Addis Ababa University College of
Computational and Natural Sciences
Department of Zoological Science

Body Mass Index and Growth Spurt in School Teenagers (13-18 years) of Atse Zerea Yaekob Primary Full Cycle School and Basso General and Preparatory School in Debre Berhan, Central Ethiopia

A Thesis Submitted to College of Computational and Natural Sciences Department of Zoological Sciences in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology

By Meklit Tirsetewold

October 2018

Declaration

This thesis has been submitted to the Department of Zoological Sciences, College of Natural and Computational Sciences, Addis Ababa University, in partial fulfillment of the requirements for the Degree of Master of Science in Biology. Therefore, I declare that it is my original work and this thesis has not been submitted to any other institution for the award of any academic diploma or degree certificate. Information obtained from other sources are dually acknowledged through citation.

_____ _____ _____

Name of candidate Signature Date

ADDIS ABABA UNIVERSITY

GRADUAT PROGRAMME

This is to certify that the thesis prepared by Meklit Trsitewold, entitled: Body Mass Index and Growth Spurts in School Teenagers (13-18 years) of Atse Zerea Yaekob Primary Full Cycle and Basso General and Preparatory Governmental School in Debre Berhan, Central Ethiopia, and submitted in partial fulfillment of the requirements for the Degree of Master of Science in biology complies with the regulations of the University and meets the accepted standard with respect to originality and quality.

Sign of Advisors_____

Signed by Examining Board :

Name	Signature	Date
1_____	(Examiner)	_____
2 _____	(Examiner)	_____
3._____	(Advisor)	_____
4._____	(Advisor)	_____
5._____	(Chairman)	_____

Acknowledgements

First of all, I would like to express my deepest gratitude to my Almighty God who gives me health, patience and wisdom that made it possible for me to complete this work.

My special thanks go to my advisor, Dr. Tilaye Wube, for his genuine constructive advice and critical comments from the beginning to the end of this research work. Without his valuable support, it would have been very difficult to be successful in writing this thesis.

I also would like to express my gratitude to Ethiopian Ministry of Education for its sponsorship and financial support for the successes of my work and Department of Zoological Sciences, Addis Ababa University, for hosting the program.

My deepest gratitude is extended to my sister Meaza Tirsitewold, and my son Eyosyas Alemu for being with me and sacrificing his time of mother-son interaction.

I am grateful to Merite Yitagesu, Head, and Genet Asfaw Deputy Director of Atse ZreaYaekob Primary Full Cycle School for their willingness to facilitate data collection; Bekele Bedane-Physical Health Education teacher from same school who helped me a lot in coordinating students in the process of taking measurements; Abaynesh Asefa, Deputy Director of Basso Secondary and Preparatory School for her willingness to assist during data collection. Elias Ayifokru is acknowledged for editing the draft paper.

I would like to extend my deepest thanks to my brother, Befekadu Tirsitewold, and my colleague Wubetie Wassie for their support in taking photographs while I was measuring height and weight of the participants.

Last but not least, all students who have participated in the study are duly acknowledged.

Table of Contents

List of Tables

Page

List of Figure

page

Appendices

Page

ABSTRACT

Body Mass Index and Growth Spurt in School Teenagers (13-18 years) of Atse Zerea Yaekob Primary Full Cycle School and Basso General and Preparatory School in Debre Berhan, Central Ethiopia by Meklit Trsitewold,Addis Ababa University in 2018.

Body mass index is a value derived from the mass and height of an individual and calculated by the body mass divided by the square of body height and its value categorized based on CDC standard under normal weight, overweight, underweight and obesity. Growth spurts are when a lot of growing takes place in a short period of time. A rapid rise in height and weight are most visible in the first year of life and around puberty, both periods when a tremendous amount of growth takes place in a short time. And to determine the percentage increment, percentage difference of height, weight and BMI under the age group 13 to 18 years in both sexes. The apparatus used to measure Height and weight was height measuring board mounted to weight measuring in standing position following the standard steps. A cross-sectional design method was used and the data collected from direct measuring of the height and weight with bare foot and light cloth.

The sample 400 students' (equal proportion of males and females) were included in the study. The results showed that the highest percentage increase of height for females (2.5%) was observed during the transition between age 17 and18 while the lowest was (0.65%) which was observed during the transition between age 15 and 16. For males, the highest height increase was 3.92% during the transition between 14 and 15 year and the lowest was 1.26% observed between 15 and 16 year olds. The highest increment of bodyweight for females was 12.87% during the transition between 13 and 14 years and the lowest was 0.2% between 15 and 16 year olds. For males, the highest body weight increase was 8.54% between 14 and 15 years and the lowest was 2.07% between 17 and 18 years. In females, BMI ranged from 18.15kg/m^2 913 year old) to 22.59kg/m^2 (17 year old). The highest percentage increment of BMI in female recorded between 13 and 14 years (10.83%) while the lowest was 0.1% recorded between 15 and 16 years. In males the respective values were 6.2% (16 to 17 Years) and -1.1% (14 to 15 years).

The results compared to other studies with similar objectives and scope, the students from the present study had significantly lower body weight than those from a private school in Addis Ababa. However, based on their BMI values, all age categories of both sexes in the present study fall under the normal weight category.
The final Conclusion of this study showed that there was no significant difference in height, weight, and BMI between male's females and all age groups of both sexes fall under the normal weight category based on their mean BMI

***Keywords**: Teenagers, BMI, height, weight, growth spurts, Debre Berhan*

1. Introduction

1.1. Background

Body mass index (BMI) is a measure which shows weather people have the right weight for their height (Web 1*). It is calculated by dividing weight in kilogram to the square of height in meter (Kg/M^2) this measures body fat based on height and weight.

BMI is calculated by the use of mathematical formula. It can also be estimated using tables in which one can match height in inches to weight in pounds to estimate BMI (Web 2).

$$BMI = \frac{Weight}{Height^2}$$

The values obtained through the formula are categorized into weight categories based on the international classification and recommendation made by World Health Organization (WHO): less than 18.5 under weight, between 18.5-24.9 normal,25-29.9 over weight and above 30 obese (WHO, 2018; Web 2).

The body mass index was invented by Belgian polymath Adolph Quetelet in the 1800s, and consequently, is known as the Quetelet index until it was termed the body mass index in 1972 by Ancel Keys (Web 1).

The new term "Body mass index" was published for the first time in July edition of 1972 in the Journal of Chronic Diseases by Ancel Key, which found BMI to be the best proxy for body fat percentage among ratios of weight and height (Keys et al.,1972). BMI was explicitly cited by Keys as being appropriate for population studies and inappropriate for individual diagnosis. Nevertheless, due to its simplicity, it came to be widely used for individual diagnosis of obesity (Kalimechkov, 2016).

The body mass index is a simple, inexpensive screening tool used to identify possible weight problems for both adults and children. It is one of the useful tools to assess who needs further testing to identify health risks such as heart disease. Individuals at risk will need further assessment (Web 3, 4).

*References obtained from unpublished articles from web pages are cited as Web 1,2,3,…

In the earlier times, BMI was not the single measurement that was used by health practitioners. There were other measurements that were in use prior to it. The most Practitioners widely used anthropometric measurements to predict fatness were skin folds, circumferences, weight and height. Circumference and skin folds have been developed by Gurney and Selliffe (Mouna, 2008).

BMI has certain limitations in some cases. It does not differentiate between muscles, bones or fat (Stefan, 2016; Web 2). For example many athletes have a high BMI but they are not fatty. Their BMI is high because they have lots of body muscle. Other people have lots of fat and not much muscle. They are too fat but their BMI is normal.

The values for BMI are age independent for adult populations and are the same for both genders. BMI may not, however, correspond to the same degree of fitness indifferent populations due; party to different body proportions (Web 2).

The human adolescent growth spurt is the rapid and intense increase in the rate of growth in height and weight than occurs during the adolescent stage of the human life cycle. The human adolescent growth spurt is noted in virtually all of the long bones of the body and most other skeletal elements. The major exception is the female pelvic, which follows a smooth and continuous increase in size until adulthood. In humans, the hormones responsible for sexual maturation also cause the adolescent growth spurt in stature and other skeletal dimensions and promote the adolescent life history stage. The growth spurt, which is a notable feature of the human adolescent growth stage, but not the only defining characteristic, begins on average at 10.0 years for girls and 12.0 for boys, however there is considerable variation between individuals and populations. The adolescent spurt and growth of skeleton ends at about 18 -19 years for girls and 20-22 years for boys and with this the adulthood or reproductive stage of life history begins (Web 5).

Due to lack of enough studies in our country, little is known about the BMI of the youth. Thus, the current study is aimed at filling some of the data gap in this area by documenting body weight, height and BMI of school teenagers of age 13 to 18 at two schools in Debre Berhan Town, central Ethiopia.

