# “Anthropometric Estimation of Bangladeshis living in three different areas”.

**By**

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## Statement of Authorship

I declare that the work presented here is my own. All sources used have been cited appropriately. Any mistakes or inaccuracies are my own.

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part a thesis presented by me for any other degree or diploma or seminar.

No other person's work has been used without due acknowledgment in the main text of the thesis.

This thesis has not been submitted for the award of any other degree or diploma in any other tertiary institution.

The ethical issues of the study has been strictly considered and protected. In case of dissemination of the findings of this project for future publication, it will be duly acknowledged as undergraduate thesis.

Signature: _____ Date: _____

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## DEDICATION

*To my beloved parents . . . . . .*

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## Acronym in this study

BHPI- Bangladesh Health Professions Institute.

CRP- Center for the Rehabilitation of the Paralyzed.

SPSS- Statistical Package for social science.

WHO- World Health Organization.

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## Abstract

**Background:** The word "anthropometry" is derived from the Greek word "anthropo" meaning "human" and the Greek word "metron" meaning "measure" (Ulajaszek 1994). The anthropometry is the science of measuring the human body & its parts (Akhter et al. 2009). The adult persons are the main productive source of any country. In Bangladesh adults are mostly working people & they mostly work in the industrial section. But in Bangladesh there is no appropriate anthropometry data for adult persons. Anthropometry is the key factor of work place design. Anthropometric data is very important for product design, machine design & other applications (Lin et al. 2004). So the study was important to conduct for ergonomics intervention.

**Aim:** To determine the anthropometric measurements for Bangladeshis aged between 18 and 60 years in 37 body dimensions.

**Methods & Materials:** The cross sectional survey method was used to carry out the research aim and objectives. The study was carried out in Centre for the Rehabilitation of the Paralyzed (CRP) & two convenience place in Bangladesh (Chandpur & Chittagong). Total one hundred fifteen (115) participants was selected for complete the research. The convenience sampling procedure was used throughout the process of participant's selection.

**Result & Discussion:** The T-test showed that the stature, eye height standing, shoulder height standing, elbow height standing, hip height standing, knuckle height standing, fingertip height standing, sitting shoulder height, sitting knee height, sitting popliteal height, shoulder-elbow length, elbow-fingertip length, overhead grip reach sitting, overhead grip reach standing, arm length vertical, downward grip length, abdomen depth sitting, buttock-knee depth sitting, buttock-popliteal depth sitting, shoulder breadth (bideltoid), span, head breadth, hand length, hand breadth, foot length & weight differences in means were statistically significant ($P < 0.05$). The present research found that male body dimension means are higher than the female body dimensions measurements means except sitting elbow length, Chest depth, Hip breadth, sitting, Head length and Head breadth.



**Keyword:** Anthropometric data, Body Dimension, Bangladeshi population.

# CHAPTER- 1 INTRODUCTION

## 1. 1. Background

The word “anthropometry” is derived from the Greek word “anthropo” meaning “human” and the Greek word “metron” meaning “measure” (Ulajaszek 1994). The anthropometry is the science of measuring the human body & its parts (Akhter et al. 2009). The fields of the anthropometry cover a variety of human body measurements, such as weight, height, and size; including skin fold thicknesses, circumferences, lengths, and breadths (McDowell et al. 2008).Anthropometry the science of measurement of the human body provides therapists with building blocks for understanding the complexities of the human form and how it interfaces with its environment. (Baker 2008, p.74).

Population changes from generation to generation, gender to gender, and age to age for example men generally are larger than women, 30 year old people stature decrease and body weight increases, and after age 50 year for men & 60 year for women, their weight decrease again (Baker 2008, p.75). Anthropometry is the key factor of work place design. Anthropometric data is very important for product design, machine design & other applications (Lin et al. 2004). The modern science of anthropometry is needed to evaluate the human. Anthropometry is very essential to the application of ergonomics (Baker 2008, p.74).

Work stations based on anthropometric data result in healthy work places. It reduces individual modification requirements. Anthropometric data determines the type of modification needed (Bake 2008, p74). In some product design applications, anthropometric measurement of a user population plays the primary role in design decision (Hsiao 2013). To fit equipment and tasks to persons of various body sizes require anthropometric data and proper procedures. In modern science anthropometry involves evaluating the human from gradually (Bake 2008, p74).

Stature is one of the most essential elements in the identification of an individual. The stature of an individual increases during childhood and through puberty, until all bone growth has closed after adulthood is reached. The value of stature is not fixed for any individual at any age but is influenced by different factors (Hansi and Ashish 2013). Stature is an essential element in the description of a human population, or an individual. Stature is one of the most important dimensions in the identification of an individual. Different body parts can be used to determine the estimation of stature. There is a correlation between stature & foot length (Parash et al. 2011).

Every individual's stature tends to decrease during the period from getting up to going to bed. This decrease is due to the elasticity and compression of the inter-vertebral disks and joint cartilages and the load carried by the body during walking upright or sitting, such as load carried or lifted. Extreme reduction of stature as a result of carrying heavy loads has been reported up to some 10 cm in some cases, although a decrease of 1-2 cm may be regarded as normal (Hansi and Ashish 2013).

The relationships between stature and length of bones differ among populations. The foot length of both sides of 100 adult Bangladeshi males showed significant positives correlation with stature (Parash et al. 2011). There is no comprehensive anthropometric data for the civilian Australian population, and so, in Australia, the use of data and design guidelines from other countries, such as Britain and United States of America (USA) is a common practice. One study was conducted with the students in an Ergonomics course in the undergraduate Industrial Design Program at the University of New South Wales (UNSW) in Australia to estimate stature, sitting height & buttock knee length (Ward 2011).

There were multiple factors which were helpful Bengali adult Muslim females to estimate stature from respective hand lengths (Laila et al. 2009). One study found that, is the United States, over 260,000 people have affected hand tool injuries each year and it is believed that worker–tool mismatches have contributed to these injuries to some extent (Aghazadeh and Mital 1987). Anthropometry measurement is influenced by gender, ethnic its & aging (Akhter 2009). The average hand lengths, breadths and depths, including finger joints of the Indian women were smaller than those of American, British and West Indian women. The hand circumferences of the present women were also smaller than those of the American women **(**Nag 2003**).**

In this study, the mean stature, head circumference, head length were found to be 152.79 cm, 51.56 cm and 17.49 cm which are close to the mean values of the Philippina, Japanese, Chinese, Manchu and Gurung females of the Nepal **(**Nag 2003**)**. A large section of the Indian population is involved in agriculture related work. Most of them are involved in paddy cultivation job. So they use different type of hand tools for various steps of paddy cultivation. So, the hand tools need to fit the contours of the hand. Hand anthropometry measurements related to the design of hand tools and other manual devices have been published for various nationalities, such as ethnic Vietnamese living in USA, United Kingdom female, Hong Kong Chinese females, Indian agricultural workers, Western Nigerian rural farm workers, Eastern Indians, Central Indian farm workers, Mexicans, Bangladesh females, Bangladesh males and a few hand anthropometric dimensions have also been measured for Filipino manufacturing workers (Kar et al. 2003).

The proper ergonomic design of work equipment is not appropriate in Jordanians due to lack of anthropo-metric data. One study found that female Jordanian finger segments were generally longer than those of Bangladeshis, Nigerians, Vietnamese, and Mexicans but not longer than those of Hong Kong Chinese or United Kingdom nationals. The Jordanian female finger was also thicker than those of Bangladeshis, Vietnamese, Mexicans, Hong Kong Chinese, and United Kingdom nationals, and significantly broader those of Nigerians, Hong Kong Chinese and United Kingdom nationals (Mandahawia et al. 2008).

In this hand anthropometry research, the computed values 5th, 50th, 95th percentiles were used for designing of hand tools, handles and control panels in different work field. The study found that the proportion of different hand dimensions had little or no difference between the workers of a Central India and Eastern India. The study found that the Indian agriculture workers right hand length is 16.80 ± 1.05 & left hand length is 16.83 ± 1.12 (Kar et al. 2003). Some other ethnic groups such as Mysorean, Santhal, Onge, Khond, British Protestant, Jew, and Somali show variations in stature (Akhter 2009).

The hand bones are good anthropometric parameters and have proven to exhibit great sexual dimorphism. The research showed that the Nigeria average hand length was 19.05±0.95 and 17.65±0.91, while the average hand breadth was 8.50±0.42 for males and 7.96±0.34 for females. The average hand indices of left and right hand for both male and female were 44.68±0.13 and 43.29±0.14, respectively. The study also showed that the male hand length, breadth and indices were higher than the females (Ibeachu, Abu and Didia 2011).

Individual anthropometric varies due to environmental factors, for example, high altitude effects on development-or to genetic heterogeneity of the populations. The six Aymara groups as shown by anthropometric measurements are significantly different from that exhibited by genetic markers. There is dissimilarity between the anthropometric and serological distances (Rothhammer and Spielman 1972).

