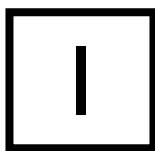


CHAPTER-I

Introduction

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INTRODUCTION

1.1 BACKGROUND

Biological (Physical) Anthropology has been defined as the study of man's biological variation in time and space. Biological anthropologists have been mainly concerned with the study of the human origins and human evolution as well as varieties of mankind in different parts of the world. Lately new dimensions have been added; namely the study of human growth and development in various human populations. The effect of environment and nutrition on the growth and development of human beings is also sought to be assessed. Biological anthropologists have developed new techniques as well as instruments to meet these new challenges over the last three decades. It has increasingly interacted with other disciplines like medicine, nutrition, public health, physiology, psychology, statistics and other allied disciplines to develop new methods and techniques.

Biological anthropologists have in recent years become increasingly concerned with the dimensions, proportions, and shape of man's immediate physical environments. Anthropometry represents the typical and traditional tool of biological anthropology for these purposes. Anthropometry has kept pace with these developments and provided suitable measurements and techniques. Customarily, it has developed powerful tools and techniques to study human variation and human evolution. Currently the techniques of anthropometrics have been modified to meet challenges of anthropological research and have now become an integral part of applied research especially in the areas of growth and development, scientific maintenance of modern health protection especially fitness as well as sports.

1.2 ANTHROPOMETRY

Anthropometry literally means “the measurement of human being”. It provides scientific methods and techniques for taking various measurements and observations on the living man and the skeleton. The origins of anthropometry are very ancient. In ancient Egypt and Greece, artists formulated various standard canons for the human body. The word “Anthropometry” was first used in the seventeenth century by a German physician, J. Sigismund Elshwltz (1623-1688) in his graduation thesis entitled “Anthropometria”. He also invented the first anthropometer (Singh and Bhasin 2004). Anthropometry as a scientific discipline, however, began with Johann Friedrich Blumenbach (1752-1840) who laid the foundation of craniometry (a sub-division of anthropometry which deals with the measurements of skull).

Anthropometry is the means of quantifying variations in body size, shape and composition. It is one of the most fundamental practical techniques of human biology, since nearly all biological functions are in some way related to one or other aspect of the physical dimensions of the body (Weiner and Lourie 1981). The use of anthropometrics provides a reasonably reproducible value and gives a topographical assessment of an individual. The application of anthropometric measurements to estimate adiposity, body composition and nutritional status is well established. Both theoretical and empirical evidence supports the utility of this approach in many populations (WHO 1995).

Anthropometry is the single most portable, universally applicable, inexpensive, and non-invasive method available to assess the size, proportions, and composition of the human body (WHO 1995). Anthropometric changes over time have also been studied. Analysis of intergenerational changes of secular trends can reveal increase or reduction in size, early or late maturity, or lack of change. Moreover, since growth in children and body dimensions at all ages reflect the overall health and well being of individuals and populations, anthropometry may also be used to predict performance, health, and survival. These applications are

important for public health and clinical decisions that affect the health and social welfare of individuals and populations (Falkner and Tanner 1986, Cameron 2002).

Anthropometric data have been extensively used in public health e.g. identification of significant growth retardation in children (Hop et al. 1997) and adolescents (Pawloski 2002). Simple indicators based on weight to height comparison and indices that use arm circumference are useful in identifying individuals at high risk of morbidity and mortality (Ko et al. 1999, Khongsdier 2002, 2005). Anthropometry has also been used for studies of chronic diseases endemic to developed countries including cardio-vascular disease, cancer, obesity and diabetes (Cox et al. 1997, Bose and Mascie-Taylor 1997, 1998; Yasmin and Mascie-Taylor 2000). Body size, frame, fat patterning and body composition are viewed as long term indicators of life patterns, and as overall measures of health and disease risk. The combined results of measured body with weight, circumferences and skinfold thicknesses can establish the amount and rate of change over time in protein-energy content of the individual.

A comparison of the patient's measurements with that of a healthy reference group helps in establishing his or her risk of complications (Lee et al. 2005). Occasional anthropometric measurements during the course of a nutrition support programme provide useful information on changes in body composition. Anthropometric measurements, along with standard nutritional assessment indices, have attempted to predict complications of undernutrition (Woodruff and Duffield 2002).

