<td>Heart size</td>
<td>Body fat</td>
</tr>
<tr>
<td>Stokes volume</td>
<td>Platelet Stickiness</td>
</tr>
<tr>
<td>Lean body mass</td>
<td>Peripheral resistance</td>
</tr>
<tr>
<td>Muscle strength/ endurance</td>
<td>Depression</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Hemoglobin concentration</td>
<td></td>
</tr>
<tr>
<td>Number and size of mitochondria</td>
<td></td>
</tr>
<tr>
<td>Insulin sensitivity free fatty acids utilization</td>
<td></td>
</tr>
<tr>
<td>Glucose tolerance</td>
<td></td>
</tr>
<tr>
<td>Lactic acid tolerance</td>
<td></td>
</tr>
<tr>
<td>Total lung capacity</td>
<td></td>
</tr>
<tr>
<td>Vital capacity</td>
<td></td>
</tr>
<tr>
<td>High-density lipoproteins</td>
<td></td>
</tr>
</tbody>
</table>

Regular physical activity leads to reduction in blood pressure, increased HDL cholesterol, decreased total cholesterol, increased body fat stored, increased aerobic


$^{32}$ Ibid
work capacity, increased clinical symptoms of anxiety, tension and depression, reduction in glucose-stimulated insulin secretion, increased heart function, reduction in mortality in postmyocardial interaction patients, prevention of Type II diabetes.\textsuperscript{33}

Some of the adaptive physiological responses to physical exercises are increased lactate threshold, increased heart volume, decreased resting heart rate, increased resting and maximum stroke volume, increased maximum cardiac output, increased maximum VO\textsubscript{2} consumption, increased capillary density and blood flow to active muscles, increased total blood volume, increased maximal ventilation, increased lung diffusion capacity, increased mobilization and utilization of fat, reduced all-cause mortality, decreased anxiety and depression, increased incident of some cancers, improved arterial endothelial function and increased insulin sensitivity.\textsuperscript{34}

\textbf{1.11 Summary of Health Related Benefits of Exercise} \textsuperscript{35}

The Healthy People 2000, National Health Promotion and Diseases Prevention Objective text,\textsuperscript{36} stated very clearly in its physical and fitness section that a number of significant benefits are associated with physical activity:

\begin{enumerate}
\item Regular physical activity increases life expectancy\textsuperscript{37}, can help older adults maintain functional independence and enhances quality of life at each stage of life.\textsuperscript{38}
\item Regular physical activity can help to prevent and manage coronary heart disease, hypertension, diabetes, osteoporosis and depression.\textsuperscript{39}
\end{enumerate}

\textsuperscript{33} C.G. Blomquist; “CV Adaptations to Physical Training” in \textit{Fitness Management} edited by David N. Camaione (Storrs: Brown and Benchmark, 1985 ), pp. 23-25.
\textsuperscript{34} American College of Sports Medicine- Guidelines for Exercise Testing and Prescription (6\textsuperscript{th} edition) (Philadelphia: Lippincott Williams and Wilkins, 2000).
\textsuperscript{35} David N. Camaione; \textit{Fitness Management} (Storrs: Brown and Benchmark, 1985 ), p. 19
3. Regular physical activity has also been associated with a lower rate of colon cancer\textsuperscript{40} and stroke\textsuperscript{41} and may be linked to reduced back injury.\textsuperscript{42}

4. Regular vigorous physical activity promotes cardio respiratory fitness and helps prevent coronary heart diseases.\textsuperscript{43}

5. Activity that builds muscular strength, endurance and flexibility may protect against injury and disability.

6. Physical activity can also produce changes in blood pressure, blood lipids, clotting factors and glucose tolerance that may help prevent and control high blood pressure, coronary heart disease and diabetes.\textsuperscript{44}

7. Evidence suggests that even small increase in light to moderate activity by the people who are least active will produce measurable healthy benefits.\textsuperscript{45}

8. A sedentary lifestyle appears to be an independent risk factor for coronary heart disease, nearly doubling a person’s risk.

9. Regular physical activity can help prevent and manage noninsulin dependent diabetes mellitus, obesity and such mental health problems as depression and anxiety.\textsuperscript{46}

10. While it is unclear what exact types and amounts of physical activity are required for precise health benefits, several health-related dimensions of physical activity are thought to be most important in producing selected health effects.\textsuperscript{47}


\textsuperscript{43} S.N. Blair et. al., “Physical Fitness and All-Cause Mortality: A Prospective Study of Healthy Men and Women”, \textit{JAMA} \textbf{262.11} (1989): 2395-2401.


\textsuperscript{45} D. Siedentop; \textit{Developing Teaching Skills in Physical Education Palo Alto} (CA: Mayfield, 1983).


Therapeutic and adopted physical education is gaining popularity in developed as well as developing countries. To conclude there are various kinds of physical education programme/ activities, some are general and some are specific in nature which works as preventive medicine against different problems. However these must be suitably selected according to sex, age and requirement.

1.12 Popular Physical Activities for Fitness Programmes

In the mid-1970s, a number of health fitness and sport experts rated fourteen sport and physical activities according to their physical fitness as well as their well-being benefits. They looked at the four physical fitness variables of cardiorespiratory endurance, muscle endurance strength and flexibility. Table-3 ranks the fourteen sports.

