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Anthropometric Parameters in Health and Diseases: A Review

I.S.I. Ogbu[1] and Emmanuel Ifeanyi Obeagu[2]

[1]Department of Medical Laboratory Science. Evangel University. Akaeze. Ebonyi State. Nigeria.
[2]Department Of Medical Laboratory Science, Kampala International University, Uganda.

Corresponding Authour: Emmanuel Ifeanyi Obeagu, Department of Medical Laboratory Science, Kampala International University, Uganda, emmanuelobeagu@yahoo.com, obeagu.emmanuel@kiu.ac.ug, 0000-0002-4538-0161

Abbreviations and Meaning
BMI- body mass index
WHO- World Health Organization
CDC- Center for Disease Control
ULL- upper leg length
UAL-upper arm length
MUAC- mid-upper arm circumference
WHR- waist-hip ratio
WC- waist circumference
BAF- brown adipose fat

Abstract.

Anthropometric parameters play a pivotal role in assessing human health and disease states. This paper aims to comprehensively explore the significance of various anthropometric measurements in understanding health outcomes and identifying potential disease risks. It covers a wide spectrum of anthropometric parameters, including body mass index (BMI), waist circumference, waist-to-hip ratio, skinfold thickness, and their implications in different health conditions. The paper highlights the intricate relationship between anthropometric measurements and various diseases such as cardiovascular disorders, diabetes, metabolic syndrome, and certain cancers. It delves into the multifaceted nature of these parameters as predictive tools for disease onset, progression, and overall prognosis. Furthermore, it examines the evolving perspectives on anthropometric indices across different populations and age groups. Additionally, this paper discusses the limitations and challenges associated with the utilization of anthropometric measurements in clinical settings, emphasizing the need for standardized protocols and continuous research advancements to enhance their accuracy and clinical applicability. Overall, this paper consolidates existing knowledge on anthropometric parameters, elucidating their crucial role as valuable indicators in assessing health status, predicting disease risks, and guiding preventive healthcare strategies.

Keywords: *anthropometry; obesity; nutritional assessment; body mass index; waist-hip ratio; body weight*

Introduction

Weight, height, length, certain skinfold thicknesses, and the circumferences of the head, waist, hips, and arms are all provided through anthropometric measures, which are noninvasive quantitative measurements of the body. Body measures in people can be used to determine nutritional status, illness risk, and current and future health. In addition to determining body composition and nutritional status, these parameters can also be used to identify obesity. The identification of underlying medical, dietary, or social issues in children can be aided by accurate serial anthropometric measurements [1]. Measurements that are abnormal call for more investigation. Athletes' body composition may also be evaluated using anthropometric measures, which can also be used to pinpoint underlying medical issues like eating disorders and enhance cardiorespiratory fitness and strength. They are also used to evaluate obese individuals and the nutritional condition of expectant mothers. Information on body composition and fat distribution is derived from several anthropometric measures and measurement combinations [2-3].

Age, sex, genetics, disease, certain hormones, and some pharmacological therapies all affect how much and where fat and fat-free mass are distributed in the body. Height, weight, head circumference, body mass index (BMI) in kg/m^2, waist, hip, and limb circumferences to measure adiposity, and skinfold thickness make up the basic components of anthropometry [4].

In the field, including people's homes or rural centers, measurements can be taken using lighter, more durable, and portable equipment or in labs, clinics, and hospitals utilizing fixed, precise equipment with a high degree of accuracy. When collecting anthropometric data, participants don light clothes and no shoes. Weight and height are measured to the nearest kilogram (kg) and centimeter (cm), respectively. Weight (kg)/height (m^2) is how BMI in kg/m^2 is determined. The measurements of the waist and hip circumferences are accurate to 0.1 cm. Weight changes regularly, thus it's best to average results from body composition exams over a certain period of time [1].

The clinical importance, benefits, and restrictions of anthropometric measures are discussed in this article along with its technical flaws and most common applications.

Methodology

Different research search engines were ustilsed for writing this paper such as Pubmed Central, Scopus, Web of Science, Google Scholar, Researchgate, Academia Edu, etc.

