Growth Characteristics of Age-based Anthropometric Data from Human Assisted Remote Healthcare Systems

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***Abstract*—This paper reports growth characteristics (height, weight, BMI, waist and hip) of Bangladeshi males at the age of 20 to 100, analyzed from 13,069 samples randomly collected from 54 locations in Bangladesh since the year 2010. The US CDC (Center for Disease Control and Prevention) demonstrates growth pattern charts for boys and girls from 2 to 20 years of age. Very few literatures report growth characteristics after the age of 20. This is due to the fact that there is no significant growth after the age of 20 for height. However, weight, BMI, waist, hip size do change over time. Our Portable Health Clinic system has for many years been archiving remote health care data records from different ages and socioeconomic levels in many locations throughout Bangladesh. This research aims to explore whether there are any significant clinical growth patterns over age. We analyzed our data and demonstrated the growth patterns. For height, there is no sharp change until the age of 49, but after the age of 50, we observe a slight decline of height and a sharp decline after the age of 80. Weight grows until the age of 49 and decline after that. Waist and Hip show similar growth characteristics with weight. The plots are demonstrated in 7 different percentiles (5th, 10th, 25th, 50th, 75th, 90th and 95th) to get an idea of the range of respective growth of males in Bangladesh.**

***Keywords*—Age and gender-based growth characteristics; portable health clinic; human assisted remote healthcare system**

I. Introduction

Growth monitoring is the single most useful tool for defining health and nutritional status in children at both the individual and population[1]. This growth charts are widely used as a clinical and research tool to assess nutritional status and the general health and well-being of infants, children, and adolescents [2]. Optimal growth depends on genetic constitution, normal endocrine function, adequate nutrition, a nurturing environment, and an absence of chronic disease. Fetal, infant, maternal, and environmental factors can interact to impair intrauterine and postnatal growth [3]. Genetic differences in birth-weight among various populations are small and, although there are some racial/ethnic differences in growth [4], these differences are now known to be relatively minor compared to worldwide variations in growth which are due to health and environmental influences (e.g. poor nutrition, infectious disease, socio-economic status) [6]. The most popular approach of growth pattern metrics developed and widely used by the CDC comprise a series of percentile curves that illustrate the distribution of selected body measurements related to the age of boys and girls. The CDC curves are based on compiled anthropometric measurements that were performed only once on the infants and toddlers who were sampled [7]. However, these CDC growth charts and their many derivatives only address the ages 2-20 years. As far as we know, there are currently no corresponding charts reflecting the same set of characteristics of human development for ages greater than 20. We aim to see if there are any significant clinical growth patterns, specifically regarding height, weight, BMI, waist, and hip for humans over the age of 20 years. We have been collecting and archiving 10 anthropometric data items from 54 different areas of Bangladesh since 2010 [5], [8], [9]. We are working on error detection, consumer behavior [10], [11], [12], [13] and healthcare well-being [14]areas. However, in this study we became interested in looking at this data to determine whether there are any significant growth patterns for individuals more than 20 years old, and therefore, the possibility of extending the very useful CDC charts. Due to the nature of Bangladesh, the uniform collection of health data can be challenging, and therefore, this long-term project was managed by our Portable Health Clinic (PHC) system, which is jointly administered by the Faculty of Information Engineering of Kyushu University, Japan, and Grameen Communications of Bangladesh [11], [15], [16]. In this effort, we focused 5 anthropometrics data: height, weight, BMI, waist, and hip. Because the underlying data was collected in often remote areas and digitized by health care workers in the field. The PHC is an e-Health system specifically designed to help provide medical advice and care in remote environments, both urban and rural. In both settings, the approach to the measurement, examination, and monitoring of health status, as well as facilitating consults by physicians, is the same. This service offers two types of packages that can be selected based on the needs of a given patient. The system comprises three main components: a set of back-end data servers, a medical call center, and numerous inexpensive front-end portable medical briefcase with monitor, roughly 20cm X 12cm in size, consisting of medical sensors and measuring equipment, which are used to identify non-communicable diseases. The briefcase system also includes a tablet computer loaded with the Android application GramHealth [17], and it can store and share a wide range of remotely gathered health care data with physicians at major health care centers [18]. The PHC service utilizes two different actors, a health care worker and an ICT assistant, having independent roles and responsibilities, and each receiving a short but intensive training program. In the first step, a patient is registered at a service location by the health care worker [19], who then conducts a health checkup using the various capabilities of the PHC monitoring briefcase, and issues the patient a registration card with a unique ID [20]. The values of the patients 10 different anthropometric data are written on the back of the registration card. To store the data properly in the PHC software, the ICT assistant double checks the data and inputs it according to the patient registration card [21].