The maximum depth of hand and Minimum Square of hand among the United Kingdom, Japan and the United States of America had large difference. The Hong Kong Chinese had overall smaller hands, and fingers had less depth. On every dimension, the Hong Kong population had a smaller standard deviation than the comparable United Kingdom data **(**Courtney 2007**).** The elbow-to-elbow breadth and hand breadth at the thumb were significantly lower in the disabled group rather than the normal group (Goswami 1987). Anthropometric and nutritional characteristics are related to genetic, environmental, lifestyle, health, socio-cultural conditions and functional status (Perissinotto 2002). The palm dimensions of Bangladeshis male seem to be smaller than Mexican, Santhal, British, and Somali people show variation in stature **(**Imrhan 2009).

Anthropometric measurement data represent an essential component of nutritional assessment in the elderly. The study found that BMI was significantly higher in women than in men (27:6 SD 5:7 v. 26:4 SD 3:7; P, 0:001) and it was lower in the oldest than in the youngest subjects (P, 0:05) of both genders. Anthropometric and nutritional both features are related to genetic, environmental, sociocultural conditions and to lifestyle, health and functional status (Perissinotto et al. 2002).

The ageing process is responsible for changes in nutritional and physiological status, such as a decrease in body weight and height (Dey et al. 1999). Anthropometry is an important tool in geriatric nutritional assessment to evaluate underweight and obesity conditions, which are both important risk factors for severe diseases and disability in the elderly (Perissinotto et al. 2002). For men and women both skinfolds on the trunk were very highly interlinked with body density than the skinfolds on the extremities, except for the umbilicus skinfold in men. This study found that the skinfold thickness that was best correlated with body density in both elderly men and women was the suprailiaca (Visser, Heuve & Deurenberg 1994). One of the researches shows that anthropometry is able to assess cardiovascular risk in men (Despres et al. 1991).

The World Health Organization (WHO) convened an Expert committee to reevaluate the use of anthropometry at different ages for assessing health, nutrition and social well-being. Anthropometry is the most important portable, unique applicable, inexpensive and noninvasive method used to assess the size, proportions and human body compositions. For this reason it is used for individual health & nutrition intervention, as well as monitoring the nutrition status (Onis & Habicht 1996).

Anthropometry is a key component of nutrition status assessment in children and adults (Lin et al. 2004). Nutritional status and anthropometric measurements are correlated. This anthropometric measurement is helpful for early detection of protein-calorie malnutrition. To determine the nutritional status, anthropometric measurements were taken such as, weight, height, sitting height, head circumference, chest circumference, and calf circumference, fat fold at triceps & calf fold. The anthropometric measurements of normal children and those with vitamin deficiencies were more or less similar (Rao & Singh 1970).

Most individuals experiences normal effects of aging. In elder people there is a loss of stature, decrease in weight, change in skin texture and loss of muscle tissue. These effects change the anthropometric measurements in the elder. The loss of muscle tissue is responsible for decrease in body dimensions of length & breadth such as, arm length, hand breadth. In-between 50-60 years of age the stature and weight decreases. In a recent study of white healthy, middle- class, elderly men & women aged 60-80 years the rate of decrease in stature was estimated at 0.5 cm/years (Chumlea and Baumgartner 1989).

Anthropometry is very commonly used as a tool to estimate the nutritional status of populations, and to monitor the growth and health of individuals. There are three most frequently anthropometric indices used such as, weight for- height, height-for-age, and weight-for-age. The weight for height is an indicator of the present state of nutrition and height for age is an indicator of past nutrition (WATERLOW et al. 1977).

The anthropometric assessment of a population should help in identifying groups at risk of poor functional outcomes (morbidity and mortality), and who is in need of further evaluation or intervention. The anthropometric study was conducted to compare with other populations to assess the severity. So, that anthropometry has been an extremely useful tool for determining the nutritional status of both individuals and populations (Gorstein 1994).

In Cuba and the United Kingdom, the anthropometric measurements are being made, or are in the process of being analyzed, on large groups of children (Waterlow et al. 1977). The maternal nutritional status assessment relies on measures of stature, pre-pregnancy weight (PPW), height, body mass index (BMI), weight gain at different trimesters, weight gain during pregnancy, skinfold thickness and limb circumferences. There is a relationship between birth weight and various maternal anthropometric measures. The measurement show that WT and BMI have the highest correlations with birth weight (BW) with $p<0.0001$. WHO bulletin reported by the Mexico Nutrition CRSP research project in six villages in the rural area for weight and body mass index showed the highest correlation with birth weight while the effect of maternal height on BW was not significant (Jananthan et al.2009).

Differences in anthropometry measurement during pregnancy appear to be related to birth weight. One piece of literature found that the smallest infants were those whose mothers had a relatively lower PPW and early pregnancy weight, and who subsequently failed to gain much weight by the third trimester (Backstrand 1995). Anthropometric measures in men were significantly higher than the corresponding levels in women. The BMI and other anthropometric measures are appropriate indices for obesity (Goh 2004).

Height data is a useful and concise summary measure of human. Chinese immigrants residing in Australia during the first four decades of the twentieth century were used to evaluate the effects of age on human stature (Morgan 2009). Short stature and excess weight in adulthood are both associated with an increased risk of health problems. Among anthropometric data at birth, birth length is the most important predictor of adult height (Tuvemo 1999).

Studies have been in our country the anthropometric data is very limited. In Bangladesh, few research completed related to anthropometry such as hand anthropometry, stature estimation etc. In the world, especially in Bangladesh the many industrial workstations are poorly designed, resulting in lost worker productivity and unnecessary injury at the workplace. An ergonomics intervention, especially anthropometry measurement is important is the design of an industrial workstation attempts to achieve an appropriate balance between the worker capabilities and work requirements to optimize: worker productivity and the total system, as well as provide worker physical and mental well-being, job satisfaction and safety.

The anthropometry measurement of a population of a country is determined to provide guidelines of workers & workstation design such as tools design. These guidelines emphasize the requirement of healthy working operator posture and are directed towards improvement of the operator's physiological efficiency. The poor working posture causes many painful musculoskeletal disorders known as cumulative trauma disorders (CTD). The physical dimensions measurement of an individual worker is essential in the design of an industrial workstation & the viewpoint of production efficiency, and operator physical and mental well-being. Anthropometry data is determined so majority of the population of the intended user group can be accommodated comfortably, without any harmful posture. Relevant anthropometric data is necessary to determine adequate posture, work height, normal and maximum working areas, clearance and visual requirements (Das & Sengupta 1996).

The people those aged 18-60 are the main productive source of any country. In Bangladesh they are mostly working people & they mostly work in the industrial section. But in Bangladesh there is no appropriate anthropometry data for these persons. Some studies were conducted in anthropometry related fields, but there is no study that includes all dimensions of human body parts in our country. So the researcher will be interested to complete the research including all physical dimensions of human body. This data is helpful for ergonomic intervention including work place designed. It will be helpful for any tools designed.

## 1.2. Significance of the study

In different countries there is some anthropometry related research completed in different dimensions of human body parts. Most developed countries use anthropometric data for designing tools. Anthropometric data is needed to ensure any work place design and to ensure accessibility. It helps to design any work place such as garments, office etc.

In Bangladesh there is no definitive anthropometric data for this people. As a result the worker suffers different types of work related musculoskeletal symptom and diseases, such as back pain, neck pain and so on. So the production is decreases day by day and increases sick leave. The average height, weight, and other body dimensions of persons of Bangladesh need to be known. We know that adult people are mostly working people in Bangladesh. So the anthropometric related data is important for all ergonomics intervention. For this reason it was important to conduct this study.

This study will be a literature resource for future study in this sector. This study will also help to estimate average anthropometric measurement of Bangladeshi people. This research is promoting Occupational Therapy professional evidence based practice facility. The respondents of the study also benefited from the study. They are aware about ergonomic intervention and work place deigned need. The respondents have their individual measurement of all body dimensions. The research influences other researchers to conduct further anthropometric related study in Bangladesh. So the study is important to conduct.

## 1.3. Aim of the study

To determine the anthropometric measurements for Bangladeshis aged between 18 and 60 years in 37 body dimensions.

## 1.4. Objectives

- To determine the anthropometric measurements of Bangladeshis aged between 18 and 60 years in 37 body dimensions.
- To determine the anthropometric differences of Bangladeshis male and female aged between 18 and 60 years in 37 body dimensions.

# CHAPTER-2 LITERATURE REVIEW

Many studies show racial variation in the cranial dimensions among different populations such as Koreans, Caucasians, Indians, Turkman and native Fars groups, Turkey, Zulu populations and Mapuche individuals in Chile (Hansi and Ashish 2013).The anthropometry differences among races are greater than among nations. Taiwanese have the longest hands, greatest wrist, & elbow height. The Japanese male has the greatest fingertip height & lower shoulder height. The Korean has the greatest sitting height and sitting eye-height. The Chinese body shape tends to have a narrow body & the Japanese body shape is wider with shorter limbs (Lin et al. 2004).