Table-3

<table>
<thead>
<tr>
<th>Sport Activities</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jogging/ Running</td>
<td>1</td>
</tr>
<tr>
<td>Bicycling</td>
<td>2</td>
</tr>
<tr>
<td>Swimming</td>
<td>3</td>
</tr>
<tr>
<td>Skating</td>
<td>4</td>
</tr>
<tr>
<td>Handball</td>
<td>5</td>
</tr>
<tr>
<td>Skiing (Nordic)</td>
<td>6</td>
</tr>
<tr>
<td>Skiing (Alpine)</td>
<td>7</td>
</tr>
<tr>
<td>Basketball</td>
<td>8</td>
</tr>
<tr>
<td>Tennis</td>
<td>9</td>
</tr>
<tr>
<td>Calisthenics</td>
<td>10</td>
</tr>
<tr>
<td>Walking</td>
<td>11</td>
</tr>
<tr>
<td>Golf</td>
<td>12</td>
</tr>
<tr>
<td>Softball</td>
<td>13</td>
</tr>
<tr>
<td>Bowling</td>
<td>14</td>
</tr>
</tbody>
</table>

According to table-3 jogging was ranked as the most beneficial health related physical fitness activity and bowling as the least beneficial. It is surprising to see that

David N. Camaione; Fitness Management (Storrs: Brown and Benchmark, 1985), p. 20.
they ranked walking eleventh. It would seem that walking should have been given a higher ranking. 49

Glover and Shephard, 50 feel differently. They state the best four aerobic activities are biking, jogging or running, swimming and walking.

There is clearly general agreement as to the types of activities that best allow an individual to gain maximum health related benefits. If cardiorespiratory health fitness and body composition are primary objectives, then jogging or running, biking, swimming and walking must be the most preferred activities as they meet all the requirements of sound aerobic physiology, which are: (1) the use of large muscle, (2) continuous activity, (3) rhythmical movement and (4) activity for the cardiorespiratory system. Equally important for total fitness is that the individual enjoy these physical activities. 51

The 2002 Survey of Participation in Sport and Physical Activities among Australians, 52 collected information on whether adults aged 18 years and over participated in a range of physical activities in the previous 12 months. Aerobics/fitness, swimming, cycling, tennis and running were among the top ten physical activities reported as being undertaken. 53

- The three most popular activities for males were walking for exercise (18%), golf (12%) and swimming (10%), while the three most popular activities for females were walking for exercise (33%), aerobics/fitness (13%) and swimming (12%). 54
- Walking is also the most common weight-bearing activity, with indications at all ages of an increase in related bone strength. 55
- In 2004-05, walking was a common form of exercise, with nearly half (49%) of those aged 15 years and over reporting walking as a form of exercise in the previous two weeks.

54 Ibid.
Walking was the only form of exercise for 25% of those aged 15 years and over, (21% of males and 29% of females).

Females were more likely to walk for exercise (53%) than males (44%).

The proportion reporting walking as the only form of exercise increases with age. At 15-24 years, only 14% reported walking as their only form of exercise, compared with 35% of those aged 65-74 years.

The average duration of all walking sessions undertaken in the previous two weeks was most commonly a half to one hour (30-59 minutes), which was reported by 48% of those who walked for exercise.

The 2004-05 National Health Survey also collected data on walking undertaken for at least ten minutes in the previous day for purposes other than sport, recreation or fitness (for example, to travel somewhere). Of Australians aged 15 years and over, 42% reported doing such walking.

According to the Sporting Goods Manufacturers’ Association\textsuperscript{56}, ten most popular activities for 2007:

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|}
\hline
Event & Millions & Avg. No. of days participated \\
\hline
Walking for fitness & 108.7 & 123.5 \\
Free weight exercise & 57.7 & 99 \\
Treadmill exercise & 50.1 & 85 \\
Running/jogging & 41.1 & 91 \\
Resistance machines & 39.3 & 91 \\
Stationary cycling & 36.2 & 148 \\
Stretching & 33.8 & 73.5 \\
Aerobic dance & 28.3 & 82 \\
Home Gym Exercises & 25.8 & 97 \\
Elliptical motion trainer & 23.6 & 73 \\
\hline
\end{tabular}
\caption{Ranking of Ten Popular Physical Fitness Activities\textsuperscript{57}}
\end{table}

\textsuperscript{56}http://weblogs.sunsentinel.com/features/health/fitness/blog/2008/09/most_popular_fitness_activities.html
\textsuperscript{57}Ibid
Since 2006, the editors of *ACSM’s Health and Fitness Journal* have surveyed fitness professionals in an attempt to identify health and fitness trends. Following were the top twenty fitness trends for 2012 according to the report:

1. Educated, certified, and experienced fitness professionals
2. Strength training
3. Fitness programs for older adults
4. Exercise and weight loss
5. Children and obesity
6. Personal training
7. Core training
8. Group personal training
9. Zumba and other dance workouts
10. Functional fitness
11. Yoga
12. Comprehensive health promotion programming at the worksite
13. Boot camp
14. Outdoor activities
15. Reaching new markets
16. Spinning (indoor cycling)
17. Sport-specific training
18. Worker incentive programs
19. Wellness coaching
20. Physician referrals

### 1.13 Importance of Scientific Authenticity of a Test for Fitness Evaluation

The top twenty fitness trends have been reported for the year 2012, which include both general and specific fitness programmes. The success of the above is dependent upon the evaluation of the programme. The process of evaluation starts with a test/s to have a set of measurements to evaluate the attainment or accomplishment of
predesigned goal/s and thereafter redefining the goal/s. Therefore a test is mandatory component of evaluation process for progress. To adopt any activity/ test the foremost question to be answered is the scientific authenticity of it. Since, test is the beginning of the process of measurement, evaluation, assessment, diagnosis, prescription and monitoring for effective treatment or training, the need for assuring the goodness of a test cannot be over ruled. The criteria of a good test is reflected from its scientific approach, logically a test is one that clearly explains the instructions for administration of the test, scoring method and interpretation of the scores. The essential components of the criteria of a good test are reliability, objectivity and validity, to lead to expertise.\textsuperscript{59} Judged by many measurement specialists to be the single most important concept in measurement, test validity continues to play a central role in test construction and in the evolution of measurement theory and practice.\textsuperscript{60} The validation of any process or test has been year marked as an important scientific endeavor.