1.2. Research Questions

The study was conducted with the aim of providing answers to the following research questions:

1. What is the percentage increment of height, weight and BMI in successive age groups in both sexes?
2. What is the mean height, weight and BMI for the age groups 13 to 18 years in both males and females?
3. How do males and females of the same age group differ for height, weight and BMI?
4. What are the weight categories of males and females in different age categories based on BMI values?

1.3. Objectives

1.3.1. General Objective

To document data on body height weight and BMI of school children of age 13-18 years at Atse ZereaYaekob Primary Full Cycle and Basso General and Preparatory Government Schools in Debre BerhanTown.

1.3.2. Specific Objectives

The specific objectives are to:

- determine the rate of chronological increase in body height, weight and BMI
- determine the sex specific chronological variation in height, weight and BMI
- analyze the difference in mean body weight, height and BMI between males and females within the same age group.
- determine the categories for each age group based on BMI values
- compare the age specific mean body weight and height of students from the present study with that of private and governmental schools in Addis Ababa.

2. Literature Review

2.1. Historical Background of BMI

Body Mass Index (BMI) is a useful mathematical formula that was derived by Adolph Quetelet in the 1800s. This finding was in use for many years and named the Quetelet Index. Building on the first finding by Quetelet, a new way of looking at the concept appeared in 1972 by Ancel Key (Stefan, 2016). The later work brought renaming of Quetelet index to become Body Mass Index.

According to Keys, (1972) the first research on ‘’body mass index” was published in July edition of 1972 in the Journal of Chronic Diseases by Ancel Keys, which was calculated as the ratio of the weight to height squared to determine body fat percentage (Web 6).

Body Mass Index measurement has been in use for centuries as a useful tool for the medical world. It helps in determining whether a patient is overweight or underweight that enables the physician for further diagnosis and treatment. Despite its undeniable usefulness, BMI was not an inherent measurement tool. It has its own limitations of not differentiating between muscle and fat.

The interest in measuring body fat due to obesity is becoming discernible issue in prosperous Western Societies. This makes the importance of BMI in measuring obesity very much known in the public and soon became an international standard of body fat measurement. It helped healthy eating initiatives of many countries, including UK (Stefan, 2016).

BMI was explicitly cited by Keys as being appropriate for population studies and inappropriate for individual diagnosis. Nevertheless, due to its simplicity it came to be widely used for individual diagnosis (Web 6).

Table 1 below shows cut off points of BMI to determine the weight categories using BMI values for adults (> 22 years) (WHO, 2004 & 2018).

Table 1. WHO Cut-off standard value of body mass index

Classification	BMI ($^{kg}/_{m^2}$)
Under weight	< 18.5
Sever under weight	< 16.00
Moderate under weight	16.00-16.99
Mild under weight	17.00-18.49
Normal range	18.5-24.99
Over weight	25.00-29.99
Obese 1	30.00-34.99
Obese 2	35.00-39.99
Obese 3	>40.00

A different categorization scheme of body weight based on BMI is used for individuals younger than 23 years. This scheme is based on percentile charts separately developed for boys and girls (Appendix 1&2). According to this chart:

BMI>95^{th} percentile Obese,

85^{th}percentile $\leq$ BMI $\leq$ 95^{th}Percentile Overweight

5^{th} percentile $\leq$ BMI $<$ 85^{th} Percentile Normal, and

$BMI < 5^{th}$ Percentile Underweight (Web 7).

Overweight and obesity are defined as abnormal or excessive fat accumulations that present a risk to health. They are major risk factors for a number of chronic diseases including diabetes and cardiovascular diseases (WHO, 2018).

BMI is useful to assess who needs further testing to identify health risks such as heart disease (Web 4). For instance, despite the crudeness of BMI as a measure, it has clear empirical links to various health outcomes especially in the case of high BMIs and their ability to demonstrate the significant health costs of severe obesity at the population level (Stefan, 2016).

Experts have expressed uncertainties about relying too heavily on BMI, stressing that it is not accurate measure of body fat. BMI fails to take age and sex of adults into account. Naturally females tend to have more body fat than men of equal BMI, while older people tend to have more body fat than younger people with the same BMI. Furthermore, BMI measurements have no way of measuring where body fat is located in the body. Studies have indicated the belly fat surrounding abdominal organs is more dangerous than peripheral fat beneath the skin in other body areas (Web 8). Also BMI is not an appropriate indicator for assessing weight in athletes with great experience in sports which require physical strength (Web 9).

2.2. The Physiological Mechanisms of Growth

Growth and development are continuous processes that begin at conception and continue through the remainder of our lives. There are broad spectrums of physical and psychological changes that are part of the maturation and life of the individual. The rate of development and growth varies depending on many factors such as age and genetic disposition .Babies grow at roughly the same pace and benchmarks for their physical and social development are roughly standard. However, as any parent can tell, no two children develop exactly within the same time frame (Web 10).

Human growth from birth to final height is a fairly regular process; it is not a linear process, an individual does not gain the same amount of height during each calendar year. In regards to tempo of growth, it is rather something that occurs in phases. According to Stefan (2016) four phases of growth were described. The infant phase from birth to three years, the childhood phase from about three years to seven years with fairly stable growth, the juvenile phase from about age seven to about eleven years and the adolescent phase from about eleven years to eighteen with rapid growth (Stefan, 2016).

Growth spurts are when a lot of growing takes place in a short period of time. A rapid rise in height and weight are most visible in the first year of life and around puberty, both periods when a tremendous amount of growth takes place in a short time. But growth spurts can also occur in other times too, though they are less obvious. Most babies go through several growth spurts during the first 12 months. Growth spurts usually last 2-3 days, but sometimes last a week or so (Web 11).

Growth spurts do not stop after the first year. Most mothers notice growth spurts every few months during the toddler years and periodically thereafter on through the teenage years. A larger gain of BMI in childhood i.e. from 2 to 8 years of age will not positively impact on final height although there is a limited increase in height gain in childhood (Web 11).

An increase of 1 BMI unit between 2 and 3 years of age was associated with a gain in heights of 0.23cm in boys and 0.29cm in girls during the same period. For full range of BMI change in childhood, the effect on height gain was 1.25cm in boys and 1.7cm in girls (Qing and Johan, 2001).

The adolescence period is the transition from childhood to adulthood. It is considered to start with the onset of puberty with its appearance of secondary sexual characteristics and the start of the adolescent growth spurt at the end of this period, most individuals have reached their final height (Bente, 2018).

There are factors that affect the normal growth of human beings. According to (Loredana, 2013) growth is influenced by several factors including genes, hormones and nutrition. In particular, hormones are key growth regulators, with a main role by the growth hormone. Nutritional status plays an important role in regulating growth and excess body weight early in life can influence growth patterns. Poor nutrition is a well-known determinant of poor somatic growth and delayed pubertal onset and progression, indirectly lowered the value of BMI.

Growth in a number of dimensions shows a significant familial resemblance. Adult stature, tempo of growth, timing and rate of sexual development, skeletal maturation, and dental development are all significantly influenced by genetic factors, with estimates of genetic transmissibility ranging from 0.41 to 0.71 (Tanner and Fetus, 1989). Twin studies have shown that the average difference in height between monozygotic twins is only 2.8 cm, compared with 12 cm for dizygotic twins of the same sex (Smith, 1977). The overall contribution of heredity to adult size and shape varies with environmental circumstances, and the two continuously interact throughout the period of growth. Children with similar genotypes, who would reach the same adult height under optimal conditions, may be differently affected by adverse circumstances. Thus, the interaction between genetic makeup and the environment is complex (Tanner, 1989). The genetic control of the tempo of growth appears to be independent of that for body size and

shape, and environmentally induced changes in tempo do not seem to significantly alter adult height or shape (Tanner and Fetus, 1994).

The trend in height and adolescent development supported the significant influence of environmental factors on an individual's genetic potential for linear growth. Since the turn of the century, children in average economic conditions have increased in height approximately 1 to 2 cm per decade (Tanner and Fetus, 1994). The gain in adult stature, however, has been less, indicating that, in part, the trend toward greater size during childhood is the result of earlier maturation and adult height achievement.

2.3. Growth Hormones and Growth Spurts of Teenagers

Growth hormone (GH) is a small protein that is made by the pituitary gland and secreted in to the blood stream.GH production is controlled by a complex set of hormones produced in the hypothalamus, in the intestinal tract and pancreas. The pituitary puts out GH in bursts; levels rise following exercise, trauma, and sleep under normal conditions. More GH is produced at night than during the day. This physiology is complex, but at a minimum, it tells us that sporadic blood tests to measure GH levels are meaningless since high and low levels alternate throughout the day. But scientists who carefully measure overall GH production report that it rises during childhood, peaks during puberty and declines from middle age onward (Harvard Medical School, 2018).