A number of anthropometrically measurable attributes of the human body like stature, relative weight, muscularity, frame size, various weight/height indices, waist circumference in relation to chest and hip circumferences, skinfolds thickness at various sites and the overall distribution of subcutaneous fat, body mass index have been known to be related to risk of developing metabolic disorders and various diseases in adults (Ko et al. 1999, Ghosh et al. 2004) and as well as children (Arif and Rohrer 2006, Chamoun and Curran-Chamoun 2006). Anthropometric methods have provided prognostic and diagnostic information for several chromosomal abnormalities e.g. Turner's syndrome (Rongen-Westerlaken et al. 1997, Parker et al.

2003). They have not only provided discriminatory factors and characteristic feature of these anomalies but also an understanding of the contributions of various chromosomes to growth (Cecil et al. 2005, Kamei et al. 2005).

1.3 ADIPOSITY

Adiposity is the result of an excessive number or size of adipose cells. Adipose cell – also called fat cell, connective tissue cells specialized to synthesize and contain large globules of fat. It is the structural and functional component of fat mass. Adipose tissue includes adipocytes, blood vessels, and structural elements, and is the primary site of lipid storage. It is located mainly in the subcutaneous and internal or visceral compartments, with its distribution under hormonal and genetic control (WHO 1995).

There are two types of adipose tissue – white adipose tissue (WAT) and brown adipose tissue (BAT). Brown adipose tissue accounts for less than 1% of the adipose mass in human adults. White adipose tissue is composed of fat cells (adipocytes) that generally contain a single, large droplet of lipid, primarily in the form of triglycerides. The nucleus of the adipocyte and cell organelles of the cytoplasm (i.e. mitochondria and others) are compressed to the outer edge of the cell between the lipid droplet and the cell membrane. Adipocytes are arranged in a network of lobules of different sizes and shapes that are held together by fibers of connective tissue. The body uses white adipose tissue to store energy for use in famines. It is now known to be a metabolically active tissue that has a major role in glucose, fatty acid, lipoprotein and cholesterol metabolism.

White adipose tissue in humans is distributed over the body. Usually a moderate proportion of the total adipose tissue is found internally around the viscera, kidneys, liver and other organs, but the largest portion is distributed more superficially and serves as the reservoir of subcutaneous fat. White adipose tissue is thus an important, metabolically active tissue and a depot of energy. It also provides mechanical protection and insulation for the body and its most vital organs.

The brown adipose cell differs in several ways from the white adipose cell. It contains several small lipid droplets in contrast to a single large lipid vacuole. The nucleus is not compressed to the periphery of the cell as in the white adipocyte. The brown adipose cell also has more mitochondria, which are larger and structurally more complex than those in the white adipocyte. In humans, brown adipose tissue is present in only certain areas of the body, primarily around the kidneys, in the back of the neck, and in the inter-scapular region of the back in the newborn infant. After infancy, brown adipose tissue involutes and disappears in most areas of the body. The brown adipose cell stores fat for its own needs and not to sustain the metabolic activities of other tissues. The main function of brown adipose tissue is not to store lipids but to generate heat (Malina and Bouchard 1989).

It has been reported that the average size increase of adipocytes (hypertrophy) happens at puberty, and it is more obvious in girls than in boys (Malina and Bouchard 1989). There is, however, considerable variation in size among adipocytes from different regions of the body, especially adipocytes composing subcutaneous fat. Adipocytes of the visceral (internal) fat have a smaller average size than those of subcutaneous fat. Cellularity of adipose tissue (hyperplasia) practically doubles with the onset of puberty and then plateaus in late adolescence and early adulthood. Adipocytes number is almost identical in boys and girls during childhood, but at puberty girls experience a greater increase in adipocytes. More recent research findings, however, indicate a wide range of individual variability in adipocytes hyperplasia and hypertrophy not only during growth but also in adulthood (Malina and Bouchard 1989).

In addition to changes in the absolute and relative amount of fat tissue in the body during growth, the distribution of fat tissue also changes. Fat distribution is the placement of fat depots on the body, and variation in the distribution of fat is currently implicated in the development of several diseases in adults. Fat depots in different areas of the body also differ in their metabolic characteristics (Vague et al. 1988, van Gaal et al. 1988, Bjorntorp 2000).

Based on fat topography, there are two major patterns of adiposity (body fatness) – overall adiposity (generalised adiposity) and regional adiposity or fat

topography (e.g. central adiposity). Both the patterns of adiposity may be linked with a variety of health risks. It is established fact that excessive accumulation of fat in the adipose tissues causes many health problems (Kopelman 2000). Anthropometric measurements have been the subject of much epidemiological research involving overweight, obesity, body fat distribution and health outcomes (Seidell et al. 2001).