1.14 Validity of a Test

In science and statistics, validity has no single agreed definition but generally refers to the extent to which a concept, conclusion or measurement is well-founded and corresponds accurately to the real world. The word "valid" is derived from the Latin word validus, meaning strong. Validity of a measurement tool (i.e. test in education) is considered to be the degree to which the tool measures what it claims to measure.\textsuperscript{61}

Test validity concerns the test and assessment procedures used in psychological and educational testing and the extent to which these measure what they purport to measure. “Validity refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests.”\textsuperscript{62}

\textsuperscript{61} \url{http://en.wikipedia.org/wiki/research_design}
\textsuperscript{62} \url{http://en.wikipedia.org/wiki/test_validity#cite_note-1999standards-0}
In the area of scientific research design and experimentation, validity refers to whether a study is able to scientifically answer the questions it is intended to answer.

Joppe\textsuperscript{63} provides the following explanation of what validity is in quantitative research: Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. In other words, does the research instrument allow you to hit "the bull’s eye" of your research object? Researchers generally determine validity by asking a series of questions and generally look for the answers in the research of others.

Wainer and Braun\textsuperscript{64} describe the validity in quantitative research as “construct validity”. The construct is the initial concept, notion, question or hypothesis that determines which data is to be gathered and how it is to be gathered. They also assert that quantitative researchers actively cause or affect the interplay between construct and data in order to validate their investigation, usually by the application of a test or other process. In this sense, the involvement of the researchers in the research process would greatly reduce the validity of a test.

1.15 Types of Validity\textsuperscript{65}

There are various types of Validity. Some of them are cited below:

1.15.1 Construct Validity

Construct validity refers to the extent to which operationalization of a construct (e.g. practical tests developed from a theory) do actually measure what the theory says they do. For example, to what extent is an IQ questionnaire actually measuring "intelligence"?

Construct validity evidence involves the empirical and theoretical support for the interpretation of the construct. Such lines of evidence include statistical analyses of the internal structure of the test including the relationships between responses to different test items. They also include relationships between the test and measures of other constructs. As currently understood, construct validity is not distinct from the

\textsuperscript{63} M. Joppe, “The Research Process” (2000), from \url{http://www.ryerson.ca/~mjoppe/rp.htm}.

\textsuperscript{64} H. Wainer and H. I. Braun; \textit{Test Validity} (Hilldale, NJ: Lawrence Earlbaum Associates, 1988), p. 76.

\textsuperscript{65} \url{http://en.wikipedia.org/wiki/research_design}
support for the substantive theory of the construct that the test is designed to measure. As such, experiments designed to reveal aspects of the causal role of the construct also contribute to construct validity evidence.66

1.15.2 Convergent Validity

Convergent validity refers to the degree to which a measure is correlated with other measures that it is theoretically predicted to correlate with.67

1.15.3 Discriminant Validity

Discriminant validity describes the degree to which the operationalization does not correlate with other operationalization that it theoretically should not be correlated with.68

1.15.4 Content Validity

Content validity is a non-statistical type of validity that involves “the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured”. For example, does an IQ questionnaire have items covering all areas of intelligence discussed in the scientific literature?

Content validity evidence involves the degree to which the content of the test matches a content domain associated with the construct. A test has content validity built into it by careful selection of which items to include. Items are chosen so that they comply with the test specification which is drawn up through a thorough examination of the subject domain. Foxcraft et al., note that by using a panel of experts to review the test specifications and the selection of items the content validity of a test can be improved. The experts will be able to review the items and comment on whether the items cover a representative sample of the behaviour domain.69

69 http://en.wikipedia.org/wiki/content_validity
1.15.5 Representation Validity

Representation validity, also known as translation validity, is about the extent to which an abstract theoretical construct can be turned into a specific practical test.\(^{70}\)

1.15.6 Face Validity

Face validity is an estimate of whether a test appears to measure a certain criterion; it does not guarantee that the test actually measures phenomena in that domain. Indeed, when a test is subject to faking (malingering), low face validity might make the test more valid.

Face validity is very closely related to content validity. While content validity depends on a theoretical basis for assuming if a test is assessing all domains of a certain. Face validity relates to whether a test appears to be a good measure or not. This judgment is made on the "face" of the test, thus it can also be judged by the amateur.\(^{71}\)

1.15.7 Criterion Validity

Criterion validity evidence involves the correlation between the test and a criterion variable (or variables) taken as representative of the construct. In other words, it compares the test with other measures or outcomes (the criteria) already held to be valid.

If the test data and criterion data are collected at the same time, this is referred to as concurrent validity evidence. If the test data is collected first in order to predict criterion data collected at a later point in time, then this is referred to as predictive validity evidence.\(^{72}\)

1.15.8 Concurrent Validity

Concurrent validity refers to the degree to which the operationalization correlates with other measures of the same construct that are measured at the same time. Returning to the selection test example, this would mean that the tests are

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\(^{70}\) http://en.wikipedia.org/wiki/representation_validity

\(^{71}\) http://en.wikipedia.org/wiki/face_validity

\(^{72}\) http://en.wikipedia.org/wiki/criterion_validity
administered to current employees and then correlated with their scores on performance reviews.\textsuperscript{73}

1.15.9 Predictive Validity

Predictive validity refers to the degree to which the operationalization can predict (or correlate with) other measures of the same construct that are measured at some time in the future. Again, with the selection test example, this would mean that the tests are administered to applicants, all applicants are hired, their performance is reviewed at a later time, and then their scores on the two measures are correlated.\textsuperscript{74}

1.15.10 Experimental Validity

The validity of the design of experimental research studies is a fundamental part of the scientific method, and a concern of research ethics. Without a valid design, valid scientific conclusions cannot be drawn. There are several different kinds of experimental validity.\textsuperscript{75}

1.15.11 Conclusion Validity

One aspect of the validity of a study is statistical conclusion validity - the degree to which conclusions reached about relationships between variables are justified. This involves ensuring adequate sampling procedures, appropriate statistical tests, and reliable measurement procedures. Conclusion validity is only concerned with whether there is any kind of relationship at all between the variables being studied; it may only be a correlation.\textsuperscript{76}

1.15.12 Internal Validity

Internal validity is an inductive estimate of the degree to which conclusions about causal relationships can be made (e.g. cause and effect), based on the measures used, the research setting and the whole research design. Good experimental techniques, in which the effect of an independent variable on a dependent variable is

\textsuperscript{73} http://en.wikipedia.org/wiki/concurrent_validity
\textsuperscript{74} http://en.wikipedia.org/wiki/predictive_validity
\textsuperscript{75} http://en.wikipedia.org/wiki/experimental_validity
\textsuperscript{76} http://en.wikipedia.org/wiki/statistical_conclusion_validity
studied under highly controlled conditions, usually allow for higher degrees of internal validity than, for example, single-case designs.\textsuperscript{77}

1.15.13 Intentional Validity

To what extent did the chosen constructs and measures adequately assess what the study intended to study?