The rest of the paper is structured as follows: Section II describes the motivation and objective of this research, Section III explains the data preprocessing and analysis methodology of our approach, Section IV describes the obtained results from our analysis followed by a discussion of the findings and finally we conclude our research at Section V.

II. Motivation and Objectives

Extensive research has documented the pattern of human growth, with regard to height, weight, and BMI, up to the age of 20. As rigorously developed and promoted by the CDC, this information has been utilized worldwide as a series of percentile curves that illustrate the distribution of selected body measurements. However, very few studies have reported this class of growth patterns using health checkup data that has been collected from Bangladesh, particularly after the age of 20. Our previous study has been reported that within the various percentile categories, we found different growth patterns; however, we could not determine a clear indication in terms of a specific age where the significant change from growth to decline occurs. Therefore, in this study our objective is to use a unique dataset to explore whether there may be identifiable growth characteristics of human growth after age of 20 by 5 interval age groups and consider the possible implications of our findings.

III. Methodology

Anthropometric data has been collected from 54 locations from 2010 to 2018. We found 40,391 records in the database. We took the following steps to analyze the data.

- Step-1: Remove the incomplete, unusual and uninterested data: After removing incomplete, unusual data and uninterested (age ¡20) data, we selected N=25,447 records for our experiment. Number of male was Nm=13,069 and number of female was Nf=12,378.
- Step-2: Group the data into 5 years intervals: We classified the data into 15 groups, each group contains 5 years age intervals i.e. 20-24, 25-29, . . . ,95-99.
- Step-3: Plot the growth charts: We plotted five anthropometric factors e.g. Height, Weight, BMI, Waist, HIP vs. each age group. Each anthropometric item in correspondence with age by seven difference percentiles (5th, 10th, 25th, 50th, 75th, 90th, and 95th) to view the distribution patterns. The curve was smoothened by using Local Polynomial Regression (LPR).

In our study, we considered anthropometric items (height, weight, BMI, waist, and hip) to explore whether clear patterns are evident.

IV. Data Analysis: Results and Discussions

This section explains the results obtained from the data analysis mentioned in Section III. The growth patterns of each anthropometric parameters are plotted and the patterns are explained.

A. Male Height

Fig. 1 shows the growth characteristics of male height based on age where x-axis represents age groups (year) and y-axis represents height(cm) for male. We find three clusters of age with similar characteristics.

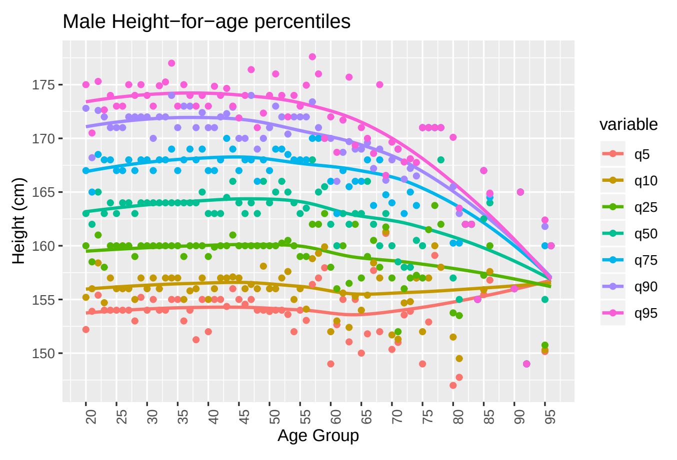

Fig. 1. Male Height for Age 20-100: 5th to 95th Percentile

1) Age level 20-49: There is no significant change in the growth at this age level. The reason could be the following: there is no significance change because generally male stop growing at the age of 18-20. Therefore, our findings comply with the natural growth of human being.
2) Age level 50-79: A decremented pattern is observed at this age zone. There could be two reasons for the height decreases with age: (a) biologically, our bone starts shrinking after this age level (b) a person of 79 years old now, was at 20 years of old in 1960s. At that period, the average height of male was 162-164cm, reported by [26], [27]. Their growth height stopped at the age of 20. That is why the growth pattern shows a decremental characteristics.

3) Age level 80-100: There is a drastic height loss in this age zone. Height of people may not decrease so drastically. This is quite surprising. We assume that this pattern is not representative. In fact, there are only 37 data samples (as in Fig. 2). Also, it can be assumed that the people were short at when their growth level stopped at their age of twenty which happened sixty to eighty years ago. People at that time, were generally short.

According to MedlinePlus [28], the tendency to become shorter occurs among all races and both sexes. Height loss is related to aging changes in the bones, muscles, and joints. People typically lose almost one-half inch (about 1 centimeter) every 10 years after age 40. Height loss is even more rapid after age 70. You may lose a total of 1 to 3 inches (2.5 to 7.5 centimeters) in height as you age. One can help prevent height loss by following a healthy diet, staying physically active, and preventing and treating bone loss.