Anthropometric techniques are well recognized and are a popular tool for the assessment of adiposity intensity (Lohman et al. 1988, WHO 1995, Bhadra et al. 2002). They are useful for health risk stratification. This approach is suitable for large-scale population surveys for its simplicity and cost effectiveness. Body mass index (BMI) is the most commonly used measure of overall adiposity (generalised adiposity) while circumferences and skinfolds are measures of regional adiposity pattern. Central body fat distribution is measured by waist circumference (WC) and three commonly used indices, waist-hip ratio (WHR), waist-height ratio (WHTR) and conicity index (CI).

1.4 BODY COMPOSITION

Mankind has long been fascinated with the composition of the human body. Recently, there have been major advances in conceptual models relating anthropometry to body composition, which provide insight into the physiological mechanisms represented by anthropometry (Wang et al. 1992). There are five organizational levels of body composition. Human body composition can be studied at the atomic, molecular, cellular, tissue and whole body level. These five levels of body composition are interrelated. This means that information at one level can be translated to another level. This permits information about body composition at various levels to be derived from anthropometric measurements made at the whole body level. Both aging and disease affect these quantitative relationships, and anthropometry provides a means of detecting the resultant changes.

Body composition techniques can be described in terms of direct, indirect and doubly indirect method. In direct methods the body component of interest is determined directly without or with only minor assumptions. In indirect techniques, the body component of interest is determined indirectly. Doubly indirect methods rely

on a statistical relationship. Several direct, indirect and doubly indirect techniques are available to measure body composition, each with its own distinct advantages and disadvantages. The choice of method will be influenced by the availability of instrumentation, invasiveness, and radiation danger to subjects, price, accuracy required, and application objectives.

The most widely studied and rather simplified model of body composition is the tissue-system level. The body composition model at the tissue level would be: body weight = (skeletal muscle + adipose tissue + bone + organs + blood + rest). Several of these components can now be measured with, for example, computed tomography (CT) or magnetic resonance imaging (MRI) for adipose tissue, creatinine excretion or *N*-methyl-histidine excretion in 24 hours urine for skeletal muscle, dual-energy X-ray absorptiometry (DXA) for bones and MRI or ultrasound for organs. On the other hand, body composition measurements at the whole body level use simple body parameters to give an insight into the body composition. Formulae, based on statistical relationships that have been established in earlier studies between body parameters (e.g. skinfold thickness) and information on body composition (e.g. body fat by density), also enable the assessment of body composition. More complex techniques are laboratory-based, while anthropometric techniques (estimates of fat mass and predicted of fat free mass) can be used to assess body composition in the field conditions, simply, non-invasively, and at a reasonable cost (Shephard 1991).

The composition of body can be viewed in a variety of ways. Two models used in most studies of body composition viz. two-compartment model and multi-compartment models (e.g. biochemical model). The first is based on the perspective of those who work with individuals in clinics, nutrition centers, fitness centers, health surveys and other such settings; the second, on the perspectives of the biochemist. Of these, the simple two-compartment model, which partitions body mass into its 'lean' and 'fat' components, has the widest application. The lean aspect of the body referred to as 'lean body mass' or 'fat free mass', and the other portion of the model is 'fat mass'. Fat free mass is everything that is not fat. The terms 'lean body weight' or 'fat-free weight' are occasionally used, but 'mass' is more appropriate (Malina and Bouchard 1989). It is a common understanding that fat free

mass increase with body weight (Mingrone et al. 2001). This report uses the terms fat-free mass (FFM) and fat mass (FM), and the two-component model is expressed as: $\text{body weight} = (\text{FFM} + \text{FM})$. Thus, body composition measures the proportion of body weight that is fat (fat mass) and that which is lean body mass (fat-free mass). Accordingly, the two-compartment model approaches body composition in a holistic manner (Forbes 1987).

The variation in body composition between individuals is large, mainly because of variations in FM. However, variations in FFM are smaller. FM is readily influenced by, for example, diet pattern and physical activity, and thus FM is the most liable component of body composition. It is also the aspect of body composition that has received most attention, because of concern that excessive fatness is a handicapping factor in physical performance and is a health risk.