1.15.14 External Validity

External validity concerns the extent to which the (internally valid) results of a study can be held to be true for other cases, for example to different people, places or times. In other words, it is about whether findings can be validly generalized. If the same research study was conducted in those other cases, would it get the same results?

A major factor in this is whether the study sample (e.g. the research participants) is representative of the general population along relevant dimensions.\textsuperscript{78}

1.15.15 Ecological Validity

Ecological validity is the extent to which research results can be applied to real life situations outside of research settings. This issue is closely related to external validity but covers the question of to what degree experimental findings mirror what can be observed in the real world (ecology = the science of interaction between organism and its environment). To be ecologically valid, the methods, materials and setting of a study must approximate the real-life situation that is under investigation.\textsuperscript{79}

1.15.16 The Relationship between External and Internal Validity

On first glance, internal and external validity seem to contradict each other: To get an experimental design one has to control for all interfering variables. That's why one often conducts experiment in a laboratory setting. While gaining internal validity (excluding interfering variables by keeping them constant) one loses ecological or external validity because one establishes an artificial lab setting. On the other hand with observational research one cannot control for interfering variables (low internal

\textsuperscript{77} http://en.wikipedia.org/wiki/internal_validity
\textsuperscript{78} http://en.wikipedia.org/wiki/external_validity
\textsuperscript{79} http://en.wikipedia.org/wiki/ecological_validity
validity) but one can measure in the natural (ecological) environment, at the place where behavior normally occurs. However, in doing so, you sacrifice internal validity.

The apparent contradiction of internal validity and external validity is, however, only superficial. The question of whether results from a particular study generalize to other people, places or times arises only when one follows an inductivist research strategy. If the goal of a study is to deductively test a theory, one is only concerned with factors which might undermine the rigor of the study, i.e. threats to internal validity.

1.16 Validation Process

Validation is the process of gathering evidence to provide “a sound scientific basis” for interpreting the scores as proposed by the test developer and/or the test user. Validation therefore begins with a framework that defines the scope and aspects (in the case of multi-dimensional scales) of the proposed interpretation. The framework also includes a rational justification linking the interpretation to the test in question.

Validity researchers then list a series of propositions that must be met if the interpretation is to be valid. Or, conversely, they may compile a list of issues that may threaten the validity of the interpretations. In either case the researchers proceed by gathering evidence – be it original empirical research, meta-analysis or review of existing literature, or logical analysis of the issues – to support or to question the interpretation’s propositions (or the threats to the interpretation’s validity). Emphasis is placed on quality, rather than quantity, of the evidence.

A single interpretation of any test may require several propositions to be true (or may be questioned by any one of a set of threats to its validity). Strong evidence in support of a single proposition does not lessen the requirement to support the other propositions.

Evidence to support (or question) the validity of an interpretation can be categorized into one of five categories:

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1. Evidence based on test content
2. Evidence based on response processes
3. Evidence based on internal structure
4. Evidence based on relations to other variables
5. Evidence based on consequences of testing

Techniques to gather each type of evidence should only be employed when they yield information that would support or question the propositions required for the interpretation in question.

Each piece of evidence is finally integrated into a validity argument. The argument may call for a revision to the test, its administration protocol, or the theoretical constructs underlying the interpretations. If the test and/or the interpretations meant to be made of the test’s results are revised in any way, a new validation process must gather evidence to support the new version.

1.17 Testing Validity

According to Chronbach and Meehl,\(^\text{81}\) the investigator is primarily interested in some criterion which he wishes to predict. One administers the test, obtains an independent criterion measure on the same subjects, and computes a correlation. If the criterion is obtained sometime after the test is given, one is studying **predictive validity**. If the test score and criterion score are determined at essentially the same time, one is studying **concurrent validity**. Concurrent validity is studied when one test is proposed as a substitute for another, or a test is shown to correlate with some contemporary criterion (e.g., psychiatric diagnosis).

**Content validity** is studied when the tester is concerned with the type of behavior involved in the test performance. Indeed, if the test is a work sample, the behavior represented in the test may be an end in itself.

Content validity is established by showing that the test items are a sample of a universe in which the investigator is interested. Content validity is ordinarily to be established deductively, by defining a universe of items and sampling systematically within this universe to establish the test.

Construct validation is involved whenever a test is to be interpreted as a measure of some attribute or quality which is not "operationally defined." The problem faced by the investigator is, "What constructs account for variance in test performance?"

Construct validation is important at times for every sort of psychological test: aptitude, achievement, interests, and so on. Thurstone's\footnote{L. L. Thurstone, “The Criterion Problem in Personality Research”, Psychometric Lab. Rep. 78 (1952): 25.} statement is interesting in this connection:

In the field of intelligence tests, it used to be common to define validity as the correlation between a test score and some outside criterion. We have reached a stage of sophistication where the test-criterion correlation is too coarse. It is obsolete. If we attempted to ascertain the validity of a test for the second space-factor, for example, we would have to get judges to make reliable judgments about people as to this factor. Ordinarily their (the available judges') ratings would be of no value as a criterion. Consequently, validity studies in the cognitive functions now depend on criteria of internal consistency . . .

We can use many methods in construct validation.

Group Differences: If our understanding of a construct leads us to expect two groups to differ on the test, this expectation may be tested directly.