GH is available as a prescription drug that is administered by injection. It is indicated for children with GH deficiency and others with very short stature. It is also approved to treat adult GH deficiency -an uncommon condition that almost always develops in conjunction with major problems affecting the hypothalamus-pituitary gland or both. The diagnosis of adult GH deficiency depends on special tests that stimulate GH production; simple blood tests are in many cases misleading (Harvard Medical School, 2018).

2.4. Factors Affecting Growth

According to WHO (2010) child growth is internationally recognized as an important indicator of nutritional status and health in populations. Growth during childhood and adolescence occurs at different rates and is influenced by the interaction between generic and environmental factors.

Genes, hormones and nutrition are among the major growth influencing factors. Nutritional status plays an important role in regulating growth and excess weight.

In particular, hormones are key growth regulators; with a main role for the (GH) and insulin like growth factors (IGF). Several lines of evidence also support the important role of nutritional status in regulating child growth. Poor nutrition is a well-known determinant of poor somatic growth, delayed pubertal onset and progression. Excess body weight is associated with early pubertal development, rapid weight gain during infancy and early life (Lordana, 2013).

The nutritional environment may have a long term effect on human development and health. Nutritional related endocrine abnormalities during pregnancy could affect the hormonal milieu of the developing fetus and in theory, affect its tempo of maturation later in life (Web 8).

Nutrition, including energy and specific nutrient intake, is a major determinant of growth. Under-nutrition is the single most important cause of growth retardation worldwide. However, in the United States the causes are typically self-induced food restriction or systematic disease, rather than poverty related (Alan et al. ,2002)

It is obvious that the ultimate size and shape an individual attains are the result of continuous interaction between generic and environmental influence during the whole period of growth. The individual's biological potential for growth is passed through the DNA from parents to the child where the genotype determines the potentialities of an organism. Several conditions of chromosome deficiency or gene mutations are described which influence growth and cause short stature (Bente, 2018).

Puberty is a dynamic period of development marked by rapid changes in body size, shape and composition, all of which are sexually dimorphic. One of the hallmarks of puberty is the adolescent growth spurt. Body composition changes, including the regional distribution of body fat, are especially large during the pubertal transition and markedly sexually demographic (Alan et al. ,2002)

The potential growth from adolescents is the result of continuous interaction between generic and environmental factors. In western countries, about 80% of the variation of body height is generic and about 20% is due to environmental factors (Bente, 2018).

The relationship between socioeconomic factors such as social class and its influence on the child growth pattern and final height is positive. Children from families belonging to high or middle socioeconomic groups in nearly all countries are taller than children from lower socioeconomic groups. Among such factors that influence human growth are income, number of family members who are educated and their living place such as urban or rural (Bente,2018).

2.5. Growth Variation in Boys and Girls

Height growth in boys compared to girls' early growth spurt, growth accelerates more slowly in boys and lasts longer, resulting in a taller adult stature among males than females (an average about 10cm or 4 inches) (Web 9).

It is likely that a majority of the girls at 12 years of age have reached the onset of puberty and that they are in the middle of their growth spurt. The onset of puberty corresponds to a biological (i.e, skeletal) age of an approximately 11 years in girls and 13 years in boys. The timing of pubertal growth spurt occurs earlier in girls and tends not to reach the same magnitude as that of boys. Girls average peak growth velocity of 9cm per year at age 12 and a total gain in height of 25cm during the pubertal growth period. Boys attain an average peak growth velocity of 10.3cm per year which occurs about 2 years later than in girls and gain 28cm in height of 25cm during the pubertal period (Vander, 2014).

The adolescence period is the transition from childhood to adulthood. It is considered to start with the onset of puberty with its appearance of secondary sexual characteristics and the start of the adolescent growth spurt. At the end of this period, most individuals have the puberty growth spurt varies considerably among populations and between individuals with populations. Generally the maximum velocity for height is about the growth velocity decreases rapidly and ends at full maturity at about 16-17 years among most girls and 18-19 years for most boys in the Western population (Stefan, 2016).

2.6. Consequences of Overweight and Obesity on Health

Both overweight and obesity increase the risks for many diseases and health conditions such as hypertension, cardiovascular diseases, mainly heart disease and stroke, gallbladder disease, musculoskeletal disorders especially osteoarthritis ,cancers of the endometrium, breast and

colon , Type 2 diabetes ,breathing problems, arthritis and respiratory problem (WHO, 2010, 2018)

People who are considered obese and have a $BMI \geq 30$ and overweigh with BMI 25-29.9 have two or more risk factors and they are advised to lose weight. Losing between 5%-10% of current weight will assist in lowering the risk factors of developing diseases associated with obesity (Web 11).

3. Materials and Methods

3.1. **Sampling of participants**

A total of 400 students (equal proportion of males and females) were included in the study. Two hundred thirty two of the participants were selected from Atse Zeara Yaekob Primary School grade 7 and 8 students and the remaining were selected from Basso Secondary School grade 9 and 10 students both from Debre Birhan Town. The town is located about 130km north of the capital Addis Ababa in the North Shoa Zone of the Amhara National Regional State (Table 2). The selection of participating students was conducted at random until the total number of required participants (n=400) was reached. Full consent was obtained from each student before measurements were conducted.

Table 2. The distribution of age and sex sample population in the two schools

Age	Atse Zerea Yaekob Primary Full Cycle School		Basso General and Preparatory School		Total
	Female	Male	Female	Male	
13	27	38	-	-	65
14	42	43	-	-	85
15	19	31	12	19	81
16	12	12	29	23	76
17	5	3	29	20	57
18	-	-	25	11	36
Total	105	127	95	73	400

3.2. Measurement of body height and weight

Body height and weight were measured using height measuring board mounted to weight measuring instrument in standing position (Prestige model) with weight and height capacity of 140kg and 2.05m, respectively (Fig.1). The measurements were conducted in May 2018. Students were barefooted while they were measured.

Figure 1. Two-in-one height and weight measurement scale used in the present study

3.3. Data analysis

BMI was calculated for each student using the formula:

$$\text{BMI} = \text{weight (kg)} / \text{height (m}^2\text{)}$$

BMI values were converted to weight categories using the percentile chart developed by the CDC as indicated below:

BMI < 5^{th} percentile = Underweight

5^{th} percentile≤ BMI < 85^{th} percentile = Normal

85^{th} percentile ≤ BMI < 95^{th} percentile = Over weight

BMI > 95^{th} percentile = Obese

3.4. Statistical analysis

Variations in percentage increment of height, weight and BMI between consecutive age groups were analysed using the nonparametric Chi-square test while differences in body height and weight between males and females were compared using the independent samples t-test. The statistical analysis was conducted on SPSS software ver. 17. The 95% confidence level was used to detrmine statistical significance.

4. Results

4.1. Height

The tallest and shortest females were 1.71m (14 year old) and 1.33m (13 year old), respectively, while for males the respective measures were 1.79m (16 year old) and 1.37m (13 year old). Males had higher mean height than females for all age groups (Table 3).

Table 3. The mean height $\pm SD$ and range in meters for males, females and both sexes

Age	Range in meters			Mean height in meters		
	Female	Male	Combined	Female	Male	Combined
13	1.33-1.60	1.37-1.69	1.33-1.69	1.49 ± 0.05	1.5±0.08	1.49± 0.06
14	1.39-1.71	1.41-1.71	1.39-1.71	1.51± 0.07	1.53± 0.06	1.51±0.07
15	1.40-1.66	1.48-1.73	1.40-1.73	1.52±0.05	1.59±0.09	1.54± 0.07
16	1.46-1.64	1.48-1.79	1.46-1.79	1.54±0.05	1.61±0.11	1.57±0.08
17	1.43-1.62	1.53-1.77	1.43-1.77	1.55± 0.04	1.65±0.04	1.61±0.04
18	1.53-1.68	1.53-1.73	1.53-1.73	1.59± 0.04	1.66± 0.05	1.64 ± 0.05

In females, the highest percentage increment of height between consecutive age groups was 2.5% (17 to 18 years) while the lowest was 0.65% for the transition between 15 to 16 years and 16 to 17 years. The variation in percentage increment between consecutive age groups was not statistically significant ($p = 0.683$). For males, the highest increment was 3.92% (14 to 15 years) and the lowest was 1.26% (15 to 16 years). However, this variation was not significant ($p = 0.736$) (Table 4).

Table 4. The percentage increase of height between consecutive age groups

Age Transition	Female	Male	Combined
From 13 years to 14 years	1.34%	2%	2%
From 14 years to 15 years	1.32%	3.92%	1.99%
From 15 years to 16 years	0.66%	1.26%	1.95%
From 16 years to 17 years	0.65%	2.48%	2.55%
From 17 years to 18 years	2.5%	2.5%	1.86%

The highest percentage difference of height between males and females of the same age was observed among 17 year olds (6.45%) while the lowest was 0.67% observed among 13 year olds. The difference showed an increase until age 17 and showed a decrease at the age of 18. The difference in mean height of males and females was not statistically significant ($p = 0.087$) (Table 5).