Body composition data are used to evaluate nutritional status, growth and development, water homeostasis and specific disease states. Today it is known that many diseases and disorders are related to abnormal body composition or to changes in body composition. The most common of these conditions is obesity, in which the amount of body fat is excessively high, leading to abnormalities in lipids and carbohydrate metabolism, high blood pressure and adult-onset diabetes. At the other end of the nutritional spectrum, energy and protein malnutrition results in a decrease in the amount of fat and protein stores in the body, and many diseases are related to abnormalities in total body water or to the distribution of body water across the intracellular and extracellular spaces. As a result, body composition becomes an indispensable indicator of health and fitness.

1.5 PHYSICAL ACTIVITY

The physical activity level (PAL) is a way to express a person's daily physical activity as a number, and is used to estimate a person's total energy expenditure. The physical activity level can also be estimated based on a list of the (physical) activities a person performs from day to day. Each activity is connected to a number, the physical activity ratio. The physical activity level is then the time-weighted average of the physical activity ratios (Swaminathan and Vaz 2012).

Physical inactivity is now identified as the fourth leading risk factor for global mortality. Physical inactivity levels are rising in many countries with major implications for the prevalence of noncommunicable diseases (NCDs) and the general health of the population worldwide. The significance of physical activity on public health, the global mandates for the work carried out by WHO in relation to promotion of physical activity and NCDs prevention, and the limited existence of national guidelines on physical activity for health in low- and middle-income countries (LMIC) make evident the need for the development of global recommendations that address the links between the frequency, duration, intensity, type and total amount of physical activity needed for the prevention of NCDs (Ghosh 2010).

For children and young people, physical activity includes play, games, sports, transportation, chores, recreation, physical education, or planned exercise, in the context of family, school, and community activities (Mukhopadhyay et al. 2005).

In order to improve cardiorespiratory and muscular fitness, bone health, and cardiovascular and metabolic health biomarkers: firstly, children and youth aged 5–17 should accumulate at least 60 minutes of moderate- to vigorous-intensity physical activity daily; secondly, the amounts of physical activity greater than 60 minutes provide additional health benefits; thirdly, most of the daily physical activity should be aerobic; lastly, vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week (Swaminathan and Vaz 2012).

1.6 PRESENT STUDY

Anthropometrics is an essential and well recognized measure of health and fitness for the general population. Besides fat patterning, other body dimensions like several circumferences, gross quantity of fat, stature, body weight, body widths etc. have been used as important indices of health and nutritional status (WHO 1995).

There is a wide range of data on growth, development, and nutritional status of the adolescents from various populations of the world (Eveleth and Tanner 1990). Recent worldwide trends have investigated regional adiposity, body composition and body fat distribution among children and adolescents (Al-Sendi et al. 2003, Li et al. 2005, Okada et al. 2005). There have been numerous studies on the growth of Indian children (ICMR 1989, 1996), but most of them have investigated height and weight only. However, to date, investigations from India on adiposity and body composition patterns are scanty (Bhadra et al. 2001, 2005a; Mukhopadhyay et al. 2005a, 2005b). Moreover, there is very little information on the anthropometric dimensions and nutritional status of adolescents from urban West Bengal (de Onis et al. 2001, Woodruff and Duffield 2002, Bhadra et al. 2004, Bose and Mukhopadhyay 2004, Mukhopadhyay et al. 2005d). To the best of the knowledge of the present worker, none of these studies have dealt, in detail, with adiposity, central body fat distribution and body composition. Therefore, there are no population based data available on body fat distribution and body composition of Muslim boys and girls.

In view of the above facts, the present investigation was undertaken to study age variations in regional adiposity, subcutaneous body fat pattern and body composition with relation to the physical activity among Muslim boys and girls. It also attempted to evaluate the nutritional status of the subjects. This study presents unique anthropometric and body composition data on Muslim boys and girls that will be useful as a comparative database for other population studies in India. Moreover, the results of the present study would yield vital information for the formulation of policies as well as initiate strategies for the well being of the adolescents, and Muslim adolescents, in particular.

1.7 OBJECTIVES OF THE STUDY

The present research aims to determine the pattern of adiposity and body composition among the adolescent Muslim school boys and girls aged 10–17 years. Other specific objectives are –

- (1) to explore the anthropometric characteristics of the boys and girls under study with special emphasis on the evaluation of nutritional status.
- (2) to evaluate generalised adiposity, central adiposity, regional adiposity and subcutaneous fat distribution among the studied sample.
- (3) to study different measures of body composition among these boys and girls.
- (4) to investigate age variations in various anthropometric and body composition measures.
- (5) to investigate the effect of physical activity on adiposity, body fat distribution and body composition variables of the studied sample.