Correlation matrices and factor analysis: If two tests are presumed to measure the same construct, a correlation between them is predicted. If the obtained correlation departs from the expectation, however, there is no way to know whether the fault lays in test A, test B, or the formulation of the construct. A matrix of intercorrelations often points out profitable ways of dividing the construct into more meaningful parts, factor analysis being a useful computational method in such studies.

Studies of change over occasions: The stability of test scores ("retest reliability," Cattell's "N-technique") may be relevant to construct validation. Whether a high degree of stability is encouraging or discouraging for the proposed interpretation depends upon the theory defining the construct.
A numerical statement of the degree of construct validity would be a statement of the proportion of the test score variance that is attributable to the construct variable. This numerical estimate can sometimes be arrived at by a factor analysis.

The concept and application of different types of validity most often overlap each other. Depending upon the situation, validity researchers adopt one or two or more methods of validation to establish different types of validity of a test as per the feasibility and adaptability.

How large a validity coefficient is considered acceptable for validity? Kirkendall, Gruber and Johnson\textsuperscript{83} proposed the following validity rating as per the coefficient of correlation obtained.

<table>
<thead>
<tr>
<th>Validity Rating</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>.80-.1.00</td>
</tr>
<tr>
<td>High</td>
<td>.70-.79</td>
</tr>
<tr>
<td>Average or Fair</td>
<td>.50-.69</td>
</tr>
<tr>
<td>Unacceptable</td>
<td>.00-.49</td>
</tr>
</tbody>
</table>

1.18 Validity of Different Run and Walk Tests

An individual’s response to run and walk or physical activity exercise is an important assessment tool, since it provides a composite assessment of their cardiac, respiratory and metabolic systems. The current gold standard for assessing a person’s aerobic exercise response is the maximum incremental cardiopulmonary exercise test. However, mostly daily activities are performed at submaximal levels of exertion and, therefore, it has been proposed that submaximal functional tests are a better reflection of physical capability. The ability to walk a set of distance is a quick, easy and inexpensive way to assess physical function. It is also an important component of quality of life, to assess the capacity to undertake day-to-day activities. Balke developed a simple test for examining functional capacity; measuring the distance walked during a defined period of time. Cooper’s twelve minute run and walk

A performance test was then developed to evaluate the physical fitness of healthy individuals.\textsuperscript{84}

Walk/run test, in which time or distance is the outcome measure, are generally accepted methods of reflecting cardiorespiratory fitness.\textsuperscript{85, 86, 87, 88, 89, 90} One-mile walk/run test performance is related to peak oxygen (\(\text{VO}_2\) peak) in children and adolescents who are not overweight.\textsuperscript{91, 92} Time based walk/run tests e.g. 9 and 12 minutes have been found to yield reliable measurements (with test-retest reliability coefficients of .92-.94)\textsuperscript{93, 94} and to have concurrent validity with measurements of \(\text{VO}_2\) peak in children and adolescents who are not overweight.\textsuperscript{95, 96, 97} Some investigators have speculated that the 12 minute walk/run tests may better measure exercise tolerance among people than tests of shorter duration.\textsuperscript{98} Other investigators,\textsuperscript{99, 100} have reported that walk/run tests of longer duration (e.g. from 12

\begin{thebibliography}{100}
\end{thebibliography}
to 15 minutes) versus shorter duration (e.g. from 5 to 9 minutes) are more reflective of VO$_2$ peak. However, Jackson and Coleman$^{101}$ have reported that there are no differences between the 9-12 minutes tests relationship with VO$_2$ peak.

According to Patricia$^{102}$, reporting of validity coefficients vary in size from study to study for the same criterion-predictor combination. For example, validity coefficient for the Cooper’s twelve minute run and walk test and maximal oxygen uptake have ranged from .27 to .94. This variability in coefficients has meant that researchers must conduct new validation studies for each situation in which the test might be used.

### 1.19 The Measurement of Cardiovascular Fitness

One of the key components of physical fitness is the ability of the circulatory and respiratory system to adjust and to recover from the effects of exercise or work. The most accurate measure of this quality is generally considered to be maximal oxygen uptake. However, this measurement requires expensive equipments and the testing is time consuming and rigorous. There have been a number of tests devised to measure cardiovascular function. Usually these tests involve running a prescribed distance and the subject’s cardiovascular endurance is measured by the elapsed time required to cover the distance. This pragmatic approach has been commonly employed in physical fitness test batteries.$^{103}$

Other tests have sought to determine cardiovascular fitness through measures of pulse rate and blood pressure after different degrees of work. For an instance, heart rate increases with exercise, the pulse of untrained individual increases considerably upon moving from a reclining to standing position, whereas the person in good condition will show a very slight increase.$^{104}$

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$^{104}$ Ibid
1.20 Problems Associated with Cardiovascular Fitness Testing

It has been found that temperature, time of day, exercise, changes in body position, altitude, humidity, digestion and current state of health also may influence cardiovascular measurements. Consequently, reliability and objectivity coefficients are often low. It has also been observed that a subject’s pulse rate is sometimes lower after mild exercise than when he entered the laboratory. Of course, one of the foremost problems associated with cardiovascular fitness testing in physical education classes is the time required for testing.\(^{105}\)

1.21 A Brief Summary of Research Findings Concerning Cardiovascular Fitness Tests\(^ {106}\)

There have been differences of opinion expressed concerning the significance of pulse rate measurements before, during and after exercise. Tuttle,\(^ {107}\) contended that it was necessary to obtain a ratio of resting pulse rate to the pulse rate after exercise. Henry,\(^ {108}\) concluded that a decrease in heart rate is an effective measure of changes in athletic conditioning and that the resting pulse rate has validity as an indirect indication of condition. Metz and Alexander,\(^ {109}\) found submaximal heart rate to be significantly related to maximal oxygen intake in twelve to fifteen year old boys.