Stature or body height is one of the most important and useful anthropometric parameters that determines the physical identity of an individual. Anthropometric measurements of different body parts are used in differentiating between ethnic groups, in identifying missing persons and suspects (Akhter 2009). The Korean body shape is moderate among the four peoples, but the upper limbs are longer. The Chinese tend to have a narrow torso with moderate limbs. The Japanese tend to have a wider torso and shorter limbs (Lin et al. 2004).

## Anthropometric data:

Anthropometric data is a collection of the dimension measurements of the human body and is useful for apparel sizing, forensics, physical anthropology and ergonomic workplace design (Hansi and Ashish 2013). The anthropometric data for infants and children reflects general health status and dietary adequacy and is used to track trends in growth and development over time (McDowell et al. 2008). Anthropometry is a branch of anthropology. Anthropometric data consists of collections of measurements, often presented annotated diagrams of human figures. The primary dimensions are measured. These are bone, muscle, and adipose tissue. This data is used in ergonomics applications in order to ensure that designs and standards are realistic (Locating Materials on Anthropometric Data in the Library 1990).

Anthropometric data differ from sex to sex. For example, a hand tool with a handle that is designed based on male anthropometric data is likely to be too large for many females, who may, therefore, be required to exert a greater proportion of their maximum force capacity than males to use it (Imrhan 2009). NHANES II, the most reliable anthropometry data set, does not include people older than 74 years. So currently there is no available data for elderly people. The adult data is also poor in the world. So, the WHO committee encouraged the countries to collect the anthropometry data in all age groups especially in adult's age group (Onis & Habicht 1996).

The potentially harmful effects of ignoring anthropometric differences between populations may be manifested when a developing nation, for example, imports equipment from a developed nation since the latter tends to design their equipment based on anthropometric data of their own population (Imrhan 2009). Some anthropometric dimensions were influenced by age, gender and ethnicity. These studies show a difference of anthropometric measurements between elderly men and women except for standing hip breadth. These finding show that there is no significant difference between male and female elderly in the hip area dimension (Y 2009).

Most anthropometry data focus on particular populations, such as children, particular medical condition, or members of a profession, such as the military or an athletic sport. In anthropometric data chronology and geography are important aspects (Locating Materials on Anthropometric Data in the Library 1990). Over the centuries, human have used tools to accomplish a variety of objectives, typically related to agricultural jobs. Currently there is a growing demand among professional hand tool users to have ergonomically designed products (Schmidtke 1984).

To design any devices for human use, engineers have to depend on anthropometric data, otherwise the resulting devices or products may turn out to be ergonomically incompatible (Lewis 1969). Anthropometric data can promote the proper design of equipment for better efficiency and more human comfort. Available anthropo-metric data useful in farm machinery design and inclusion of other dimensions was suggested for making the data more comprehensive.

The anthropometric resource data is limited for individuals with specific disabilities, such as cerebral palsy. Due to lack of appropriate anthropometric data, the design of seating and mobility devices for specific disabled people is hampered (Hobson & Molenbroek 1990). In Britain two sets of anthropometric reference data are mostly used in nutritional assessment of elderly people. The first set is data from Nottingham on weight, demispan, demiquet (weight/demispan) for men and mindex (weight/demispan) for women. The second set comprises data from body mass index, mid-upper arm circumference, triceps skinfold thickness, and arm muscle circumference. The research shows men and women in Edinburgh were significantly shorter than those in Nottingham (0.79 m *v* 0.72 m, $P<0.05$ and 0.8 m *v* 0.73 m, $P<0.01$ respectively. French anthropometric data is different from British data due to geographical variation (Bannerman 1997). One British study was conducted with seventeen body dimensions in car drivers. This research was carried out to design cars (Haslegrave 1980).

Anthropometric data is important. Anthropometric data is used to improve the design of things and spaces for people to use so that they are more comfortable, efficient, easy to use and safer than previous designs. It is necessary to provide some idea of the dimensions that are really important for the particular design under consideration the problems that have been encountered by others and the in recommendations. For example if a seat height is to be decided and for economic or other reasons it is not possible to provide any adjustability. You need to know the average popliteal height, vertical distance from the sole of the foot to the crook of the knee (Use of anthropometric Data 2013).

The anthropometric data are important to design safe and efficient workplaces, equipment and tools. For example, a hand tool with the trigger designed to fit most male hands comfortably is likely to be too large for most females. The hand anthropometry and hand posture and grip strength is interlinked (Mandahawia et al. 2008). Child anthropometric data analysis of different ages is complicated by the fact that children are still growing. British Growth Reference and the 2000 Centers for Disease Control and Prevention (CDC) Growth Reference data is widely used in the United States to determine the child of taller, shorter, or about average height (Vidmar, Carlin and Hesketh 2004).

Anthropometric data are also used to evaluate health and dietary status, disease risk, and body composition changes that occur over the adult lifespan (National Health and Nutrition Examination Survey 2009, p.2). In applying anthropometry data we commonly need to make corrections for clothing, posture variation and so on. To collect anthropometric data need to maintain standard anthropometric posture (Pheasant 1900, p. 28). Anthropometric data & proper procedures are important to fit equipment and task to persons of various body sizes requires (Kroemer 1933, p.56).

## Body dimension:

Body dimensions provide the basis for the development of information models made to measure pattern making. Body dimension also provide a suggested list of data requirements for the collection of body measurements. The numeric identification, dimension name, definition, category, references will need to be included in body dimensions (Lee 1994).

Most research has shown that there are anthropometric differences between different populations in almost every dimension of the human body (Abeysekera and Shahnavaz 1989). The human anthropometric dimensions and equipment dimension measurement mismatches are a contributing factor in decreased productivity, discomfort, accidents, biomechanical stresses, muscular fatigue, injuries, and cumulative traumas. Therefore, many researchers noted that using relevant anthropometric data is importance for equipment design (Mandahawia et al. 2008). This study describes 37 body dimensions. The body dimensions definition follows below:

## The 37 body dimensions definition:

| Body Dimensions | Definition |
|---|---|
| Stature | The vertical distance from the floor to the top of the head, when standing. |
| Eye height, standing | The vertical distance from the floor to the outer corner of the right eye, when standing. |
| Shoulder height, standing | The vertical distance from the floor to the tip (acromion) of the shoulder, when standing. |
| Elbow height, standing | The vertical distance from the floor to the lowest point of the right elbow, when standing, with the elbow flexed at 90 degrees. |
| Hip height, standing | The vertical distance from the floor to the trochanter landmark on the upper side of the right thigh, when standing. |
| Knuckle height, standing | The vertical distance from the floor to the knuckle (metacarpal bone) of the middle finger of the right hand, when standing. |
| Fingertip height, standing | The vertical distance from the floor to the tip of the extended index finger of the right hand, when standing. |
| Sitting height | The vertical distance from the sitting surface to the top of the head, when sitting. |

| | |
|---|---|
| Sitting eye height | The vertical distance from the sitting surface to the outer corner of the right eye, when sitting. |
| Sitting shoulder height | The vertical distance from the sitting surface to the tip (acromion) of the shoulder, when sitting. |
| Sitting elbow height | The vertical distance from the sitting surface to the lowest point of the right elbow, when sitting, with the elbow flexed at 90 degrees. |
| Sitting thigh height | The vertical distance from the sitting surface to the highest point of the top of the horizontal right thigh, with the knee flexed at 90 degrees. |
| Sitting knee height | The vertical distance from the floor to the top of the right kneecap, when sitting, with the knees flexed at 90 degrees. |
| Sitting popliteal height | The vertical distance from the floor to the underside of the thigh directly behind the right knee; when sitting, with the knees flexed at 90 degrees. |
| Shoulder-elbow length | The vertical distance from the underside of the right elbow to the right acromion, with the elbow flexed at 90 degrees & the upper arm hanging vertically. |
| Elbow-fingertip length | The distance from the back of the right elbow to the tip of the extended middle finger, with the elbow flexed at 90 degrees. |

| | |
|---|---|
| Overhead grip reach, sitting | The vertical distance from the sitting surface to the center of a cylindrical rod firmly held in the palm of the right hand. |
| Overhead grip reach, standing | The vertical distance from the floor to the center of a cylindrical rod firmly held in the palm of the right hand |
| Forward grip reach | The horizontal distance from the back of the right shoulder blade to the center of a cylindrical rod firmly held in the palm of the right hand. |
| Arm length, vertical | The vertical distance from the tip of the right middle finger to the right acromion, with the arm hanging vertically. |
| Downward grip reach | The vertical distance from the right acromion to the center of a cylindrical rod firmly held in the palm of the right hand, with the arm hanging vertically. |
| Chest depth | The horizontal distance from the back to the right nipple. |
| Abdominal depth, sitting | The horizontal distance from the back to the most protruding point on the abdomen. |
| Buttock-knee depth, sitting | The horizontal distance from the back of the buttocks to the most protruding point on the right knee, when sitting with the knee flexed at 9o,degrees. |

| | |
|---|---|
| Buttock-popliteal depth, sitting | The horizontal distance from the back of the buttocks to back of the right knee just below the thigh when sitting with the knee flexed at 9o, degrees. |
| Shoulder breadth (biacromial) | The distance between the right and left acromions. |
| Shoulder breadth (bideltoid) | The maximum horizontal breadth across the shoulders between the lateral margins of the right & left deltoid muscles. |
| Hip breadth, sitting | The maximum horizontal breadth across the hips or thighs, whatever is greater, when sitting. |
| Span | The distance between the tips of the middle fingers of the horizontally outstretched arms and legs. |
| Elbow span | The distance between the tips of the elbows of the horizontally outstretched upper arms when the elbows are flexed so that the fingertips of the hands meet in front of the trunk. |
| Head length | The distance from the glabella (between the browridges) to the most rearward protrusion (the occiput) on the back, in the middle of the skull. |
| Head bread | The maximum horizontal breadth of the head above the attachment of the ears. |
| Foot length | The maximum length of the right foot, when standing. |

| | |
|---|---|
| Foot breadth | The maximum breadth of the right foot, at right angle to the long axis of the foot, when standing. |
| Weight | Body weight taken to the nearest tenth of a kilogram. |

(Kroermer 2009, pp. 11-15).