Table 5. The percentage difference in height between males and females of the same age

Age in year	Mean height in meters		Percentage Difference in %
	Female	Male	
13	1.49	1.5	0.67%
14	1.51	1.53	1.32%
15	1.52	1.59	4.61%
16	1.54	1.61	4.55%
17	1.55	1.65	6.45%
18	1.59	1.66	4.40%

4.2. Weight

Weight for females ranged between 31kg (13 year old) and 67kg (18 year old) and for males between 31kg (13 year old) and 72kg (18 year old). Females had slightly higher weight than males among 14 and 15 year olds while 18 year old males had higher mean weight than their female counterparts. Interestingly, 17 year old females had higher mean body weight than their 18 year old counterparts (Table 6).

Table 6. The mean ± SD and range of body weight of males, females and both sexes combined

Age in year	Range of weight in Kg			Mean weight in Kg		
	Female	Male	Combined	Female	Male	Combined
13	31-57	32-35	31-57	40.71±5.9	40.14±5.6	40.47±5.78
14	32-60	33-50	32-60	45.95±6.49	43.09±4.99	44.54±5.75
15	35-59	35-64	35-64	48.32±5.48	46.77±6.36	47.73±5.82
16	39-65	36-65	36-65	49.29±5.49	50.02±5.94	49.68±5.73
17	45-61	39-66	39-66	54.43±5.18	54.2±5.96	54.29± 5.59
18	45-67	45-72	45-72	53.55±6.93	55.32±5.44	54.78±5.89

The highest percentage increment of weight in females was observed between 13 and 14 year olds (12.87%) while the lowest was between 15 and 16 year olds (0.2%). A negative increment was observed between 17 and 18 year olds (0.02%). For males, the highest increment was 8.54% recorded between 14 and 15 year olds which were also similar to that of 16 and 17 year olds (8.36%). The lowest increment (2.07%) was observed between 17 and 18 year olds. The variations in percentage increment were not statistically significant for both males ($p = 0.352$) and females ($p = 0.174$) (Table 7).

Table 7. The percentage increase of weight between consecutive age groups in both sexes

Age Transition	Percentage increase of weight		
	Female	Male	Combined
From 13 years to 14 years	12.87%	7.35%	10.06%
From 14 years to 15 years	5.16%	8.54%	7.16%
From 15 years to 16 years	0.2%	6.95%	4.09%
From 16 years to 17 years	10.43%	8.36%	9.28%
From 17 years to 18 years	-0.02%	2.07%	0.9%

The highest percentage difference of body weight between males and females was 6.64% recorded among 14 year olds while the lowest was 0.42% recorded among 17 year olds and this difference was not significant (p = 0.891) (Table 8).

Table 8. The percentage difference of weight between males and females within the same age group

Age in year	Mean weight		Percentage Difference between same age
	Female	Male	
13	40.71	40.14	1.42%
14	45.95	43.09	6.64%
15	48.32	46.77	3.31%
16	49.29	50.02	1.48%
17	54.43	54.2	0.42%
18	53.55	55.32	3.31%

4.3. Body Mass Index

Females had higher BMI values than males for each age group. The highest and lowest mean BMI for females were 22.59 kg/m^2 (17 year olds) and 18.15 kg/m^2 (13 year olds) respectively while for males, the respective values were 20.02 kg/m^2 (18 year olds) and 17.97 kg/m^2 (13 year olds) (Table 9).

Table 9. Mean ±SD BMI for males, females and both sexes combined

Age in year	Mean of BMI in $\frac{kg}{m^2}$		
	Female	Male	Combined
13	18.15± 1.81	17.97±1.51	18.07± 1.69
14	20.12±2.37	18.28±1.64	19.21±2,01
15	19.79±2.31	18.08±1.85	19.14±2.13
16	20.7±1.99	18.55±1.71	19.54±1.84
17	22.59±2.26	19.70±1.61	20.87±1.87
18	21.11±2.36	20.02±1.98	20.35±2.10

The highest percentage increment of BMI in females for consecutive age groups was recorded between 13 and 14 years (10.83%) while the lowest was 0.1% recorded between 15 and 16 years. In males, the respective values were 6.2% (16 to 17 years) and -1.1% (14 to 15 years). There was negative increment of BMI for 17 to 18 year old females 14 to 15 year males and 14 to 15 year and 17 and 18 year old for the combined data. There was no significant difference in the percentage increment for males ($p = 0.259$) and females ($p = 0.198$) (Table 10).

Table 10. The percentage increase of BMI in both sexes and the combined

	Percentage increase of BMI		
Age group	Female	Male	Combined
From 13 years to 14 years	10.83%	1.73%	6.31%
From 14 years to 15 years	2.88%	-1.1%	-0.36%
From 15 years to 16 years	0.1%	2.6%	2.09%
From 16 years to 17 years	9.03%	6.2%	6.81%
From 17 years to 18 years	-6.55%	1.62%	-2.49%

All of the calculated BMI values for both males and females of all age categories fall under the normal body weight category. The difference in BMI values of males and females was not statistically significant ($p = 0.095$) (Table 11).

Table 11. Body weight categories based on BMI values

Age Group	BMI			
	Male	Category	Female	Category
13	17.97	Normal	18.15	Normal
14	18.28	Normal	20.12	Normal
15	18.08	Normal	19.79	Normal
16	18.55	Normal	20.70	Normal
17	19.70	Normal	22.59	Normal
18	20.02	Normal	21.11	Normal

4.4. Comparison with similar studies

The data generated from the present study was compared with two similar studies that have similar objectives and scope. One of these was conducted in a private school and the other in two government schools both in Addis Ababa.

The height of females for each age group in the three studies did not show significant difference ($p = 0.717$). Although, males from the Private School (Deliverance Private School) (Zeritu Abate, 2018) had slightly higher mean height than the other two schools, the difference between the three schools was not statistically significant ($p = 0.954$) (Table 12).

Table 12. Mean ± SD of height (m) of male and female students from the present study and two other similar studies in Addis Ababa

Age	Present study (n = 400)		Addis Ababa governmental school (Etagegne Aschalew, 2018) (n = 400)		Addis Ababa Private school (Zeritu Abate, 2018) (n = 477)	
	Female	Male	Female	Male	Female	Male
13	1.49 ± 0.05	1.5±0.08	1.48±0.04	1.46±0.06	1.49±0.07	1.5±0.09
14	1.51± 0.07	1.53± 0.06	1.52±0.05	1.53±0.06	1.52±0.06	1.56±0.09
15	1.52±0.05	1.59±0.09	1.53±0.06	1.6±0.07	1.54±0.07	1.61±0.09
16	1.54±0.05	1.61±0.11	1.54±0.06	1.64±0.06	1.56±0.06	1.65±0.09
17	1.55± 0.04	1.65±0.04	1.57±0.06	1.66±0.05	1.58±0.06	1.69±0.08
18	1.59± 0.04	1.66± 0.05	1.64 ± 0.07	1.666±0.05		

Females from the private school had higher mean body weight for each age category. The highest mean weight recorded for females in the present study (54.43kg in 17 year olds) was lower than that of 14 year olds from the private school (58.11kg). The difference in weight between the three schools was statistically significant ($p = 0.001$). Similarly, males from the private school had significantly higher body weight compared to the other two schools ($p = 0.003$). For instance, the highest body weight in the present study which was 55.32kg (18 year olds) was lower than that of 14 year olds from the private school (58.73kg) (Table 13).

Table 13. Mean ± SD of weight (kg) of male and female students from the present study and two other similar studies in Addis Ababa

Age	Present study (n = 400)		Addis Ababa governmental school (Etagegne Aschalew, 2018) (n = 400)		Addis Ababa private school (Zeritu Abate, 2018) (n = 477)	
	Female	Male	Female	Male	Female	Male
13	40.71±5.9	40.14±5.6	41.2±2.87	37.8±4.91	51.98±8.99	49.81±10.05
14	45.95±6.49	43.09±4.99	44±7.53	42.8±7.44	58.11±10.15	58.73±10.33
15	48.32±5.48	46.77±6.36	47±5.28	48±5.76	62.07±9.62	67.28±11.76
16	49.29±5.49	50.02±5.94	47.2±5.61	49.7±5.79	66.8±10.7	73.65±7.36
17	54.43±5.18	54.2±5.96	50.1±7.19	52±6.06	72.07±9.03	77.98±3.89
18	53.55±6.93	55.32±5.44	48.8±6.27	56.6±5.63		

Similar to body weight, both females and males from the private school had significantly higher BMI than the other two schools ($p = 0.00$). In females, the highest BMI value (22.59 kg/m^2) in the present study which was recorded for 17 year olds was lower than the smallest BMI recorded for females from the private school (23.00 kg/m^2 for 13 year olds). This was the same for males too. The highest BMI in the present study which was recorded for 18 year olds (20.02 kg/m^2) was lower than the lowest value recorded for the private school (22.00 kg/m^2 for 13 year olds) (Table 14).