In general, the correlations among various tests of cardiovascular condition have been quite low. Several explanations for this have been suggested, such as the fact that the scoring systems are different. Clark,\(^ {110}\) in studying the relationships of initial and recovery pulse rate and recovery index, found similar relationships for both male and female subjects. The main finding of her study was that recovery pulse rate

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\(^{106}\) Ibid


increased in proportion to the duration of exercise up to two minutes of exercise. After that point the increase in recovery pulse rate diminished markedly in magnitude.

Cooper,\textsuperscript{111} did extensive research in an attempt to establish a rating scale for measuring relative values of activities in terms of cardiorespiratory conditioning. His research showed the importance of activities such as running, swimming, cycling, walking, handball, basketball, squash and others in the development of cardiorespiratory endurance. Cooper provides a simple twelve minute run-walk scoring scale for people to evaluate their own condition. Doolittle and Bigbee,\textsuperscript{112} reported that the twelve minute run-walk test correlated .90 with maximum oxygen intake and was thus a highly valid and reliable indicator of cardiorespiratory fitness. Maksud and Coutts,\textsuperscript{113} found similar reliability (.92) with boys eleven through fourteen and a correlation of .65 between the twelve minute run-walk test and aerobic capacity. There have been number of run and walk tests with different modified protocols, some of the popular are cited as nine minute run-walk test, six minute run-walk test, 2.4 km run test, Rockport fitness walking test and one mile jog test etc.

The emphasis on using criterion-referenced health fitness standards has surfaced strongly.\textsuperscript{114} Criterion-referenced or minimal health fitness standards presuppose that if an individual cannot perform at or above the standard, the person lacks sufficient health fitness. That is, if one’s health fitness status on any item is below a stated criterion, then one has not achieved an acceptable level of health fitness. Failure to achieve an acceptable level suggests an increased risk that health problems may occur in the future for an instance in Cooper’s twelve minute run and walk test.

Running and walking is the most popular and adopted form of physical activity for all the ages and sex worldwide. Similar trends have been observed in India. Hence, running/ walking programs needs to be evaluated time to time to sustain the motivation as one of the most accepted way of active lifestyle. Eventually,

\textsuperscript{111} Kenneth H. Cooper; \textit{Aerobics} (New York: Bantam Books, 1968).
contradicting to USA and other developed countries India does not have a valid test to evaluate cardio respiratory endurance across the ages and sex. It is evident that Cooper’s twelve minute run and walk test is available for testing cardio respiratory fitness of people. Indian professionals/ students/ scholars are adopting the same for the different purposes. It should be noted that the available validation for the test has been done according to the American population or others. Unfortunately the validation for the same test has yet not been done scientifically for the Indian populations. Hence, the research scholar was motivated to conduct a study to examine the validity of Cooper’s twelve minute run and walk test across the age from 13 to 60 years and above with modifications for male population of NCT of Delhi.

1.22 Statement of the Problem

The undertaken study was entitled as A Study on the Validation of Cooper’s Twelve Minute Run and Walk Test for Selected Male Populations of NCT-Delhi.

1.23 Purpose of the Study

The purpose of the study was to test the validity of modified Cooper’s twelve minute run and walk test (distance covered in twelve minute) and its modifications namely distance covered in run and walk test in the given time durations of eight minutes, nine minutes, ten minutes, and eleven minutes independently for male populations of the age categories from 13 to 19 years, from 20 to 29 years, from 30 to 39 years, from 40 to 49 years, from 50 to 59 years and from 60 to above 60 years residing in NCT of Delhi, using VO2 max, distance covered in modified Cooper’s twelve minute run and walk test (D 12), exercise heart rate at the termination of modified Cooper’s twelve minute run and walk test (EHR 12) as criterion measures.

1.24 Delimitations of the Study

1. The study was delimited to the physically active male populations of the age categories from 13 to 19 years, from 20 to 29 years, from 30 to 39 years, from 40 to 49 years, from 50 to 59 years and from 60 to above 60 years.
2. The study was delimited to male populations only.
3. The study was delimited to people from different states residing in NCT of Delhi at least for last three years.
4. Performance variables were distances covered in the given time durations.
5. Maximal Volume of Oxygen Consumptions (VO$_2$ max) were estimated from modified Cooper’s twelve minute run and walk test, BYU one mile jog test and bicycle ergometer test.
6. The criterion measures were VO$_2$ max estimated from modified Cooper’s twelve minute run and walk test (CVO$_2$ max), VO$_2$ max estimated from BYU one mile jog test (JVO$_2$ max) and VO$_2$ max estimated from bicycle ergometer test (BE VO$_2$ max), distance covered in modified Cooper’s twelve minute run and walk test (D 12), exercise heart rate recorded at the termination of modified Cooper’s twelve minute run and walk test (EHR 12).

1.25 Limitation of the Study

All the subjects consented for experimentations (testings) and gave the release from liabilities for participating as sample or subject for the study. All the subjects participated in all the field tests but failed to participate in the laboratory tests due to lack of administrative feasibility (distance, time and cost), considered as a limitation of the study. The research scholar has overcomed the above limitation by testing atleast thirty (N ≥ 30) sample in the laboratory for each selected age category.

1.26 Hypotheses of the Study

1. It was hypothesized that modified Cooper’s twelve minute run and walk test will be a valid test for selected male populations i.e. age categories from 13 to 19 years, from 20 to 29 years, from 30 to 39 years, from 40 to 49 years, from 50 to 59 years and from 60 to above 60 years of NCT of Delhi.
2. It was hypothesized that selected age categories will have different time criterion for run and walk tests.
1.27 Definitions and Explanations of the Related Terms

1.27.1 Body Mass Index (BMI)

1. Body Mass Index (BMI) is a relationship between weight and height that is associated with body fat and health risk.\textsuperscript{115}

2. A standardized estimate of an individual’s relative body fat calculated from his or her height and weight. The formula for calculating BMI is weight in kilograms (kg) divided by height in meters (m) squared.\textsuperscript{116}

3. BMI was a supporting variable to understand and explain the samples of selected age categories in the conducted study.