Clinical Significance

Anthropometric data is useful in defining obesity in the adult population, and it is often used to assess nutritional status in children. To guarantee proper development patterns and determine the danger of obesity, anthropometry is essential in all children and adolescents at each preventative visit to a medical facility. Obesity is a significant, modifiable risk factor for heart disease, stroke, type 2 diabetes, dyslipidemia, and hypertension. Using anthropometric data to determine obesity is one of the finest clinical applications. An increased odds ratio of dyslipidemia, hypertension, and hyperglycemia was associated with larger anthropometric measures [1]. The most crucial element of anthropometry is accurate serial measurements throughout time. Solitary aberrations from the development pattern curve might be caused by an acute sickness or a normal variety. However, a consistent alteration in the development curve over time is a reliable sign of an atypical growth pattern and necessitates more research. Weight, length, and head circumference are given for children under the age of two. It is advised to measure a child's weight, length, and body mass index (BMI) for children older than two years old in order to assess their dietary needs and risk of obesity.

To compare the kid to the general population, the measures are plotted on gender- and age-specific World Health Organization (WHO) or Center for Disease Control (CDC) charts. Anthropometric measures are used to assess nutritional health and the likelihood of developing illness in people. The WHO charts are used for the growth of healthy children under optimal dietary and environmental conditions regardless of ethnicity, socioeconomic status, and feeding, providing a "goal" standard for optimal growth while the Centers for Disease Control and Prevention (CDC) charts are specific to children in the United States [5-8]. A shorter upper leg length (ULL) is associated with metabolic syndrome, and the lengths of the extremities are connected to chronic disorders. Diabetes among Japanese Americans is associated with shorter upper arm length (UAL) [7-8]. In order to diagnose microcephaly in children, head circumference is frequently employed. Z-scores and BMI computations can be used to identify childhood obesity and malnutrition [9]. The mid-upper arm circumference (MUAC) is a measurement that may be used to determine the degree of malnutrition and evaluate the nutritional status of pregnant women [10]. According to one study, ultrasonography is not as effective in measuring regional adiposity as anthropometric measurements of the waist and hip circumferences [11].

Anthropometric data have been found useful in chronic medical conditions such as myocardial infarction, congestive heart failure, stroke, cognitive impairment, and dementia. A shorter upper leg length (ULL) is associated with metabolic syndrome, and the lengths of the extremities are connected to chronic disorders. Diabetes among Japanese Americans is associated with shorter upper arm length (UAL) [7-8]. In order to diagnose microcephaly in children, head circumference is frequently employed. Z-scores and BMI vcomputations can be used to identify childhood obesity and malnutrition [9]. The mid-upper arm circumference (MUAC) is a measurement that may be used to determine the degree of malnutrition and evaluate the nutritional status of pregnant women [10]. According to one study, ultrasonography is not as effective in measuring regional adiposity as anthropometric measurements of the waist and hip circumferences [11].

Anthropometric Parameters

These are non-invasive bodily measures that are taken directly, as well as indices that are generated from them. They include body mass index (BMI) in kg/m^2, which is calculated using the user's height and weight. Measurements of the waist, hips, skin fold thickness (triceps), and head size are used to calculate the waist-hip ratio (WHR). It is also possible to measure and utilize in therapeutic settings the length of the extremities.

Height

The degree to which someone is tall may be determined by their height. Variations in human height are influenced by both environmental and genetic variables [12]. The stadiometer is a tool used to gauge height. It's a lengthy ruler that is fastened to the wall. It has an adjustable, sliding horizontal headgear that rests atop the head. The person is measured for height while standing on a level surface, free from any jewelry or other objects that might impede an accurate measurement. The individual should have their head, buttocks, and heels in contact with the wall that the stadiometer is mounted. The difficulty in measuring height may be due to the misconception that it is simple to do so, which can lead people to ignore the several procedures necessary for an accurate measurement. If not, the measurement is often accurate. The United Nations tracks changes in the nutritional state of developing countries using information on height and other factors. Average height in human societies may simplify complicated information about the population's origins, upbringing, socioeconomic status, food, and health care system. variations in a people's economics were linked by Baten *et al.* to variations in height [13].

Weight

It is easier to measure weight than height. Weight and mass are not the same quantities; mass is an intrinsic property of matter, whereas weight is a force that results from the action of gravity on matter. Similarly, fat will weigh less than lean piece of tissue of the same mass. BMI and weight also are not the same though popular usage will suggest otherwise. Weight is a factor of BMI which is an index of weight and height. Weight loss is associated with reductions in risk factor for several cardiovascular, pulmonary, and cancer conditions, [14-15]. The incidence of various types of cancers [16], stroke [17], osteoarthritis [18] and infertility [19], increase with excess body fat. Excess body fat may protect against the incidence but not the associated mortality, of pre-menopausal breast cancer [16], and hip fracture [20].