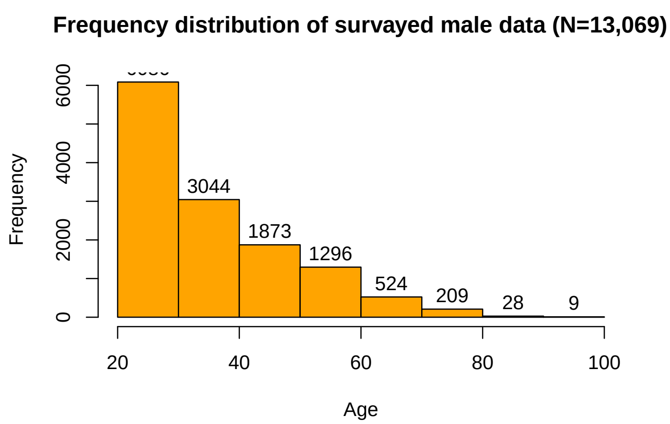

Fig. 2. Frequency of Male Data Samples

B. Male Weight

Fig. 3 shows the growth characteristics of male weight vs. age groups. The graphs are also plotted in seven difference percentiles. Our observations from this graph are the following:

1) Age level 20-49: An incremental pattern is observed at this age zone. Males gradually gain weight until the age of 50. This pattern is quite natural.
2) Age level 50-79: A decremental pattern is observed. Males lose weight at this age level. This pattern is also quite natural.
3) Age level 80-100: Very interesting pattern is observed at this age level. According to the graph, the weight is increasing at this age level which is not natural. It is assumed that the number of sample data is not representative at this age level. As described earlier, there are only 24 samples at age group 80-84, only 9 samples at 85-89 age group, 8 samples at 90-94 age group and only 2 samples at 95-99 age group. Therefore, we need more samples to draw a conclusion.

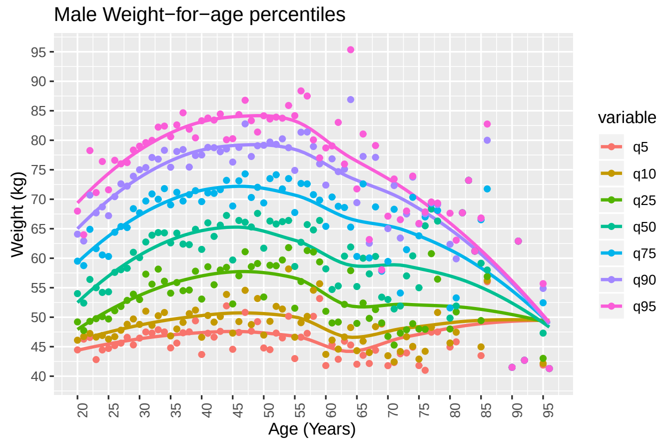

Fig. 3. Male Weight for Age 20-100: 5th to 95th Percentile

C. Male BMI

Fig. 4 shows the male BMI vs. age groups. Body mass index (BMI) is calculated using the formula (kg/m2) and defined as weight (kg) divided by height (m) squared.

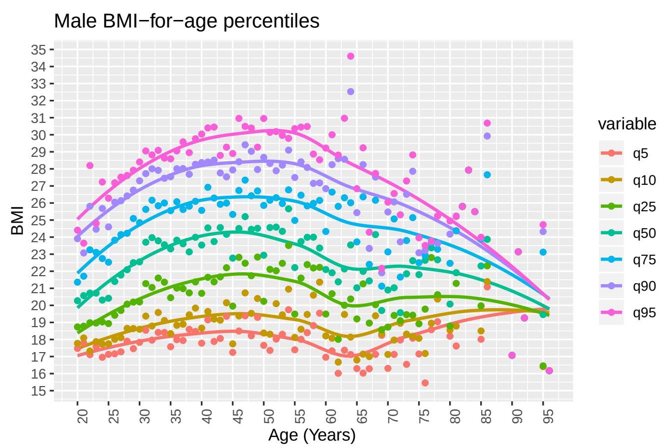

Fig. 4. Male BMI for Age 20-100: 5th to 95th Percentile

From the graph, we can observe the followings:

1) Age level 20-44: An incremental pattern is observed at this age zone. BMI is weight (in kilograms) height squared (in centimeters). We observed similar pattern at the age group in height. This pattern is quite natural.
2) Age level 45-64: A decremental pattern of BMI is observed. As people gain weight, without changing the height, this pattern is natural.
3) Age level: Age level 65-80: There is a drastic drop after the age of 60. in this age zone. This is surprising. There is a smooth decline of BMI after the age of 60. These are our eyeball measurements. More accurate mathematics are required to detect the cutoff point.