## Bangladeshi population:

Bangladesh is located in the northeastern part of South Asia and covers an area of 147,570 square kilometers. It is almost entirely surrounded by India, except for a short southeastern frontier with Myanmar and a southern coastline on the Bay of Bengal. Bangladesh is still struggling to emerge from poverty. Industry has emerged as the largest sector of the economy, contributing about 30 percent of the gross domestic product (GDP). Bangladesh is the most densely populated country in the world (NIPORT, Mitra and Associates, and ICF International 2013, p.1). At present time the total population of Bangladesh is 161,083, 804(July 2012 est.). The age difference estimation is 0-14 years: 33.6%, 15-24 years: 18.8%, 25-54 years: 37.2%, 55-64 years: 5.6%, & 65 years and over: 4.8% (Bangladesh Demographic Profile 2013).

The adult's nutrition and health is particularly important because it is this age group that is primarily responsible for the economic support of the rest of a country. Adults are sustaining the socioeconomic and cultural integrity of their community (Onis & Habicht 1996). In this study, the researcher was defining Bangladeshi adults aged between 18 and 60 years to determine the anthropometric measurements. Both male and female Bangladeshi people were being included in the study. Bangladeshi adult are the working people in Bangladesh. They are working in different sectors. Now a day's maximum adult people work in garments sectors in our country.

# CHAPTER-3 METHODS AND MATERIALS

## 3.1. Study design

The cross sectional survey method was used to carry out the research aim and objectives. The cross sectional design was used because the research analyses the present estimation of Bangladeshis aged 18-60 years anthropometric measurement of 37 body dimensions. The study also compares the male and female measurement differences. Quantitative methods are appropriate for this study as the issue is known about, and is relatively simple and clear-cut. Under the quantitative method, the cross sectional methods was used. Cross-sectional studies are carried out at one time point or over a short period. A cross sectional survey methods is appropriate for this study because cross sectional study analyses the present situation (Levin 2006). The study aim is to find out the present anthropometry estimation of the Bangladeshis both male & female. So the cross sectional method is appropriate for this study.

## 3.2. Study setting

The study was carried out in Centre for the Rehabilitation of the Paralyzed & two convenient places in Bangladesh (Chandpur & Chittagong). CRP is situated in Dhaka district under the Savar Thana. This area is about 35 kilometer from the Dhaka district. Centre for the Rehabilitation of the Paralyzed (CRP) is a non-government organization. CRP works for the disabled people to integrate them into mainstream society. CRP's vision is "To ensure the inclusion of disabled people into mainstream society". CRP is a specialized hospital for spinal cord injury patients. CRP has 100 bed hospitals. Here stay patients, caregivers, doctors, staffs, students and other people. The caregivers come from different regions of Bangladesh.

CRP also has an academic institute named Bangladesh health profession institute (BHPI) & nursing college. Under the Bangladesh health profession institute (BHPI) three B.Sc. courses are running. The number of students is approximately 600-650. Both male and female student studies here. The students come from different districts in Bangladesh. Chittagong is situated at the foot of the mountain and South-East costal area of Bangladesh with 20 Thana. Chandpur was turned into a district in 1984. The district consists of 6 municipalities, 60 ward and 7 upazilas (Amardesh.Com 2013).

## 3.3. Participants

A participant refers to the entire group of people or items that meet the criteria set by the researcher. The participants of this study were Bangladeshi peoples both male and female who stay in Centre for the Rehabilitation of Paralyzed (CRP) and two convenient places in Bangladesh. To conduct the study, one hundred fifteen (115) participants were selected. The participants were students, staff in CRP, and other local people at two selected districts. Participants were both male and female Bangladeshis aged between 18 to 60 years. In Bangladesh all district people were allow for this study.

*3.3.1. Sampling procedure*

Participants who met the inclusion criteria were taken as a sample in this study. The convenient sampling procedure was used throughout the process of participant's selection. Participants for this study were selected conveniently from above mentioned place. The participants were selected based on inclusion criteria. Convenient sampling is a process in which a sample is draw from the subjects conveniently available. The researcher will be selecting the adults or research subjects that are convenient to the researcher. The 115 Bangladeshi people were selected from CRP and other convenient places at two selected districts. Here, the statistical calculation was used. The calculation is:

$$\text{Sample size (n)}: \frac{Z^2 . P . Q}{r^2}$$

$$= \frac{(1.96)^2 . 0.5 . 0.5}{(0.1)^2}$$

[Here, Z = 1.96, P (prevalence) = 0.5, q = 0.5, r (sampling error) = 0.1]

## 3.4. Inclusion criteria

- Both males and females within 18- 60 years age range.
- Voluntary participants.

### 3.5. Exclusion criteria

- Pregnant females at the time of data collection were excluded.
- Persons with disability & any kind of postural deformity were excluded.
- Persons with mental health problem were excluded.

### 3.6. Data collection procedure

The researcher fixed a date and time with the participant, according to his /her available time. At first, the eligible participants were informed about the consent form. The research used both male and female data collectors to collect data. Data collector were 3rd year B.Sc. students in Occupational Therapy department. In this study, training was provided to each data collectors. The data collectors have an ergonomics subject in 3rd year course curriculum & have knowledge in anthropometry. Data collectors collected data from those who gave consent. The Kroemer adapted anthropometry measurement table was used during data collection in a quiet place rather than a work place. The BHPI class room and other suitable places were used during data collection. The subjects maintained an upright posture during measurement. The measure was taken in a smooth surface.

### 3.7. Data collection instrument

To collect the data, the researcher used some data collection instruments including:

- Measuring tape: the researcher used an appropriate measuring tape to measure the body dimensions. The measurement tape was steel. The measurement tape scale is divided into cm, mm & inch.
- Consent form: 'informed consent' is a written document outlining the risks of the experiment and the possible benefits. The two part of consent from including information sheet and consent form. In this study, the researcher used both Bangla and English Consent forms. All of the study subjects were informed about the research aim & objectives. The researcher obtained consent to participate from every subject. The participants were informed that they have the right to withdraw their consent and terminate participation at any time.

- ❖ Weight machine & measurement scale: the researcher used a weight machine. Weight machine was used after the check of the validity and reliability. The researcher also used measurement scales. The scales were plastic and were used to consider the participants safety.
- ❖ Kroemer adapted Anthropometry measurement table: to describe the body dimensions and application, the Kroemer adapted anthropometry measurement table was used in fitting the human book. This table has 37 body dimensions. All dimensions are defined. The table is given in detail in the appendix section.
- ❖ Demographic questionnaire: demographic information of the respondents was collected by using self-demonstrated demographic questionnaires. Demographic information includes age, sex, living area, home district, marital status, educational level, monthly income and occupation. See appendix for the questionnaire.

### 3.8. Data analysis

Data entry and analysis was performed by using the Statistical Package for social science (SPSS), Inc. version 17. To reduce the impact of the missing value and increase the reliability of the analysis, the total analysis process was carried out using the SPSS computer package. At first the researcher was selecting the variable & then inputting the data into SPSS. Every questionnaire had a code number to input into the SPSS software. Descriptive analysis was also used to find out the frequency and percentage of different socio-demographic data such as, age, sex, educational level, marital status, living area & occupation. The researcher was calculating body dimensions mean values & standard deviation (SD). The researcher was also finding out the $5^{th}$, $50^{th}$ & $95^{th}$ percentile values. These three percentiles are widely used to classify various health conditions, and sex-age-specific anthropometric measures cut points (Wang & Chen 2012). The raw data was put on the Microsoft & Excel sheet. The 'T' test was performed to find the level of significance of difference between the two group (male & female) means.

## 3.9 . Ethical considerations

The researcher gained permission from the authority of BHPI & authorities were informed about the purpose of the study. Informed consent was given for the participant's data. The researcher ensured that the confidentiality was maintained regarding the participant's data. Participants were not individually identified. Each participant was informed about the study before beginning and was given written consent. The researcher was ensure the participant safety when take measurement. Female data was collect by female data collectors.