The range of weights associated with the lowest death rate has historically served as the basis for healthy weight recommendations. However, there is the issue of reverse causation, whereby people commonly lose weight as a result of illnesses that are deadly, creating the impression that death rates are higher among those who are less overweight. Alcoholism, cancer, and depression are a few conditions that can cause weight loss yet go years without being recognized as such. Second, confounding variables such as smoking (smokers often weigh less and have greater mortality than non-smokers), drunkenness, food composition, and physical activity may obscure the relationship between body weight and mortality [13]. According to the Dietary Guidelines for Americans published in 1980 (Department of Agriculture, 1980), a healthy weight is defined as having a BMI range between 21 and 25. This recommendation is consistent with those made by the WHO Expert Committee and the Steering Committee of the American Institute of Nutrition [21].

Adults who gain weight run a proportionate risk of developing coronary heart disease, hypertension, and type 2 diabetes [16, 22-23]. The lack of weight growth, especially among those older than 50, does not always mean that fat levels have decreased. To varied degrees, fat replaces muscle mass, and much of it is stored in the belly, which increases waist circumference.

Body Mass Index.

The body's entire fat content may be estimated by BMI in kg/m^2, which is a reliable measure of general physical health. Calculating a person's BMI is significant since it provides for more information about health risk factors than do basic weight and height measurements. The acceptable BMI ranges change depending on factors including age, gender, and, in certain situations, personal traits. BMI readings under 18.5 are often categorized as underweight; readings between 25 and 29.9 as overweight; and readings over 30 as obese. A more thorough categorization of BMI values was offered by the International Obesity Task Force [13, 24-25], as follows:

i. healthy weight	18.5 – 24.9
ii. overweight	25 – 29.9
iii. obesity class 1	30 – 34.9
iv. obesity class 11	35 – 39.9
v. obesity class 111	≥ 40.

Weight (kg) is divided by the squared height (m) yields the (BMI), also known as the Quetelet Index. When height is recorded in inches and weight is determined in pounds, the BMI is calculated as follows: weight (in lb)/height (in inches) 2 x 703. Measurements of height and weight are always correct and do not significantly add to BMI assessment mistakes. However, BMI does not distinguish between lean and fat mass and may not be very trustworthy in older persons, because differential loss of lean mass contributes more to fluctuations in weight.

BMI does not make a body fat or health diagnosis for a person, but it does screen for weight categories that may cause health issues. It should also be compared to the patient's age and ethnicity [26]. It is helpful for epidemiological research and makes it easier to evaluate measurement findings. Values are frequently converted back to weight for certain heights and displayed in tables with recommended weight ranges [27]. Although visceral adiposity, which is the primary cause of insulin resistance in obesity, may not be a strong indicator of visceral adiposity, the BMI is a good indicator of body proportions [28-29]. Ogbu and Chukwukelu came to the conclusion in their study report that assessment of WC was a stronger predictor of metabolic syndrome than either BMI or waist-hip ratio [27].

Waist Circumference (WC)

The iliac crest and the lower ribs are used to determine waist circumference. As fat accumulates in the visceral organs, it rises. The white form of fat that is deposited there is different from subcutaneous brown adipose fat (BAF) in that it is more sensitive to insulin. Visceral fat is digested easily to produce triglycerides and fatty acids that exacerbate or induce insulin resistance and is resistant to the anti-lipolytic effects of insulin [29]. Insulin sensitivity increases with an increase in WC. According to studies, WC is a more accurate predictor of metabolic syndrome than BMI or the waist-hip ratio [27]. It has a higher predictive value than both in metabolic syndrome, [27] and correlates with measures of risk of coronary heart disease such as hypertension and blood lipids [30]; yet it is a more accurate measure of visceral fat mass than BMI, [31]. However, the cutoff point suggested by the National Cholesterol Education Adult Treatment Panel 111 (ATP 111) and International Diabetes Federation, (IDF) for men >102cm, appeared too high since it gave near absolute specificity and comparatively low sensitivity among the men and a new cutoff point of 93cm was suggested [27]. But WC varies with nation and ethnicity [32]. The issue with WC and BMI is that it might be challenging to select a point on the continuum without sacrificing either sensitivity or specificity [33].