Table 14. Mean ± SD of BMI (kg/m^2) of male and female students from the present study and two other similar studies in Addis Ababa

Age	Present study (n=400)		Addis Ababa governmental school (Etagegne Aschalew, 2018) (n=400)		Addis Ababa Private school (Zeritu Abate, 2018) (n=477)	
	Female	Male	Female		Female	Male
13	18.15± 1.81	17.97±1.51	18.64±1.22	17.61±2.38	23±2.85	22±3.49
14	20.12±2.37	18.28±1.64	19.07±3.28	18.22±2.74	25. ±3.74	24±3.6
15	19.79±2.31	18.08±1.85	20.11±2.24	18.6±1.59	26.21±3.92	25.79±3.64
16	20.7±1.99	18.55±1.71	19.93±2.36	18.32±1.79	27.25±4.3	27.14±2.84
17	22.59±2.26	19.70±1.61	20.38±2.99	18.82±1.76	28.49±3.18	27.3±1.86
18	21.11±2.36	20.02±1.98	20.28±2.54	20.45±1.73		

5. Discussion

Female students had shorter height compared to the males in each group. Similar result was reported in Addis Ababa private school studied by Zeritu Abate (2018). There are certain reasons for the difference in height. Height growth in boys, compared to girls, shows early growth spurt, growth accelerates more slowly in boys and lasts longer, resulting in a taller adult stature among males than females (Web 9).

Women stop growing in height due to closing of epiphyseal plates. Although growth of human beings is dependent on many factors like gene, weather conditions, nutrition and health conditions, biologically, men grow taller than women (Web 12). The highest percentage difference in mean height between males and females was obtained for 17 years (6.45%). The adolescence is considered to start with the onset of puberty with its appearance of secondary sexual characteristics and the start of the adolescent growth spurt. At the end of this period, most individuals have reached their final height (Stefan, 2016). The lowest percentage difference was 0.67% in age group of 13 years.

The highest percentage increment of height was observed during the transition from 17 to 18 years, 2.5% in females and 14 to 15 years 3.92% in males. This contrast to other study done by Zeritu Abate (2018) in Addis Ababa private school, where highest percentage increment was observed from 13 to 14 years in females (2%) and the highest percentage increment of males height was between 13 and14 years (4%).

Estrogens affect the female body shape in a number of ways, including increasing fat stores. Estrogens cause higher levels of fat to be stored in a female body than in a male body. They also affect body fat distribution causing fat to be stored in the buttocks, thighs and hips in female (Web 13). For this study females were heavier than males in the age groups of 14 and 15 while the males had higher body weight in the age groups of 16 and 18 and this shows that the result is similar to the fact. During the adolescent growth spurt, the rate of fat increase in girls almost doubles than that of boys. Fat cells are mostly seen in the gluteal femoral areas such as pelvis, buttocks, and thigh and to a lesser extent in the breasts because of changes in female hormone levels. After adolescence, the accumulation of sex – specific fat more or less stops , or decreases dramatically and there is usually no further increase in the number of fat cells (Patrick, 2002).

In this study females were heavier than males in the age groups of 15. The onset of puberty in girls usually starts at around the age of 10 years. Girls on the average start their growth spurt between the ages of 10 and 14, about a year before boys (Web 14). Excess body weight is associated with early pubertal development, rapid weight gain during infancy and early life (Lordana and Francesco, 2013).

Among females, the highest percentage increment of body weight for consecutive age groups was recorded for 13-14 years (12.87%). This result was similar with studies in Addis Abeba private school (Zeritu Abate 2018). And the lowest percentage increment of body weight recorded for 17-18 years old (-0.02%). Since adolescence, the accumulation of sex specific fat more or less stops or decreases dramatically and there is usually no further increase in the number of fat cells (Patrick, 2002).

The average weight of a teenager can fluctuate a bit from one year to the next, finally stabilizing around 18-20 years of age (Web 14). The result of percentage difference of weight between males and females in this study contrasts with the study at Addis Ababa private school where the highest percentage difference of weight obtained at the age group of 16 (10.25%) and the lowest percentage difference at 14 age group (1.07%).

In the present study, all age groups of males and females are categorized under normal weight. No results were found for the underweight, overweight or obesity at all categories. In the study conducted at Addis Ababa private school, except males of age group 13 , all participants were categorized as overweight (Zeritu Abate, 2018). In a research done in Southern Taiwan, the result of the BMI of the participants was classified into underweight 20.0%, normal 49.1%, overweight 13.8%, and obese 17.1% (Klein, 2008). But in the case of present study, 100% were normal weight. The research done in Southern Taiwan suggested that underweight, overweight and obesity are crucial problems in that country. Another study done in Iowa, USA, showed that 3%, 59%, 17%, and 21% as underweight, normal, at risk, and overweight respectively (Klein, 2008). But in the case of the present study all of the participants for both sexes in each age groups are normal. This showed that the result was not similar. A study done in Ambo including participants from 10 years to 19 years, showed that the prevalence of underweight was 27.2% with more males, 4.4% overweight, 68.5% normal category. The proportion of normal weight females was higher than that of males (Meseret et al., 2010)

6. Conclusion

Based on the results of the study, the following conclusions are drawn:

- There was no significant difference in height, weight, and BMI between males and females
- Females had highest increase in height between age 17 and 18 and males between 14 and 15 years
- The highest body weight increase occurred between age 13 and 14 for females and 14-15 for males
- All age groups of both sexes fall under the normal weight category based on their mean BMI
- Compared to similar studies at a private school, the students in the present study had significantly lower body weight

7. Recommendation

Based on the general study and the above conclusions, the following recommendations have been formulated.

- Parents, school administrators, health centers and all stakeholders should contribute to maintain the normal body weight of students.
- The inclusion of body mass index in the curriculum of physical health education will have a great benefit for both parents and students.
- To enhance the understanding of body mass index precisely, the stakeholders should give short training, workshop and seminars at school level is strongly recommended.
- For further research, there is a need to increase number of schools and properly documented and the student's body mass index should be included in the student's report card.

8. References

8.1. References from published articles

Alan,D.,James,N.,Pamela,A. (2002). Growth at Puberity. ***Journal of Adolecent Health***,31: 192-200.

Bente, N. (2018). ***Growth of School Children***. Orebero University,Sweden.

Etageghehu Aschalew (2018). BMI and growth spurt in teenage school children in Addis Ababa governmental school. MSc Thesis, Addis Ababa University.

Harvard Medical School (2018).***Growth Hormone***. Harvard Health Publishing, Massachusetts.

Li-Na, C and Min-Li,C. (2017).Influencing Factors of the Body Mass Index of Elementary students in Southern Taiwan,China. ***Int.J.Environ.Res. Public Health*** , 14:220.

Klein, S. (2008). ***Body Mass Index Baseline Study***. Polk County, Iowa, USA.

Lordana, M. and Francisco, C. (2013). ***Obesity and Growth during Childhood and Puberty***. University of Chieti, Chieti, Italy.

Maria,V., Anna,M., Fredrik,N., Solving, H., Lotta, H., Anna, R., Anneli,I. and Annelie, C.(2014). Body mass index is not a reliable tool in predicting celiac disease in children. ***BMC Pediatrics***, 14:165

Meseret Yetubie,J emal Haidar.(2010).Socio Economic and Demographic Factors Affecting Body Mass Index of Adolescent Students. Ambo in Ethiopia. ***International Journal of Biomedical Sciences***, 4:321.

Mouna, A., Marie, F. and Sandrine, P. (2008). History and measuring of the body mass index. Interest of other Anthropometric Measurement, European Child Obesity Group.

Patrick, J.B, (2002). ***Why does fat deposit on the hips and thighs of women and around the stomach of men***. University of New South Wales,Australla's.

Qing, H and Johan, K. (2001). BMI in childhood and It's Association with Height Gain, Timing of puberty and Final Height. Hong Kong University, China.

Smith, DW. (1977).***Growth and its Disorders***. Philadelphia: WB Saunders Co.

Stefan, K. (2016). ***Body Mass Index***. Elite Gymnastics Academy CIC, London.

Tanner, JM. Fetus, IM.(1989). ***Physical Growth from Conception to Maturity***. Cambridge, MA: Harvard University Press.

Tanner, JM., Charles, IL., Thomas, C. (1994). ***The Diagnosis and Treatment of Endocrine***

Disorders in Childhood and Adolescence, 4th edition. Springfield: 137–92.