1.27.2 Concurrent Validity

1. Validity of a test or a measurement tool that is established by simultaneously applying a previously validated tool or test to the same phenomenon, or data base, and comparing the results. Concurrent validity is achieved if the results are highly correlated (the same or similar) at a statistically significant level.\textsuperscript{117}

2. The degree to which results from one test agree with results from other different tests.\textsuperscript{118}

1.27.3 Construct Validity

1. Construct validity defines how well a test or experiment measures up to its claims. It refers to whether the operational definition of a variable actually reflects the true theoretical meaning of a concept.\textsuperscript{119}

2. Validity of a test or a measurement tool that is established by demonstrating its ability to identify or measure the variables or constructs that it proposes to identify.

\textsuperscript{115} \texttt{http://walking.about.com/od/diet/g/bmi.htm}
\textsuperscript{116} Ibid
\textsuperscript{118} Mosby's Dictionary of Complementary and Alternative Medicin, © 2005, Elsevier
\textsuperscript{119} \texttt{http://www.experiment-resources.com/construct-validity.html#ixzz1oKJnILjw}
or measure. The judgment is based on the accumulation of correlations from numerous studies using the instrument being evaluated.\textsuperscript{120}

1.27.4 Content Validity

1. Validity of a test or a measurement as a result of the use of previously tested items or concepts within the tool.\textsuperscript{121}
2. The degree to which the items within a research instrument or measurement tool represent the universe of content for the concept being measured or the domain of a given behavior.\textsuperscript{122}
3. The degree to which an experiment or measurement actually reflects the variable it has been designed to measure.\textsuperscript{123}

1.27.5 Criterion Validity

A test is said to have criterion-related validity when the test has demonstrated its effectiveness in predicting criterion or indicators of a construct.\textsuperscript{124}

1.27.6 Face Validity

Face validity is a simple form of validity in which researchers determine if the test seems to measure what it is intended to measure. Essentially, researchers are simply taking the validity of the test at face value by looking at whether a test appears to measure the target variable. On a measure of happiness, for example, the test would be said to have face validity if it appeared to actually measure levels of happiness.\textsuperscript{125}

1.27.7 Heart Rate

1. The number of heart beats per unit of time, usually expressed as beats per minute.\textsuperscript{126}

\textsuperscript{120} Mosby's Medical Dictionary, 8th edition. © 2009, Elsevier.
\textsuperscript{121} Ibid
\textsuperscript{122} Ibid
\textsuperscript{123} Ibid
\textsuperscript{124} Mosby's Dictionary of Complementary and Alternative Medicine. (c) 2005, Elsevier.
\textsuperscript{125} http://psychology.about.com/od/researchmethods/f/validity.htm
\textsuperscript{126} Ibid
\textsuperscript{126} The American Heritage® Medical Dictionary Copyright © 2007, 2004 by Houghton Mifflin Company. Published by Houghton Mifflin Company.
2. The frequency with which the heart beats, calculated by counting the number of QRS complexes or ventricular beats per minute.\textsuperscript{127}

### 1.27.8 Physical Activity

1. Physical activity is any bodily activity that enhances or maintains physical fitness and overall health and wellness.\textsuperscript{128}

2. Athletic, recreational or occupational activities that require physical skills and utilize strength, power, endurance, speed, flexibility, range of motion or agility.\textsuperscript{129}

3. Any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level. In these Guidelines, physical activity generally refers to the subset of physical activity that enhances health.\textsuperscript{130}

4. Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure above resting level.\textsuperscript{131}

### 1.27.9 Physical Fitness

1. The ability to function efficiently and effectively, to enjoy leisure, to be healthy, to resist disease, and to cope with emergency situations.\textsuperscript{132}

2. The ability to carry out daily tasks with alertness and vigor, without undue fatigue, and with enough energy reserve to meet emergencies or to enjoy leisure time.\textsuperscript{133}

### 1.27.10 Polar Heart Rate Monitor

1. A device that measures and displays one’s heart rate while exercising. Commonly, it has a monitor strap held in place around the chest by an elastic band. The heart rate is displayed on a watch, badge, or translated into sound through earphones. Walkers, runners, bikers use heart rate monitors to achieve the intensity of

\textsuperscript{127} Mosby's Medical Dictionary, 8th edition. © 2009, Elsevier

\textsuperscript{128} http://en.wikipedia.org/wiki/Physical_exercise

\textsuperscript{129} McGraw-Hill Concise Dictionary of Modern Medicine, © 2002 by The McGraw-Hill Companies, Inc.

\textsuperscript{130} http://www.cdc.gov/physicalactivity/everyone/glossary/


\textsuperscript{132} Ibid

\textsuperscript{133} Mosby's Dental Dictionary. Copyright © 2004 by Elsevier, Inc.
workout they want. Various models have other functions such as a stopwatch, time of day, pre-set workouts, calories burned.\(^{134}\)

2. A small machine that straps over the chest or onto the wrist to accurately measure a person’s heart rate.\(^{135}\)

### 1.27.11 Predictive Validity

1. Predictive Validity occurs when the criterion measures are obtained at a time after the test.\(^{136}\)

2. In predictive validity, one assesses the operationalization's ability to predict something it should theoretically be able to predict.\(^{137}\)

3. The effectiveness of one set of test or research results as a predictor of the outcome of future experiments or tests.\(^{138}\)

4. In predictive validity dependent variable is predicted by one or more independent variables.

### 1.27.12 Ratings of Perceived Exertion (RPE)

1. RPE is a subjective rating that the trainee assigns to the intensity of his/her exercise based on their perception of how hard the physical exertion was.\(^{139}\)

2. Subjective numeric rating (range from 6 to 19) of exercise intensity based on how a subject feels in relation to level of physiologic stress. An RPE of 13 or 14 (exercise that feels “somewhat hard”) coincides with an exercise heart rate of about 70% maximum.\(^{140}\)

3. In the conducted study RPE was used to control the intensity of exercise as a safety measure and to have consistent performance.