# CHAPTER-4 RESULT

## 4.1. Socio-demographic characteristics of the participants

The study sample contained 115 participants. Among the participants 60 (52.2%) were male & 55 (48.2%) were female. Table 1 show that most study subject's age ranged between 18-28 years. The percentage is 86.9%. In this research the results found that most of the participants are educated. More than half of the total respondents had a bachelor level of education.

In this study the bachelor degree was taken by a significant number of participants (70.4%). The illiterate subjects are very few, 0.8% participants are illiterate. The study gender is almost same (male 52.2% & female 48.2%). The maximum participants are single & there is no divorced & widow subjects. Most of the study subjects live in urban areas. The student's occupation is significant of the study participants. In the research 87.8% of subjects are students. The others occupation statistics is given in the table 1.

**Table-1: Socio-demographic characteristics of the participants.**

| Variables | N*=115 | % |
|---|---|---|
| **Age in years** | | |
| 18-28 years | 100 | 86.9 |
| 29-39 years | 09 | 7.8 |
| 40-50 years | 03 | 2.6 |
| 51-60 years | 03 | 2.6 |
| **Sex** | | |
| Male | 60 | 52.2 |
| Female | 55 | 47.8 |
| **Educational level** | | |
| Up to primary School | 03 | 0.24 |
| Up to secondary School | 09 | 7.8 |
| Up to higher Secondary School | 19 | 16.5 |
| Bachelor | 81 | 70.4 |
| Masters or above | 03 | 2.6 |
| **Marital status** | | |
| Single | 99 | 86 |
| Married | 16 | 14 |
| **Living area** | | |
| Rural | 37 | 32.2 |
| Urban | 78 | 68.8 |
| **Occupation** | | |
| Public service | 03 | 2.6 |
| Private service | 06 | 5.2 |
| Student | 101 | 87.8 |
| Housewife | 03 | 2.6 |
| Unemployed | 02 | 1.7 |

N = Total number of participants

## 4.2. Anthropometric measurements of male and female

Descriptive statistics (Tables 2) for each anthropometric body dimension are given as mean standard deviation and selected percentile ($5^{th}$, $50^{th}$ and $95^{th}$). The anthropometric data of 37 body dimensions of 60 male and 55 female Bangladeshi people are shown in table 2. The results show that maximum male means value is higher than female adults mean.

**Table -2: Mean, SD and percentile value (mm) for Bangladeshis male (n=60) & female (n=55).**

| | Male Percentile | | | | | Female Percentile | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dimensions** | **5th** | **50th** | **95th** | **Mean** | **SD** | **5th** | **50th** | **95th** | **Mean** | **SD** |
| Stature | 1665 | 1680 | 1819 | 1682.75 | 73.314 | 1430 | 1520 | 1630 | 1516.27 | 79.647 |
| Eye height, standing | 1441 | 1577.50 | 1689.50 | 1565.93 | 69.900 | 1317.20 | 1420 | 1496 | 1417.84 | 66.738 |
| Shoulder height, standing | 1300.25 | 1390 | 1529 | 1399.67 | 64.525 | 1084 | 1260 | 1342 | 1255.82 | 59.456 |
| Elbow height, standing | 980 | 1060 | 1189.50 | 1067.75 | 56.982 | 896 | 980 | 1042 | 973.18 | 49.154 |
| Hip height, standing | 821 | 940 | 1079.50 | 944.33 | 78.694 | 816 | 900 | 972 | 893.09 | 67.113 |
| Knuckle height, standing | 690 | 750 | 849.50 | 752.80 | 48.753 | 566 | 675 | 722 | 668.73 | 41.968 |
| Fingertip height, standing | 570.50 | 627.50 | 709.50 | 627.17 | 38.139 | 528 | 590 | 642 | 590.36 | 32.014 |
| Sitting height | 722 | 860 | 1083 | 869.90 | 110.757 | 738 | 800 | 1252 | 833.09 | 138.479 |
| Sitting eye height | 660.50 | 745 | 1050.50 | 760.58 | 105.176 | 616 | 700 | 1162 | 720.55 | 129.381 |
| Sitting shoulder height | 510.50 | 570 | 659.50 | 583.75 | 81.129 | 486 | 540 | 676 | 552.91 | 89.446 |
| Sitting elbow height | 160.50 | 200 | 290 | 219.42 | 68.681 | 180 | 230 | 280 | 226.91 | 28.227 |
| Sitting thigh height | 100 | 137.50 | 199.75 | 152.03 | 79.512 | 100 | 130 | 200 | 143.27 | 62.466 |
| Sitting knee height | 480.50 | 529 | 580 | 527.70 | 28.928 | 438 | 480 | 550 | 475.82 | 52.808 |
| Sitting popliteal height | 410 | 440 | 470 | 438.58 | 20.974 | 362 | 400 | 506 | 408.95 | 36.005 |
| Shoulder-elbow length | 300.50 | 340 | 400 | 346.83 | 26.280 | 280 | 320 | 362 | 320 | 33.444 |
| Elbow-fingertip length | 415.25 | 455 | 490 | 456.42 | 26.039 | 246 | 400 | 458 | 402.49 | 55.340 |
| Overhead grip reach, standing | 1090 | 1185 | 1309.50 | 1176.25 | 99.275 | 998 | 1070 | 1196 | 1079.09 | 97.999 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Overhead grip reach, standing | 1610 | 2010 | 2179.50 | 1987.17 | 143.016 | 1708 | 1800 | 1928 | 1798.82 | 112.542 |
| Forward grip reach | 610 | 670 | 764.75 | 675.75 | 48.893 | 558 | 630 | 1184 | 655.09 | 143.947 |
| Arm length, vertical | 685.75 | 760 | 839.50 | 765.58 | 61.507 | 630 | 670 | 740 | 677.55 | 36.791 |
| Downward grip reach | 581 | 650 | 730 | 657.75 | 39.072 | 486 | 590 | 642 | 581.18 | 53.860 |
| Chest depth | 160 | 205 | 259.50 | 206.67 | 32.699 | 158 | 210 | 272 | 212.64 | 33.882 |
| Abdominal depth, sitting | 160.50 | 222.50 | 274.75 | 221.08 | 31.219 | 120 | 200 | 270 | 195.09 | 41.034 |
| Buttock-knee depth, sitting | 485 | 552.50 | 590 | 546.17 | 34.719 | 438 | 510 | 580 | 513.58 | 41.173 |
| Buttock-popliteal depth, sitting | 380 | 450 | 509.75 | 448.92 | 37.946 | 358 | 420 | 482 | 421.18 | 36.476 |
| Shoulder breadth (biacromial) | 320 | 367.50 | 429.50 | 367.75 | 33.754 | 282 | 360 | 430 | 356.67 | 47.796 |
| Shoulder breadth (bideltoid) | 390.50 | 450 | 509.50 | 450.08 | 34.266 | 318 | 440 | 506 | 433.64 | 50.520 |
| Hip breadth, sitting | 240.50 | 310 | 379 | 310 | 44.693 | 220 | 330 | 412 | 327.36 | 56.861 |
| Span | 768 | 1705 | 1879 | 1652 | 270.583 | 1440 | 1520 | 1644 | 1525.73 | 85.144 |
| Elbow span | 640 | 737.50 | 959 | 758.08 | 145.498 | 300 | 780 | 861 | 749.09 | 134.168 |
| Head length | 160.50 | 200 | 215 | 193.75 | 20.370 | 158 | 200 | 240 | 197.55 | 28.689 |
| Head breadth | 150 | 170 | 190 | 163.75 | 13.226 | 138 | 170 | 210 | 174.45 | 22.14 |
| Hand length | 170 | 180 | 204.75 | 184.75 | 12.536 | 128 | 170 | 190 | 165.45 | 21 |
| Hand breadth | 80 | 90 | 148 | 94.12 | 19.676 | 70 | 80 | 91 | 78.55 | 6.782 |
| Foot length | 210.25 | 245 | 280 | 247.28 | 21.725 | 200 | 220 | 250 | 224.73 | 12.598 |
| Foot breadth | 90 | 100 | 114.75 | 100.28 | 7.526 | 80 | 90 | 120 | 95.82 | 16.660 |
| Weight | 45.05 | 61 | 85.70 | 62.15 | 11.471 | 39.80 | 54 | 69.40 | 53.73 | 8.528 |

### 4.3. Anthropometric measurements differences between male and female

The table 3 also shows the t-test results for male-female differences in means. T-tests for differences in means showed gender differences in the Bangladeshi people's data. The results of the T-tests are given in the rightmost columns, respectively, of the table 3. The mean and standard deviation for each dimension, for each gender, are shown in Table 3. The last column shows the P-value between the two genders and the significance test results for the differences.