Teferi Mekonnen, Worku Anmaw and Yeshanehe Seyum, (2018).Overweight/Obesity among adults in North western Ethiopia. Biomed Central, Bahir Dar Ethiopia. ***The Official Journal of the Belgian Public Health Association***.76:18

Vander, (2014). Body mass is not a reliable tool in predicting celiac disease in children. Linkoping University, Sweden.

World Health Organization (2004). Global Database on Body Mass Index.

World Health Organization (2010).Nutrition landscape Information System (NLIS).

World Health Organization (2018).Obesity

Zelalem Alamrew, Mola Gedefaw, Kidist Nigetu, Meseret Tsegaye and Dagmawi Alemu, (2015).Risk factors of overweight and obesity among high school students in Bahir Dar City, North west Ethiopia, Bahir Dar University College of Medicin and Health Sciences Msc Thesis.

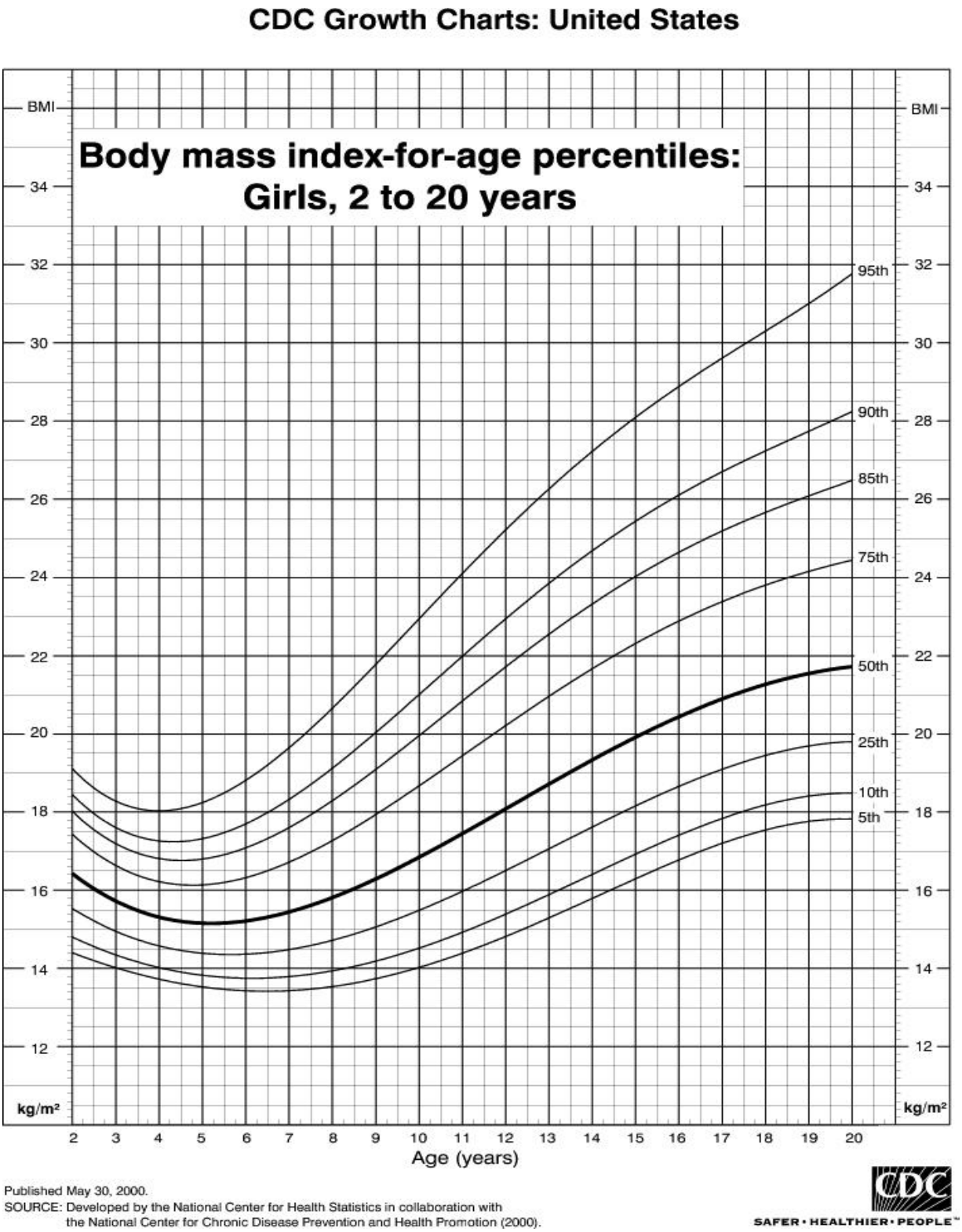
Zeritu Abate , (2018).BMI and growth spurt in school teenager, Addis Ababa Private School. Msc Thesis, Addis Ababa University.

8.2 References from websites

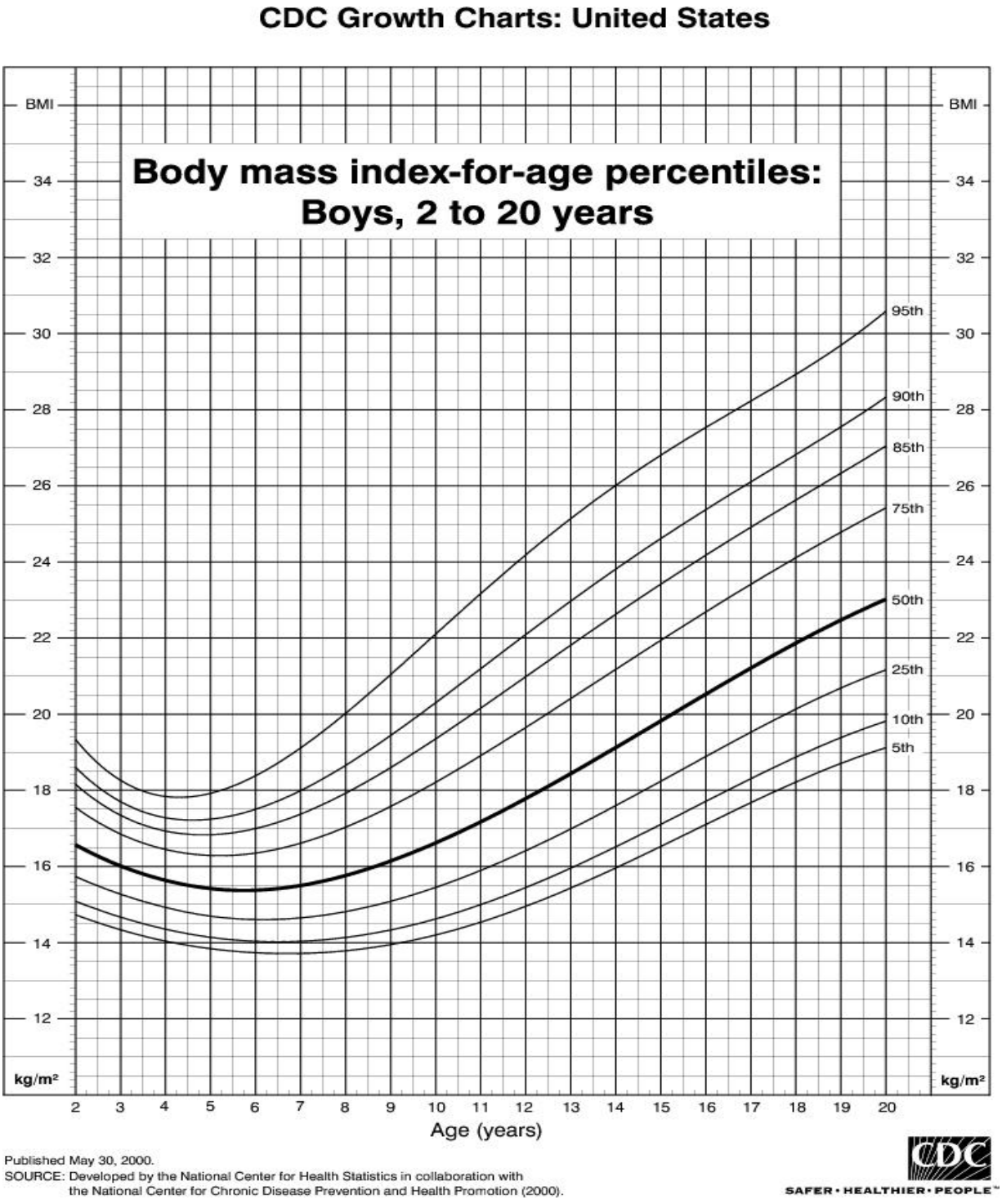
1. en.m.wikipedia.org/wiki/Body mass index
2. https://www.calculate .com
3. http: //www.cdc.gov>bmi for pactiti.
4. https://www.MyVMC.com investigations pp.20.
5. https://carta.antropogeny.0rg/moca/topics/adolescent-growth-spurt
6. www.stk-sport.co.uk 2014
7. http://en.wikpidia.org/wiki/body-mass-index Weblight.com
8. https://en.m.wikibooks.org.
9. https://en.wikibooks.org/wiki/human-phyiology
10. htt://www.annual reviews .org
11. https:// Kelly mom.com/hot – topics/growth – spurts
12. https://www.Quora.com
13. https://en.wikipedia.org/wiki/Female-body-shape
14. https:/trc.taboola.comm.