\(^{134}\) [http://walking.about.com/od/trainer/g/heartmonitor.htm](http://walking.about.com/od/trainer/g/heartmonitor.htm)
\(^{135}\) [http://www.sportsmedicinedictionary.com/definition/heart-rate-monitor.html](http://www.sportsmedicinedictionary.com/definition/heart-rate-monitor.html)
\(^{136}\) [http://psychology.about.com/od/researchmethods/f/validity.htm](http://psychology.about.com/od/researchmethods/f/validity.htm)
\(^{137}\) [http://psychology.about.com/od/researchmethods/f/validity.htm](http://psychology.about.com/od/researchmethods/f/validity.htm)
\(^{139}\) [http://www.bodyresults.com/e2rpe.asp](http://www.bodyresults.com/e2rpe.asp)
1.27.13 Recovery Heart Rate

1. Recovery heart rate is the heart rate measured at a fixed (or reference) period after ceasing activity, typically measured over a one minute period. In the conducted study it was measured for five minutes after termination of activity/test.

2. Recovery heart rate refers to the measurement of the rate of heart beat (or pulse) following the completion of aerobic exercise.

1.27.14 Validity

1. The extent to which a measuring device measures what it intends or purports to measure.

2. Validity is the extent to which a test measures what it claims to measure.

1.27.15 VO₂ Max

1. VO₂ max (also maximal oxygen consumption, maximal oxygen uptake, peak oxygen uptake or aerobic capacity) is the maximum capacity of an individual's body to transport and use oxygen during incremental exercise, which reflects the physical fitness of the individual. The name is derived from V - volume per time, O₂ - oxygen, max - maximum. VO₂ max is expressed either as an absolute rate in litres of oxygen per minute (l/min) or as a relative rate in millilitres of oxygen per kilogram of body weight per minute (ml/kg/min). The latter expression is often used to compare the performance of endurance sports athletes.

2. VO₂ max is the maximal oxygen uptake or the maximum volume of oxygen that can be utilized in one minute during maximal or exhaustive exercise. It is measured as millilitres of oxygen used in one minute per kilogram of body weight.

3. The largest amount of oxygen one can consume and use to produce energy during maximal or very intense exercise.

141 http://en.wikipedia.org/wiki/Heart_rate
142 http://weightloss.about.com/od/glossary/g/recheartrate.htm
143 Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition. © 2003 by Saunders
144 http://psychology.about.com/od/researchmethods/f/validity.htm
145 http://en.wikipedia.org/wiki/VO2_max
146 http://sportsmedicine.about.com/od/glossary/g/VO2Max.htm
147 http://www.fitnessforweightloss.com/terms/maximal-oxygen-uptake/
1.27.16 Workload

1. Workload refers to the total energy output of a system, particularly of a person or animal performing a strenuous task over time.\(^{148}\)

2. The amount of work performed or capable of being performed by a person usually within a specific period.\(^{149}\)

1.28 Significance of the Study

Regular physical activity increases life expectancy, gives functional independence, enhances quality of life, prevents and manages different types of diseases and sicknesses namely coronary heart disease, hypertension, diabetes, osteoporosis and depression associated with a lower rate of colon cancer and stroke, reduced back injury; prevents and controls blood pressure, blood lipid profile; improves clotting factors, increases glucose tolerance along which helps to increase strength, endurance and flexibility including cardiorespiratory fitness. Thus protect us against injury and disability across all the ages.

It is unclear that what exact type and amounts of physical activities are required for precise health benefits, several health-related dimensions of physical activity are thought to be most important for providing selected health effects. These effects are evaluated by adopting some test/s. While adopting a test the question of scientific authenticity, specifically validity is always under question for application to specific age sex and requirements.

Jogging/running tests have been extensively addressed in this chapter. It was found that the Indian professionals/ students/ scholars are adopting the same for the different purposes. It should be noted that the available validation for the test has been done according to the American population or others. Unfortunately the validation for the same test has yet not been done scientifically for the Indian populations. Hence, the research scholar was motivated to conduct a study to examine the validity of Cooper’s twelve minute run and walk test across the age from 13 to 60 years and


above with modifications for male populations of NCT of Delhi. The findings of the study will be helpful for:

- Providing scientifically authentic cardio respiratory run and walk tests for selected male populations of NCT of Delhi, age ranging 13 to above 60 years of age.

- Assessing cardio respiratory fitness of the people for different purposes such as qualifying, grouping, screening, selection, placement, achievement assessment, program assessment, professional evaluation for health, fitness and wellbeing etc.

- Validated test may be utilized by the physical educators for the purpose of research. This may be in the form of observational research in which measures are taken to study the status or for establishing norms; or evaluating a endurance training program in order to understand the improvement as an effect of games/sports/physical activity participation.

- Assessing physiological adaptations with special reference to cardio respiratory endurance as an effect of exercise (run and walk) of a training program/camp and other research purposes etc.

- Discrimination of the male populations into various categories or groups for programming and programme management.

- Study targeted the general masses, which was a remarkable research gap for selected male populations mainly age groups from 13 to 19 years, from 20 to 29 years, from 30 to 39 years, from 40 to 49 years, from 50 to 59 years and from 60 to above 60 years, hence the paradigm of the research has increased the horizon of applications in India.

- It has been observed that the research has given enough impetus to promote the practices of physical activity in the participants and it is believed that such practices has very strong future potential to promote the practices of physical activity. Thus physical activity will increase life expectancy; will give functional independence; will prevent and manage different types of diseases and sicknesses such as coronary heart disease, hypertension, diabetes, osteoporosis and depression; regular physical activity is associated with a lower rate of colon cancer, stroke and reduced back injury; regular physical activity will prevent
and control blood pressure, blood lipid profile, will improve clotting factors; will increase glucose tolerance along with increase in strength, endurance and flexibility including cardiorespiratory fitness. Thus will protect us against injury and disability across all the ages.