The't' test was performed to find the level of significance of difference between two gender group means (Table 3). The T-test showed that the stature, eye height standing, shoulder height standing, elbow height standing, hip height standing, knuckle height standing, fingertip height standing, sitting shoulder height, sitting knee height, sitting popliteal height, shoulder-elbow length, elbow-fingertip length, overhead grip reach sitting, overhead grip reach standing, arm length vertical, downward grip length, abdomen depth sitting, buttock-knee depth sitting, buttock-popliteal depth sitting, shoulder breadth (bideltoid), span, head breadth, hand length, hand breadth, foot length & weight differences in means were statistically significant ($P < 0.05$). The others dimensions were not significant. Tables 3 also show the percentile values (5th, 50th, and 95th) for each dimension for males and females, respectively. These percentiles may also be used for comparison with those published for other populations.

**Table-3: the Mean, SD, percentile values (mm) for Bangladeshis male & female (n==115) and t-test results for male-female differences in means.**

| Body Dimension | Mean | SD | 5th %tile | 50th %tile | 95th %tile | Differences in male-female means | t-value | p-value |
|---|---|---|---|---|---|---|---|---|
| Stature | 1603.13 | 112.973 | 1460.00 | 1600.00 | 1768.00 | 166.48 | 11.672 | 0.000* |
| Eye height, standing | 1495.10 | 100.793 | 1358.00 | 1485.00 | 167.00 | 148.097 | 11.597 | 0.000* |
| Shoulder height, standing | 1330.87 | 95.068 | 1196.00 | 1320.00 | 1501,00 | 143.848 | 12.398 | 0.000* |
| Elbow height, standing | 1022.52 | 71.246 | 918.00 | 1010.00 | 1172.00 | 94.568 | 9.489 | 0.000* |
| Hip height, standing | 919.83 | 77.457 | 828.00 | 929.00 | 1046.00 | 51.242 | 3.740 | 0.000* |
| Knuckle height, standing | 712.59 | 61.997 | 606.00 | 710.00 | 802.00 | 84.073 | 9.868 | 0.000* |
| Fingertip height, standing | 609.57 | 39.739 | 558.00 | 600.00 | 684.00 | 36.803 | 5.578 | 0.000* |
| Sitting height | 853.30 | 125.592 | 758.00 | 830.00 | 1232.00 | 36.809 | 1.580 | 0.117 |
| Sitting eye height | 741.43 | 118.566 | 620.00 | 710.00 | 1144.00 | 40.038 | 1.827 | 0.070 |
| Sitting shoulder height | 569.00 | 86.230 | 490.00 | 560.00 | 652.00 | 30.841 | 1.939 | 0.055* |
| Sitting elbow height | 223.00 | 53.224 | 178.00 | 220.00 | 281.00 | -7.492 | -0.753 | 0.453 |
| Sitting thigh height | 147.84 | 71.691 | 100.00 | 135.00 | 200.00 | 8.761 | 0.653 | 0.515 |
| Sitting knee height | 502.89 | 49.311 | 440.00 | 500.00 | 570.00 | 51.882 | 6.607 | 0.000* |
| Sitting popliteal height | 424.41 | 32.601 | 378.00 | 430.00 | 474.00 | 29.638 | 5.448 | 0.000* |
| Shoulder-elbow length | 334.00 | 32.688 | 290.00 | 330.00 | 400.00 | 26.833 | 4.804 | 0.000* |
| Elbow-fingertip length | 430.63 | 50.335 | 374.00 | 430.00 | 490.00 | 53.926 | 6.776 | 0.000* |
| Overhead grip reach, sitting | 1129.78 | 109.663 | 1016.00 | 1130.00 | 1276.00 | 97.159 | 5.275 | 0.000* |
| Overhead grip reach, | 1897.09 | 159.734 | 1682.00 | 1890.00 | 2141.00 | 188.348 | 7.800 | 0.000* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| standing | | | | | | | | |
| Forward grip reach | 665.87 | 105.640 | 560.00 | 650.00 | 770.00 | 20.659 | 1.048 | 0.297 |
| Arm length, vertical | 723.48 | 67.454 | 640.00 | 720.00 | 820.00 | 88.038 | 9.210 | 0.000* |
| Downward grip reach | 621.13 | 60.332 | 540.00 | 620.00 | 721.00 | 76.568 | 8.778 | 0.000* |
| Chest depth | 209.52 | 33.259 | 160.00 | 210.00 | 262.00 | -5.970 | -0.961 | 0.339 |
| Abdominal depth, sitting | 208.65 | 38.368 | 148.00 | 210.00 | 270.00 | 25.992 | 3.842 | 0.000* |
| Buttock-knee depth, sitting | 530.58 | 41.160 | 468.00 | 530.00 | 590.00 | 32.585 | 4.601 | 0.000* |
| Buttock-popliteal depth, sitting | 435.65 | 39.612 | 360.00 | 440.00 | 492.00 | 27.735 | 3.988 | 0.000* |
| Shoulder breadth (biacromial) | 362.45 | 41.263 | 300.00 | 365.00 | 430.00 | 11.077 | 1.445 | 0.151 |
| Shoulder breadth (bideltoid) | 442.22 | 43.414 | 346.00 | 445.00 | 506.00 | 16.447 | 2.058 | 0.042* |
| Hip breadth, sitting | 318.30 | 51.392 | 240.00 | 320.00 | 400.00 | -17.364 | -1.828 | 0.070 |
| Span | 1591.61 | 212.931 | 1110.00 | 1600.00 | 1860.00 | 126.273 | 3.313 | 0.001* |
| Elbow span | 753.78 | 139.654 | 560.00 | 755.00 | 880.00 | 8.997 | 0.344 | 0.732 |
| Head length | 195.57 | 24.662 | 160.00 | 200.00 | 230.00 | -3.795 | -0.823 | 0.412 |
| Head breadth | 170.96 | 18.280 | 140.00 | 170.00 | 210.00 | -6.705 | -1.990 | 0.049* |
| Hand length | 175.52 | 19.594 | 150.00 | 180.00 | 195.00 | 19.295 | 6.041 | 0.000* |
| Hand breadth | 86.67 | 16.828 | 70.00 | 85.00 | 100.00 | 15.571 | 5.572 | 0.000* |
| Foot length | 236.50 | 21.155 | 208.00 | 235.00 | 275.00 | 22.556 | 6.731 | 0.000* |
| Foot breadth | 98.15 | 12.877 | 85.00 | 100.00 | 115.00 | 4.465 | 1.878 | 0.063 |
| Weight | 58.12 | 10.975 | 42.80 | 56.00 | 76.20 | 8.432 | 4.441 | 0.000* |

N= 115 for each variable, * Indicates Significance at the 5% level

# CHAPTER-5 DISCUSSION

In Bangladesh the anthropometric data is not sufficient. There is no research that has data for all body dimensions. Probably, the present anthropometric study was the first research in Bangladesh perspective that was carried out among Bangladeshis with a view to measure 37 body dimensions. The purpose of the study was to find out the anthropometric estimation for Bangladeshis aged between 18-60 years old. The present study results provide some baseline information regarding all body dimensions measurements.

In Bangladesh one of the studies was conducted to estimate stature using head measurements in the Garo adult female. The Garo people do not represent the whole of Bangladeshi adults. In year 2001 it was estimated that total of two million Garos live in Bangladesh (Bangladesh.Com 2013). According to the last census in Bangladesh done in 2011, the total population was 14, 97, 2,364 (Bangladesh Bureau of Statistics 2012). The Garo study found that the adult females stature mean (cm) was 152.79 and head length mean 17.49 cm. But the current study found that the Bangladeshi adults females stature & head length mean (mm) was 1516.27 & 197.55. We see the result that the Garo female is longer than the present study females and the Garo females head length is lower than Bangladeshi adult females.

Another two researches were also conducted about foot length and correlation with hand length & stature of Bengali Muslim female and male. One study found Bengali adult Muslim females stature and right and left hand length mean (cm) is 156.02, 16.39 and 16.34. The other research found that Bangladeshi adult's male mean stature was 167.97 cm and the mean right foot length was 25.30 cm and right foot length was 25.32 cm. respectively. The present research identifying the Bangladeshi females mean stature (1516.27 mm) was lower than Bengali Muslim females and the hand length (165.45 mm) was bigger than Muslim females. In the present's research, male respondents mean stature (1682.75 mm) was higher than Bangladeshi male and the foot length (247.28 mm) was lower than Bangladeshi male.

In the world, a lot of anthropometric research has been conducted based on hand anthropometric dimension. The Vietnamese (160.5 mm, 40.9 cm) and Bangladeshi people palm length (167.64 mm) or breadth (41.95 cm) is smaller. The palm dimensions mean (41.95 cm) of Bangladeshi female seem to be smaller than those of Mexicans (42.6 cm), Hong Kong Chinese (42.6 cm) and Jordanians (40.35 cm) & larger than those of Vietnamese (40.9 cm), UK residents (40.5 cm) and two Indian sub-populations (34.2 cm). The Bangladeshi finger and finger segment length is significantly smaller than those of all other populations (Imrhan, Sarder & Mandahawi 2009). One study shows that the North Indian population has larger hand length and hand breadth in males than females (Krishan, Kanchan and Asha 2012).