Appendices

Apendix1. CDC Growth charts - BMI for age percentile for girls



Appendix 2: CDC Growth charts - BMI for age percentile for boys



Apendix 3. Measuring weight and height

Appendix 4. The raw data on height, weight and BMI

Data Sheet for height, weight and BMI												
No	Age	Sex	Height	Weight	BMI		No	Age	Sex	Height	Weight	BMI
1	13	M	1.46	36.4	16.9		1	13	F	1.54	45.2	18.97
2	13	M	1.44	34	16.42		2	13	F	1.49	36	16.21
3	13	M	1.41	39	19.6		3	13	F	1.52	41	17.74
4	13	M	1.54	37.6	16.03		4	13	F	1.57	46	18.69
5	13	M	1.57	42	17.07		5	13	F	1.6	45	17.57
6	13	M	1.51	45	19.73		6	13	F	1.5	45.8	20.44
7	13	M	1.37	35.5	18.72		7	13	F	1.59	57	22.6
8	13	M	1.4	38	19.39		8	13	F	1.46	39.5	18.3
9	13	M	1.48	38	17.35		9	13	F	1.52	49	21.21
10	13	M	1.51	38	16.66		10	13	F	1.53	41	17.52
11	13	M	1.69	53.5	18.94		11	13	F	1.49	46	20.27
12	13	M	1.53	44	18.8		12	13	F	1.53	41	17.52
13	13	M	1.52	46	19.91		13	13	F	1.51	41	16.66
14	13	M	1.46	37.7	17.37		14	13	F	1.44	36	17.39
15	13	M	1.63	47	17.73		15	13	F	1.46	37	17.37
16	13	M	1.39	33	17.09		16	13	F	1.58	41	16.46
17	13	M	1.53	40	17.09		17	13	F	1.41	34	17.17
18	13	M	1.47	40	18.51		18	13	F	1.57	41	16.66
19	13	M	1.45	36	17.14		19	13	F	1.45	40	19.04
20	13	M	1.57	44.3	18.29		20	13	F	1.52	41	17.74
21	13	M	1.54	38	16.03		21	13	F	1.45	31	14.76
22	13	M	1.55	42	17.5		22	13	F	1.48	40.5	18.72
23	13	M	1.47	40	18.51		23	13	F	1.47	35	16.2
24	13	M	1.4	35	17.85		24	13	F	1.4	32	16.33
25	13	M	1.4	32.8	16.32		25	13	F	1.56	50	20.58
26	13	M	1.54	54.2	23.2		26	13	F	1.44	36	17.39
27	13	M	1.47	37	17.12		27	13	F	1.45	41	19.52
28	14	M	1.56	39	16.03		28	13	F	1.51	36.7	15.79
29	14	M	1.52	41	17.75		29	13	F	1.51	41	17.98
30	14	M	1.56	49	20.13		30	13	F	1.46	39	18.31
31	14	M	1.52	45	19.48		31	13	F	1.58	50.3	20.4
32	14	M	1.71	56	19.15		32	13	F	1.53	37	15.81
33	14	M	1.58	45	18.03		33	13	F	1.46	38	17.84
34	14	M	1.58	45	18.03		34	13	F	1.42	36	17.82
35	14	M	1.53	41	17.51		35	13	F	1.33	31	17.51
36	14	M	1.59	46	18.19		36	13	F	1.41	34	17.09
37	14	M	1.51	40	17.54		37	13	F	1.49	50	22.52
38	14	M	1.57	49	19.87		38	13	F	1.51	45	19.74
39	14	M	1.53	38.8	16.23		39	14	F	1.68	49.2	17.73
40	14	M	1.55	40	16.64		40	14	F	1.67	60	21.51
41	14	M	1.6	44.2	17.58		41	14	F	1.48	49.8	22.37

Data Sheet for height, weight and BMI

No	Age	Sex	Height	Weight	BMI		No	Age	Sex	Height	Weight	BMI
42	14	M	1.46	40	18.77		42	14	F	1.54	41	17.3
43	14	M	1.58	45.6	18.49		43	14	F	1.44	50	24.15
44	14	M	1.41	35	17.6		44	14	F	1.52	49	21.21
45	14	M	1.46	40	18.76		45	14	F	1.46	50	23.47
46	14	M	1.6	43	16.79		46	14	F	1.46	40	18.78
47	14	M	1.58	40	16.02		47	14	F	1.46	36.7	16.9
48	14	M	1.53	45	19.22		48	14	F	1.45	37	17.62
49	14	M	1.52	40	17.31		49	14	F	1.55	44	18.33
50	14	M	1.59	48.4	19.38		50	14	F	1.71	50	17.12
51	14	M	1.49	36	16.21		51	14	F	1.45	45	21.43
52	14	M	1.57	45.8	18.25		52	14	F	1.52	46	19.91
53	14	M	1.56	44	18.08		53	14	F	1.46	45	21.13
54	14	M	1.53	44	18.79		54	14	F	1.6	55	21.48
55	14	M	1.62	49.2	19.05		55	14	F	167	50.3	18.28
56	14	M	1.43	39	19.07		56	14	F	1.47	45	20.83
57	14	M	1.47	40	18.51		57	14	F	1.55	47	19.58
58	14	M	1.59	45	17.79		58	14	F	1.47	35	16.2
59	14	M	1.47	45	20.82		59	14	F	1.53	50	21.37
60	14	M	1.57	51	20.69		60	14	F	1.44	36	17.39
61	14	M	1.59	44	17.4		61	14	F	1.43	38	18.54
62	14	M	1.43	33.8	16.13		62	14	F	1.45	35	16.67
63	14	M	1.53	40	17.08		63	14	F	1.57	48	19.51
64	14	M	1.51	34	14.91		64	14	F	1.45	42	20
65	14	M	1.45	36	17.12		65	14	F	1.56	57	23.46
66	14	M	1.59	49.2	19.77		66	14	F	1.39	32.8	16.58
67	14	M	1.47	40	18.51		67	14	F	1.47	44	20.37
68	14	M	1.49	49	22.07		68	14	F	1.49	44	19.82
69	14	M	1.42	49	23.3		69	14	F	1.56	51	20.99
70	15	M	1.58	41	16.42		70	14	F	1.58	49	19.6
71	15	M	1.65	50	18.36		71	14	F	1.46	40	18.78
72	15	M	1.55	40	16.64		72	14	F	1.5	42	18.67
73	15	M	1.48	41	18.71		73	14	F	1.5	54.2	24.44
74	15	M	1.6	45.5	17.96		74	14	F	1.5	51	22.67
75	15	M	1.68	56	19.84		75	14	F	1.47	56	25.97
76	15	M	1.6	40	15.63		76	14	F	1.51	47	20.61
77	15	M	1.53	44	18.79		77	14	F	1.53	45	19.23
78	15	M	1.61	48	18.51		78	14	F	1.58	51	20.4
79	15	M	1.6	40	15.63		79	14	F	1.45	51	24.29
80	15	M	1.7	59.5	20.41		80	14	F	1.47	46	21.3
81	15	M	1.58	51	20.42		81	14	F	1.46	41	19.25
82	15	M	1.73	55	18.37		82	15	F	1.4	47.5	23.98
83	15	M	1.61	51	19.67		83	15	F	1.59	53.5	21.34