D. Male Waist

Fig. 5 shows the growth of male waist size over age.

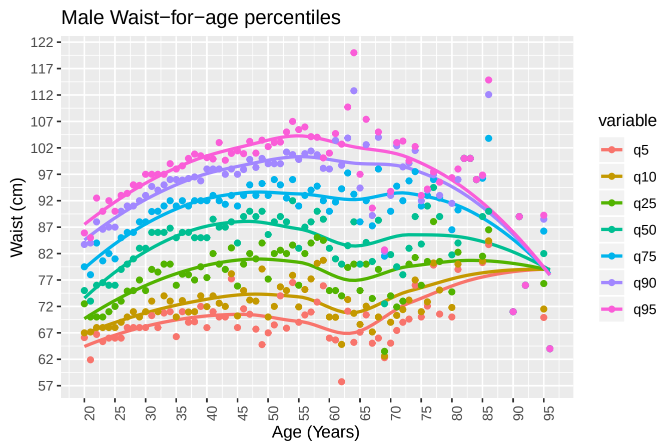

Fig. 5. Male Waist for Age 20-100: 5th to 95th Percentile

1) Age level 20-44: An incremental pattern is observed at this age zone. Males gradually change waist until the age of 44. This pattern is quite natural.
2) Age level 45-64: A slight decremental pattern is observed. It is assumed the bone starts shrinking at this age level.
3) Age level 65-100: This is quite surprising. We assume that this pattern is not representative.

E. Male Hip

Fig. 5 shows the growth of male hip size over age.

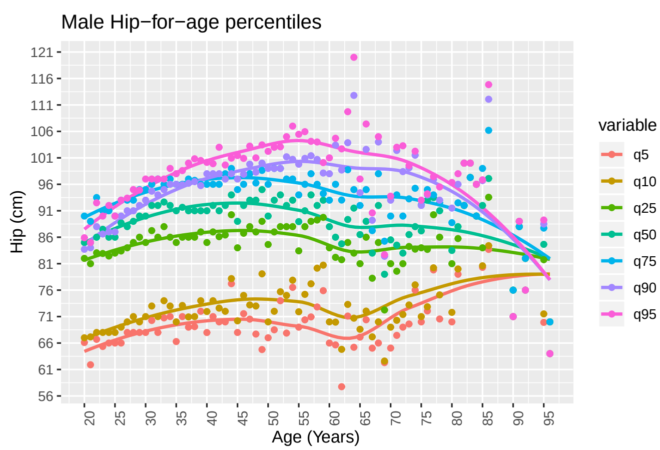

Fig. 6. Male Hip for Age 20-100: 5th to 95th Percentile

1) Age level 20-44: An incremental pattern is observed at this age zone. Males gradually gain weight and become fatty who do not do regular exercise.
2) Age level 45-79: A decremental pattern is observed. This pattern is also quite natural.
3) Age level 80-100: There is a drastic hip change in this age zone. Hip of people may not decrease so drastically. This is quite surprising. We assume that this pattern is not representative. In fact, there are only 37 data samples (as in Fig. 2).

Our present analysis described the relationship of age and male hip comprise a series of percentile curves. Most people stop growing in height by the time they hit age 20 though the hip bones can keep growing even as people enter their 70s. In order to explain more rigorously this growth pattern for the male hip, we would in principle need a continuous record of the anthropometric items of each specific person in the sample.

V. Conclusion

This study investigated anthropometric growth patterns, specifically regarding height, for males over the age of 20 years. Over forty thousands health records were randomly collected by using our portable health clinic system from 54 locations in Bangladesh since the year 2010. Incomplete records, uninterested records (young patients, age ¡20 years) were removed. Finally N=25,447 (male: N=13,069 and female: N=12,378) records were considered. We plotted the mean of anthropometric item in correspondence with age by 7 different percentiles (5th, 10th, 25th, 50th, 75th, 90th and 95th) to represent the growth patterns of different age groups. The obtained curves were smoothened by Local Polynomial Regression (LPR). The resulting plots comprise a series of percentile (5th, 10th, 25th, 50th, 75th, 90th, and 95th) curves that illustrate the distribution by height, weight, BMI, waist, and hip. For height, there is no sharp change until the age of 49, but after the age of 50, we observe a slight decline of height and a sharp decline after the age of 80. Weight grows until the age of 49 and decline after that. Waist and Hip show similar growth characteristics with weight. A very small samples were available from old people (¿80 years old). The obtained growth patterns at this age level are not representative. The study will continue to collect more samples, find growth pattern for females and compare with those of males. Once the range for age based anthropometric data is known, it will be much easier to predict measurement errors of the patients for remote healthcare systems.

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