The United States of America, the Hong Kong Chinese and Japan had significantly ($p<0.002$) larger hands than the Japanese on every-body dimension, and smaller hands than American females ($p<0.002$) but similar finger lengths to the American females (COURTNEY 2007). Comparison between Chinese (Beijing) and Japanese elderly also showed anthropometric dimensions differences (Haitao et al. 2007). The hand length mean of the Indian women (16.96 cm) was also smaller than those of the American women (17.90 cm) (Nag, Nag & Desai 2003). In the present study, the females mean hand lengths were found as 165.45 mm which is smaller than Indian and American women.

The hand length and breadth mean of the Jordanian people is 171.27 mm & 93.99 mm (Mandahawia, Imrhanb, Shobakia & Sarder 2008). To compare the Jordanian population, the current research found hand length and breadth means (175.52 mm) were highest and breadth means (86 mm) were smallest. Another anthropometric research identifying Nigerian, Indian agricultural workers, Korean female hand length means was 170.51 mm, 160.09 mm, 170 mm respectively (Kar et al. 2003). The Bangladeshi female hand length means (165.45 mm) are smaller than Nigerian female & Korean female and larger than Indian agricultural workers.

The anthropometric measurements are not similar in all countries of the world. The North Indian population stature is significantly higher in males (161.65 cm) than in females (153.13 cm) (Krishan, Kanchan and Asha 2012). One world anthropometric study found the stature height for North America male (1790 mm) & female (1650 mm), France male (1770 mm) & female (1630 mm), and North Africa male (1690 mm) and female (1610 mm) (Kroermer 2009, pp. 4-15). But the present study was found the Bangladeshi adult's stature means is male (1682.75 mm) and female (1516.27 mm). That means the stature is smallest than other populations in the world. The 5th percentile UNSW student in Australia stature (1534 mm) is only 6mm less than the corresponding USA female dimension but 14mm more than the British and 8mm more than in another Australian female study (Ward 2011).

This present study found that female stature is 1430 mm, which means less than UNSW student stature, USA and British female stature. The 95th percentile female UNSW student stature (1730 mm) was between the 95th percentile statures for British females (1720 mm) and USA females (1756 mm) (Ward 2011). The present study's respondents adult's female $95^{th}$ percentile statures was 1630 mm. The $95^{th}$ percentile of male stature is Brazil (1837 mm), Australia (1877 mm), USA (1888 mm), Netherlands (1954mm) and British (1880 mm) respectively (Ward 2011). But the present study found that male $95^{th}$ percentile stature is 1819 mm. The measurements data is less than these countries.

The 5th percentile female sitting heights are Brazil (808 mm), USA (815 mm), Netherlands (844 mm), Australia (815 mm) and British (800 mm). But the present research finding that $5^{th}$ percentile of sitting height is 738 mm. The sitting height is less than other populations. The Bangladeshi adult's female $5^{th}$ percentile Buttock-knee depth is 438mm smaller than UNSW female buttock-knee length (508 mm), British females (517 mm), Netherlands (554 mm) and, Brazil (530 mm).

The Japanese have the largest length but the smallest eye height. The Taiwanese have narrower hip, but shoulder is highest & widest. The Taiwanese people have longest hand, greatest wrist and elbow height. The Korean people have greatest sitting height and sitting eye-height. There are a lot of factors that influence the anthropometric data variation such as hereditary influences, economic development, and social environment, type of work and labor structure (Krishan, Kanchan and Asha 2012).

### Bangladeshis Male-Female differences:

In this study, the t-test done for differences in means showed gender differences (male & female) aged between 18-60 years of Bangladeshi people. The study found that the male and female stature, eye height standing, shoulder height standing, elbow height standing, hip height standing, knuckle height standing, fingertip height standing, sitting shoulder height, sitting knee height, sitting popliteal height, shoulder-elbow length, elbow-fingertip length, overhead grip reach sitting, overhead grip reach standing, arm length vertical, downward grip length, abdomen depth sitting, buttock-knee depth sitting, buttock-popliteal depth sitting, shoulder breadth (bideltoid), span, head breadth, hand length, hand breadth, foot length & weight means is significantly ($p<0.05$) different.

The researcher found through the t-test that is significantly different between male and female data of Bangladeshi people. The non-significant differences were sitting height, sitting eye height, sitting elbow height, sitting thigh height, forward grip reach, chest depth, shoulder breadth (biacrominal), hip breadth sitting, elbow span, head length, and foot breadth. The present research found that male body dimension means are higher than the female body dimensions measurements means except sitting elbow length, Chest depth, Hip breadth, sitting, Head length and Head breadth. The sitting elbow length means are male (219.42 mm) & female (226.91 mm), Chest depth means male (206.67 mm), female (212.64 mm), Hip breadth, sitting male (310 mm), female (327.36 mm), Head length (193.75 mm), female (197.55 mm) and Head breadth male (163.75 mm), female (174.45 mm).

Due to poor anthropometric data for people in our country, the work place & industrial setting is poorly designed. Workers suffer many musculoskeletal disorder such as neck pain, back pain, carpal tunnel syndrome etc. In Bangladesh the adult people are productive source of earning. But the Bangladeshi people have no appropriate anthropometric data. Determining all body dimensions is important in many points of view. Determining body dimensions is important in the design e. g. chair popliteal height, seat depth (buttock to popliteal length) hip breadth, sitting height (back height), elbow height, lumbar depth.

This anthropometric data is important for ergonomically sound chair design. In this research, the researcher use percentile to assess anthropometric measures. The strength of percentile is indicating the expected prevalence and is intuitively more understandable (Wang and Chen 2012). Percentiles from the reference population have a uniform distribution and may be useful since they are easy to interpret (Gorstein 1994).

# CHAPTER -6 LIMITATIONS AND RECOMMENDATIONS

## 6.1. Limitations of the study

This research has some limitations. The research participants are small in number. The study participants do not represent the whole country's people. The extreme values are lumped to the highest/lowest percentile. The researcher used three data collectors. That's why the data is varying person to person. The study site was selected conveniently from three Bangladeshis area.

## 6.2. Recommendations

As a consequence of this researcher it is recommended to do further study including all groups of Bangladeshi people. It is recommended further study could be conducted in a large number of sample groups and with a longer time frame. It is also is recommended to do further study with use of more modern equipment such as foot caliper, anthropometer, height machine etc.

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# CHAPTER-7 CONCLUSION

Probably, this is the first anthropometric study that carried out on the Bangladeshi people with 37 body dimensions and the result of the present study will provide some baseline information regarding 37 body dimensions. The result of the present study indicates the male and female means is significantly different.

All above finding shown that anthropometry is important for ergonomics intervention. Understanding of anthropometry is essential to the application of ergonomics. Anthropometry provides the parameters of human size and shape that allow designers to fulfill the needs of both comfort and function. Anthropometry plays an important role in industrial design, clothing design, ergonomics, and architecture. Changes in life styles, nutrition and ethnic composition of populations lead to changes in the distribution of body dimensions and require regular updating of anthropometric data collections. Anthropometric data is important for adapt the environment where the individuals work. To fit equipment & tasks to persons of different body sizes need anthropometric data. The adults anthropometric data is very essential for any country to work place deign or tools deign. It will be enriches the ergonomics sectors interventions.

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# APPENDIX 1A: CONSENT FORM (English)

Assalamu-alaikum/Namasker. My name is Md. Murad Hossain Khan Student of B.Sc. in Occupational therapy at Bangladesh Health Professions Institute (BHPI), CRP. I am conducting a study for partial fulfillment of Bachelor of Science in Occupational Therapy degree, titled, **"Anthropometric Estimation for Bangladeshi people from three different areas".**

Through this research, I will measure the 37 human body dimensions of Bangladeshi adults. For this regard, I would need to collect data from the Bangladeshi adults. Considering the area of research, you have met the inclusion criteria and I would like to invite you as a subject of my study. If you participate in this study, I will measure your body dimensions. The measurements that would be given are safe and will not cause any harm. I want to meet you a sessions during your free time. Your participation will be voluntary. You have the right to withdraw consent and discontinue participation at any time. Information from this study will be anonymously coded to ensure confidentiality.

If you have any query about the study or your right as a participant, you may contact with, researcher Md. Murad Hossain Khan or Md. Monjurul Habib lecturer in Department of Occupational Therapy, BHPI, CRP, Savar, Dhaka-1343.

Do you have any questions before I start?

So may I have your consent to proceed with the participation?

Yes: ☐ No: ☐

Signature of the Researcher _____

I …….have read and understand the contents of the form. I agree to participant in the research without any force.