Data Sheet for height, weight and BMI

No	Age	Sex	Height	Weight	BMI		No	Age	Sex	Height	Weight	BMI
84	15	M	1.51	42.6	18.42		84	15	F	1.49	35	15.77
85	15	M	1.71	49.4	17.09		85	15	F	1.57	48.8	19.51
86	15	M	1.49	42	18.91		86	15	F	1.6	56	21.88
87	15	M	1.55	35	14.56		87	15	F	1.49	50	22.52
88	15	M	1.65	42	15.42		88	15	F	1.55	57	23.75
89	15	M	1.62	45	17.14		89	15	F	1.5	49.2	22.22
90	15	M	1.55	48	19.97		90	15	F	1.55	56	23.33
91	15	M	1.69	52	18.2		91	15	F	1.52	45	19.48
92	15	M	1.6	42	16.4		92	15	F	1.56	41	16.87
93	15	M	1.64	46	17.1		93	15	F	1.56	51	20.99
94	15	M	1.64	49	18.21		94	15	F	1.58	42	16.8
95	15	M	1.59	45	17.79		95	15	F	1.58	45	18
96	15	M	1.73	54	18.04		96	15	F	1.61	51	19.69
97	15	M	1.6	49	19.14		97	15	F	1.48	45	20.55
98	15	M	1.6	43.7	16.79		98	15	F	1.45	45	21.43
99	15	M	1.5	40	17.77		99	15	F	1.46	42	19.72
100	15	M	1.62	64	24.38		100	15	F	1.5	42	18.67
101	16	M	1.67	49.3	17.92		101	15	F	1.59	49	19.37
102	16	M	1.79	65	20.28		102	15	F	1.66	53	19.2
103	16	M	1.64	53	19.7		103	15	F	1.58	59	23.6
104	16	M	1.75	55	17.95		104	15	F	1.48	51	23.29
105	16	M	1.48	36	16.43		105	15	F	1.47	51	23.61
106	16	M	1.57	44	17.85		106	15	F	1.48	50	22.83
107	16	M	1.59	44	17.4		107	15	F	1.46	45	21.13
108	16	M	1.6	50	19.53		108	15	F	1.55	40.6	16.67
109	16	M	1.65	50	18.36		109	15	F	1.53	40	17.09
110	16	M	1.69	50.5	17.5		110	15	F	1.55	59	24.58
111	16	M	1.69	54.5	19.25		111	15	F	1.48	47.4	21.92
112	16	M	1.68	51	18.06		112	15	F	1.53	48	20.51
113	16	M	1.59	44	17.4		113	15	F	1.45	52	24.76
114	16	M	1.56	50	20.54		114	15	F	1.56	47	19.34
115	16	M	1.64	55	20.44		115	15	F	1.4	37	18.88
116	16	M	1.67	50	17.92		116	15	F	1.55	50	20.83
117	16	M	1.65	51	18.73		117	15	F	1.55	44	18.33
118	16	M	1.68	50.3	17.71		118	15	F	1.5	48	21.33
119	16	M	1.67	59.7	21.51		119	15	F	1.53	55	23.5
120	16	M	1.71	50	17.09		120	15	F	1.51	47	20.61
121	16	M	1.6	55	21.48		121	15	F	1.57	48	17.48
122	16	M	1.67	51	18.28		122	15	F	1.56	51	20.99
123	16	M	1.69	51	17.85		123	15	F	1.55	56	23.33
124	16	M	1.52	39	16.88		124	15	F	1.52	42	18.18
125	16	M	1.59	42	16.61		125	15	F	1.47	50	23.15
126	16	M	1.52	39	16.88		126	15	F	1.57	49	19.92

Data Sheet for height, weight and BMI

No	Age	Sex	Height	Weight	BMI		No	Age	Sex	Height	Weight	BMI
127	16	M	1.65	48	17.63		127	15	F	1.6	51	19.92
128	16	M	1.66	52	18.87		128	15	F	1.53	46	19.66
129	16	M	1.58	42.2	16.82		129	15	F	1.54	47.5	19.83
130	16	M	1.61	41.8	16.2		130	15	F	1.53	55	23.5
131	16	M	1.66	48	17.41		131	15	F	1.55	51	21.25
132	16	M	1.65	52	19.1		132	16	F	1.57	49	19.92
133	16	M	1.65	54	19.83		133	16	F	1.48	40	18.26
134	16	M	1.63	49	18.44		134	16	F	1.48	49	22.37
135	16	M	1.64	52	19.33		135	16	F	1.52	54.5	23.81
136	16	M	1.7	50	17.3		136	16	F	1.59	51	20.16
137	16	M	1.7	52	17.99		137	16	F	1.53	39	16.67
138	16	M	1.71	46	15.73		138	16	F	1.57	45	18.29
139	16	M	1.63	55	20.7		139	16	F	1.54	53	22.36
140	16	M	1.6	57	22.26		140	16	F	1.51	55	24.12
141	16	M	1.62	62	23.62		141	16	F	1.47	49	22.69
142	17	M	1.68	65	23.03		142	16	F	1.52	44	19.05
143	17	M	1.66	55	19.95		143	16	F	1.63	50	18.8
144	17	M	1.65	45	16.52		144	16	F	1.57	45	18.29
145	17	M	1.77	59	18.83		145	16	F	1.52	48	20.78
146	17	M	1.66	53	19.23		146	16	F	1.52	53	22.94
147	17	M	1.66	60.7	21.77		147	16	F	1.59	51	20.16
148	17	M	1.7	60	20.76		148	16	F	1.6	45	17.58
149	17	M	1.61	45	17.36		149	16	F	1.46	42	19.72
150	17	M	1.58	50.3	20.42		150	16	F	1.56	52	21.4
151	17	M	1.71	55	18.8		151	16	F	1.5	41	18.22
152	17	M	1.53	39	16.66		152	16	F	1.46	49.8	23
153	17	M	1.59	51	20.17		153	16	F	1.47	45	20.83
154	17	M	1.77	60	19.15		154	16	F	1.5	45	20
155	17	M	1.62	48	18.28		155	16	F	1.58	52	20.88
156	17	M	1.64	58	21.56		156	16	F	1.59	52	20.63
157	17	M	1.73	60	20.04		157	16	F	1.52	50	21.65
158	17	M	1.65	51	18.73		158	16	F	1.64	54.2	20.45
159	17	M	1.63	48	18.06		159	16	F	1.53	55	23.5
160	17	M	1.66	55.5	19.95		160	16	F	1.49	41.5	18.47
161	17	M	1.63	50	18.81		161	16	F	1.56	55	22.63
162	17	M	1.67	47.5	17.21		162	16	F	1.56	47.5	19.34
163	17	M	1.62	48	18.28		163	16	F	1.63	65	24.44
164	17	M	1.62	55	20.95		164	16	F	1.59	56	22.13
165	17	M	1.68	56	19.84		165	16	F	1.56	51	20.99
166	17	M	1.61	51	19.67		166	16	F	1.57	51	20.73
167	17	M	1.64	54	20.07		167	17	F	1.5	46	20.44
168	17	M	1.64	55	20.44		168	17	F	1.58	55	22
169	17	M	1.68	51	18.06		169	17	F	1.53	56	23.93
170	17	M	1.65	59	21.67		170	17	F	1.51	55	24.12

Data Sheet for height, weight and BMI

No	Age	Sex	Height	Weight	BMI		No	Age	Sex	Height	Weight	BMI
171	17	M	1.64	61	22.67		171	17	F	1.59	49	19.37
172	17	M	1.72	66	22.3		172	17	F	1.59	57.6	22.53
173	17	M	1.7	60	20.76		173	17	F	1.5	58	25.78
174	17	M	1.67	56.7	20.43		174	17	F	1.5	60.4	27.11
175	17	M	1.66	54	19.59		175	17	F	1.62	51	19.47
176	18	M	1.67	52.3	18.64		176	17	F	1.52	47	20.35
177	18	M	1.72	62	20.95		177	17	F	1.54	61	25.74
178	18	M	1.63	49	18.44		178	17	F	1.55	44.5	18.75
179	18	M	1.71	55	18.8		179	17	F	1.55	59	24.58
180	18	M	1.67	55	19.72		180	17	F	1.58	49.5	19.6
181	18	M	1.73	65	21.71		181	17	F	1.43	47	23.38
182	18	M	1.64	51	18.96		182	17	F	1.57	55	22.36
183	18	M	1.72	62	20.95		183	17	F	1.56	61	25.1
184	18	M	1.68	59	20.9		184	17	F	1.61	61	23.55
185	18	M	1.64	55	20.44		185	17	F	1.5	52	23.11
186	18	M	1.72	53	17.91		186	17	F	1.62	59	22.52
187	18	M	1.62	52	19.81		187	17	F	1.62	56	21.37
188	18	M	1.71	55	18.8		188	17	F	1.57	55.6	22.76
189	18	M	1.62	52	19.81		189	17	F	1.61	56	21.62
190	18	M	1.73	56	18.71		190	18	F	1.59	48.4	18.97
191	18	M	1.61	45	17.36		191	18	F	1.55	59	20.42
192	18	M	1.68	55	19.48		192	18	F	1.61	55	21.24
193	18	M	1.67	51	18.28		193	18	F	1.61	60	23.17
194	18	M	1.65	55	20.2		194	18	F	1.59	57	22.53
195	18	M	1.62	56	21.33		195	18	F	1.54	49	20.68
196	18	M	1.58	55	22.03		196	18	F	1.68	60	21.28
197	18	M	1.71	55	18.8		197	18	F	1.62	53	20.23
198	18	M	1.69	57.6	19.95		198	18	F	1.53	46.6	19.66
199	18	M	1.53	48.4	20.93		199	18	F	1.59	67	26.48
200	18	M	1.61	72	27.77		200	18	F	1.6	44.4	17.58