Hip Circumference

Hip circumference, which is measured at the largest circumference around the buttocks, was found to be inversely correlated with abdominal visceral and subcutaneous adiposity depots but positively correlated with leg fat mass [34]. Whereas hip circumference assesses skeletal frame size and adipose and muscle mass in the buttock and thigh regions, waist circumference measures the amount of visceral and subcutaneous adiposity around the abdomen. Circumference has been suggested to be less associated with risk of disease and even potentially protective [35].

Waist – Hip Ratio (WHR)

The measurements of waist circumference (WC) and waist-hip ratio (WHR) are used to identify abdominal obesity. While WHR does not, WC primarily captures the level of obesity. The risk of cardiovascular disease and type 2 diabetes may grow even while one's BMI is still within a healthy range. This is based on how the body's fat is distributed. A quick, low-cost, and precise technique to determine your body fat percentage is with WHR. It can also assist in predicting diabetes and heart disease risk. The quantity of fat in a person's hips and abdomen matters to even determine whether or not they are healthy. The body's distribution of fat around the abdominal and buttock regions is determined using the WHR. A moderate WHR is defined by the WHO as being 0.85 or less for women and 0.90 or less for males [23].

Skinfold Thickness

Measurement of skinfold thickness (triceps) is useful in assessing and monitoring nutritional status in patients who cannot be weighed. It estimates subcutaneous adipose tissue, which is converted into percentage of total body weight. There are as many different formulae and calculations as there are ways to measure skinfold thickness. Skinfold measurement test is one of the oldest and most common methods of determining a person's body composition and body fat percentage. You can measure the following places: abdomen: just below the belly button; midaxilla: midline of the side of the body; pectoral area: the center of the upper chest, just in front of the armpit; quadriceps: middle of the upper thigh; subscapular area: beneath the edge of the shoulder blade; suprailiac area: just above the iliac crest of the hip bone: also known as the triceps, the upper arm's back. The abdomen, midcalf, and midthigh can also be used to quantify it [36].

These tests' precision may be influenced by the kind of calipers being employed, the tester's skill, and the patient's state of hydration at the time of the test. To measure skinfolds accurately and precisely, one needs rigorous training. The fold of skin and subcutaneous fat is difficult to pick up consistently, it may be larger than the calipers can measure in severely obese people, it compresses with repeated measurements, and careless use of the calipers can inflict pain, bruising, and skin damage on subjects.

It may not be accurate to assume that subcutaneous fat represents total body fat, because subcutaneous fat is different from visceral fat. With age, weight fluctuation, illnesses like diabetes, and in women during pregnancy, postpartum, and menopause, subcutaneous fat and subsequently skinfold thicknesses at the various places fluctuate at varied rates. The test might not be the ideal option for determining fat percentages, especially if you're attempting to perform the assessment yourself because utilizing the calipers might be challenging [37]. How It may not be accurate to assume that subcutaneous fat represents total body fat, because subcutaneous fat is different from visceral fat. With age, weight fluctuation, illnesses like diabetes, and in women during pregnancy, postpartum, and menopause, subcutaneous fat and subsequently skinfold thicknesses at the various places fluctuate at varied rates. The test might not be the ideal option for determining fat percentages, especially if you're attempting to perform the assessment yourself because utilizing the calipers might be challenging [37].

Head Circumference

During the first two years of life, when the brain is developing quickly and the open sutures between the bones of the skull are closing, the head circumference is commonly measured. After delivery, the pace of head development slows down, and by the time a child is two years old, their heads have reached their adult size. The largest occipitofrontal circumference is used to calculate head circumference. Infants with male and female heads have varied sizes. Infants born prematurely experience far quicker head growth than those born at term. When determining the presence of hydrops and various malformation syndromes, the head circumference is measured [38].

Conclusion

An important clinical technique for determining one's health and well-being is anthropometry. In spite of its flaws, BMI is frequently used to evaluate weight and wellbeing, particularly in adults. In the adult population, especially in the elderly, a straightforward WC measurement may be sufficient. It is recommended that more comparison studies be conducted on these metrics and indices across a range of populations, health conditions, ethnicities, and age groups in order to confirm and enhance their use.

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