Signature of the participant _____

## APPENDIX 1B: CONSENT FORM (Bangla)

এই গবেষণাটি অকুপেশনাল থেরাপীর একটি অংশ এবং গবেষণাকারীর নাম মোঃ মুরাদ হোসেন খাঁন। সে বাংলাদেশ হেলথ প্রফেশন ইন্সটিটিউট এর বি.এস.সি ইন অকুপেশনাল থেরাপীর ৪র্থ বর্ষের ছাত্র। এই গবেষণাটির শিরোনাম বাংলাদেশী যুবকদের এন্থ্রপয়েমেট্রিকাল পরমাপ এবং এই গবেষণার উদ্দেশ্য বাংলাদেশের যুবকদের এন্থ্রপয়েমেট্রিকাল পরিমাপ করা।

এই গবেষণাতে আমি একজন অংশগ্রহনকারী এবং আমি পরিস্কার ভাবে এই গবেষণার উদ্দেশ্য সম্পর্কে অবগত। আমার যে কোন সময় এই গবেষণা থেকে নিজেকে সরিয়ে আনার অধিকার আছে। এজন্য আমি প্রশ্নের উত্তর প্রদান করার জন্য কারো কাছে দায়বদ্ধ না। এই গবেষনাটির সাথে আমার কোন সম্পৃক্ততা নেই এবং আমার চিকিৎসার সাথে বর্তমানে এবং ভবিষ্যতে কোনভাবে সম্পৃক্ত না।

আমি আর অবগত আছি যে,এই কথোপকথন থেকে নেওয়া সমস্ত তথ্যাবলি নিরাপদে এবং গোপন রাখা হবে। আমার নাম এবং ঠিকানা কোথাও প্রকাশ করা হবে না। শুধুমাত্র গবেষণাকারী এবংতার সমন্বয়কারী এই তথ্যাবলী দেখার ক্ষমতা রাখেন।

আমি এই গবেষণাকারীর এবং তার গবেষনার সমন্বয়কারীর সাথে এই গবেষনার পদ্ধতি সম্পর্কে অথবা যে কোন প্রশ্নের উত্তর জানার জন্য কথা বলতে পারব।

আমি উপরোক্ত তথ্যগুলো ভালোভাবে জেনে নিজ ইচ্ছায় এই গবেষণা অংশগ্রহণ করছি।

| | |
|---|---|
| অংশগ্রহনকারীর স্বাক্ষর/ টিপসই | তারিখঃ |
| গবেষণাকারীর স্বাক্ষর | তারিখঃ |
| সাক্ষ্যপ্রদানকারীর স্বাক্ষর/ টিপসই | তারিখঃ |

# APPENDIX 2A: Demographic Questioner

Code no:

Age:

Sex:

Educational status:

- Illiterate (who can neither read nor write)
- No formal Education (who can read or write but have not attended schools or college)
- Primary School (who have attended the school up to class V)
- Secondary School Certificate (SSC)
- Higher Secondary School Certificate (H.S.C)
- Bachelor
- Masters or above

Living area: Rural/Urban

Home district:

Marital status: Single/Married/Divorced/Widow

Occupation: Public service/Private service/Student/Housewife/ Unemployed

Monthly income (Either own or family):

## APPENDIX 3A: Kroermer Anthropometric Body Dimension Questioner

| Dimensions | Description | Acquired measurement |
|---|---|---|
| Stature | The vertical distance from the floor to the top of the head, when standing. | |
| Eye height, standing | The vertical distance from the floor to the outer corner of the right eye, when standing. | |
| Shoulder height, standing | The vertical distance from the floor to the tip (acromion) of the shoulder, when standing. | |
| Elbow height, standing | The vertical distance from the floor to the lowest point of the right elbow, when standing, with the elbow flexed at 90 degrees. | |
| Hip height, standing | The vertical distance from the floor to the trochanter landmark on the upper side of the right thigh, when standing. | |
| Knuckle height, standing | The vertical distance from the floor to the knuckle (metacarpal bone) of the middle finger of the right hand, when standing. | |
| Fingertip height, standing | The vertical distance from the floor to the tip of the extended index finger of the right hand, when standing. | |
| Sitting height | The vertical distance from the sitting surface to the top of the head, when sitting. | |
| Sitting eye height | The vertical distance from the sitting surface to the outer corner of the right eye, when sitting. | |
| Sitting shoulder height | The vertical distance from the sitting surface to the tip (acromion) of the shoulder, when sitting. | |
| Sitting elbow height | The vertical distance from the sitting surface to the lowest point of the right elbow, when sitting, with the elbow flexed at 90 degrees. | |
| Sitting thigh height | The vertical distance from the sitting surface to the highest point of the top of the horizontal right thigh, with the knee flexed at 90 degrees. | |

| | | |
|---|---|---|
| Sitting knee height | The vertical distance from the floor to the top of the right kneecap, when sitting, with the knees flexed at 90 degrees, | |
| Sitting popliteal height | The vertical distance from the floor to the underside of the thigh directly behind the right knee; when sitting, with the knees flexed at 90 degrees. | |
| Shoulder-elbow length | The vertical distance from the floor to the underside of the right elbow to the right acromion, with the elbow flexed at 90 degrees & the upper arm hanging vertically. | |
| Elbow-fingertip length | The distance from the back of the right elbow to the tip of the extended middle finger, with the elbow flexed at 90 degrees. | |
| Overhead grip reach, sitting | The vertical distance from the sitting surface to the center of a cylindrical rod firmly held in the palm of the right hand. | |
| Overhead grip reach, standing | The vertical distance from the floor to the center of a cylindrical rod firmly held in the palm of the right hand. | |
| Forward grip reach | The horizontal distance from the back of the right shoulder blade to the center of a cylindrical rod firmly held in the palm of the right hand. | |
| Arm length, vertical | The vertical distance from the tip of the right middle finger to the right acromion, with the arm hanging vertically. | |
| Downward grip reach | The vertical distance from the right acromion to the center of a cylindrical rod firmly held in the palm of the right hand, with the arm hanging vertically. | |
| Chest depth | The horizontal distance from the back to the right nipple. | |
| Abdominal depth, sitting | The horizontal distance from the back to the most protruding point on the abdomen. | |
| Buttock-knee depth, sitting | The horizontal distance from the back of the buttocks to the most protruding point on the right knee, when sitting | |

| | | |
|---|---|---|
| | with the knee flexed at 9o,degrees. | |
| Buttock-popliteal depth, sitting | The horizontal distance from the back of the buttocks to back of the right knee just below the thigh when sitting with the knee flexed at 9o, degrees. | |
| Shoulder breadth (biacromial) | The distance between the right and left acromions. | |
| Shoulder breadth (bideltoid) | The maximum horizontal breadth across the shoulders between the lateral margins of the right & left deltoid muscles. | |
| Hip breadth, sitting | The maximum horizontal breadth across the hips or thighs, whatever is greater, when sitting. | |
| Span | The distance between the tips of the middle fingers of the horizontally outstretched arms and legs. | |
| Elbow span | The distance between the tips of the elbows of the horizontally outstretched upper arms when the elbows are flexed so that the fingertips of the hands meet in front of the trunk. | |
| Head length | The distance from the glabella (between the browridges) to the most rearward protrusion(the occiput) on the back, in the middle of the skull. | |
| Head breadth | The maximum horizontal breadth of the head above the attachment of the ears. | |
| Hand length | The length of the right hand between the crease of the wrist and the tip of the middle finger, with the hand flat. | |
| Hand breadth | The breadth of the right hand across the knuckles of the four fingers. | |
| Foot length | The maximum length of the right foot, when standing. | |
| Foot breadth | The maximum breadth of the right foot, at right angle to the long axis of the foot, when standing. | |
| Weight | Body weight taken to the nearest tenth of a kilogram. | |

Adapted from Kroermer, K.H.E (2009), Fitting the Human, Introduction to Ergonomics, 6$^{th}$Edition.

# APPENDIX 4A: Permission Letter

**Permission Letter**

Date: 4th August, 2013
To
The Head of the Department
Department of Occupational Therapy
Bangladesh Health Professions Institute
C.R.P, Chapain, Savar
Dhaka-1343

Subject: An application for seeking permission to conduct the research project.

Madam,
With due respect and humble submission to state that I am seeking permission to conduct the research project as a part of my 4th year course module. My research title is "Anthropometric Measurement for Bangladeshi Adults". The aim of this study is to determine the anthropometric measurement of the Bangladeshi adults. Now I am seeking for your kind approval to start my research project and I would like to ensure that anything's of my study will not bring any harm to the participants.

So I therefore pray and hope that you would be kind enough to grant me the permission to conduct the research and will help me to conduct a successful study as s part of my course module.

I remain
Madam 04.08.13

Md. Murad Hossain Khan
4th year B.Sc in Occupational Therapy
BHPI, CRP, Savar, Dhaka-1343.

Attachment: Proposal of the study.

| Signature and comments of the supervisor | Signature and comments of the Head of the department |
|---|---|
| It is a good proposal. I recommend it for further proceeding.<br><br>12/August/2013<br>Md. Monjurul Habib<br>Lecturer in Occupational Therapy<br>Dept. of Occupational Therapy<br>BHPI, CRP, Savar, Dhaka-1343 | As per supervisor's comment it may allow to conduct the study.<br><br>12.08.13<br>Nazmun Nahar<br>Assistant Professor & Head of the Department.<br>Dept. of Occupational Therapy<br>BHPI, CRP, Savar, Dhaka-1343 |