Chapter – I

INTRODUCTION

Movement and activity are basic functions needed by human organism to grow, develop, and maintain health. However, physical activity is no longer a natural part of our existence. We live in an automated world where most of the activities that used to require strenuous physical exertion, can be accomplished by machines with the simple pull of a handle or push of a button. For instance, if there is a need to go to a store most of the people drive their automobiles. Similarly, during a normal visit to a multi-level shopping mall, it can easily be observed that almost everyone chooses to ride the escalators instead of taking the stairs. Automobiles, elevators, escalators, telephone, intercoms, remote controls, electric garage door openers, etc. are all modern-day commodities that minimize the amount of movement and efforts required by the human body.¹

One of the most significant detrimental effects of modern-day technology has been an increase in chronic conditions which are related to a lack of physical activity, like hypertension, heart diseases, chronic low back pain and obesity. These conditions are also referred to as hypo-kinetic diseases. The term “hypo” implies low or little, and “kinetic” implies motion. While lack of vigorous physical activity is a fact of modern life that most people can no longer avoid, if we want to enjoy many of the twenty first century commodities and still expect to live life to its fullest, a lifetime exercise program must become a part of daily living.²

Health related fitness and athletic training programs are designed to control body weight and body composition. This is accomplished through regular exercise and proper nutrition. Being overweight is associated with many medical problems such as hypertension, diabetes, and heart diseases. These illnesses lead to increased morbidity and reduced longevity. It is important to realize that adulthood obesity is a complex problem with physical inactivity being just one cause among many. Excess body fat lowers aerobic fitness and reduces the ability to perform many activities requiring jumping and moving quickly. However, being too thin is not desirable either. Suitable body composition is important for general health and appearance and for

² Ibid.
maximizing athletic performance. For these reasons, accurate measurements of body composition are needed to develop sound preventive health and athletic programs.\(^3\)

Body composition is an important component of fitness or wellness. People whose body composition is optimal tend to be healthier, can move more efficiently, and feel better about them. To reach wellness, one must determine what body composition is right for him and then work to achieve it. Successful management of body composition requires co-ordination of many aspects of a wellness program, including proper nutrition, adequate exercise and stress management.\(^4\)

The human body is an extremely complicated organism consisting of an inconceivably large number of microscopic building blocks called cells. Basically, these cells are individual independent living organisms with their own energy supply (metabolism), and this makes them individually viable in a suitable environment. They are merged into cellular units (tissue) within the body, and different types of tissues such as muscle, nerve, or glandular cell tissues, unite cells of the same shape and function. Specific tissue types with “productive functions” are combined with other tissue types that fulfill


predominantly "auxiliary functions" to form organs (kidney, lungs, stomach etc.). Individual organs that work toward the same end constitute organ system, such as the nervous system, digestive system, respiratory system, cardiovascular system etc.\textsuperscript{5}

Five-level model of Body Composition

According to Wang, Pierson, and Heymsfield\textsuperscript{6} Body-composition research is a branch of human biology that has three interconnecting areas: body-composition levels, measurement techniques, and biological factors that influence body composition. In the first area, which is inadequately formulated at present, five levels of increasing complexity are proposed: I atomic; II molecular; III cellular; IV tissue-system; and V whole body. Although each level and its multiple compartments are distinct, biochemical and physiological connections exist such that the model is consistent and functions as a whole. The model also provides the opportunity to clearly define the concept of a body composition steady state in which quantitative associations exist over a specified time interval between compartments at the same or different levels. Finally, the five-level model provides a matrix for creating explicit body-composition equations, reveals gaps


in the study of human body composition, and suggests important new research areas. The following figure presents a detailed description of each level and its associated components.

Figure 1: The Five-Level Model of Body-Composition

The explanation of five organizational levels of body composition and their major compartments as shown in Figure 1 is as follows. At the atomic level, the major chemical elements are oxygen, carbon, hydrogen, nitrogen, & other elements such as calcium and phosphorus. Whole body measurements of these constituents are usually made with research techniques such as neutron activation analysis, and provide important information. For example, nitrogen
balance is an indicator of protein turnover, and total body calcium is an indicator of total bone mineral.\textsuperscript{7}

The next level of body composition comprises of the major molecular compartments such as water, protein, glycogen, mineral (osseous and non-osseous) and fat. Water and osseous minerals can be measured directly, but fat, protein, glycogen and non-osseous minerals must be estimated by indirect techniques. Each of the several methods used to estimate this latter group of constituents relies on assumptions that relate measurable aspects of body composition. Anthropometric methods of estimating total body fat and fat free mass (FFM) are usually developed using indirect techniques.

The cellular level of body composition consists of cells, extracellular fluid (ECF) and extracellular solids (ECS). A widely used model considers the total cellular mass to be composed of two components – fat (a molecular-level compartment), and the fat free cell mass referred to as body cell mass (BCM), where most metabolic processes take place. Cells are the body’s main functional compartments. Several equations based on anthropometry have been developed to predict body cell mass at the cellular level, although their accuracy is a matter of debate and none is widely used.\textsuperscript{8}

\textsuperscript{7} Ibid.
\textsuperscript{8} Ibid.
The tissue-system level of body composition consists of the major tissue, organ and systems; thus body weight is equal to adipose tissue + skeletal muscle + bone + residual (visceral organs, etc.). Adipose tissue includes adipocytes, blood vessels, and structural elements, and is the primary site of lipid storage. It is located mainly in the subcutaneous and internal or visceral compartments, with its distribution under hormonal and genetic control.9

A steady-state relationship exits between the various body-composition compartments. That is, there are stable quantitative relationships between compartments at the same and different levels of body composition that remains relatively constant over a specified time (usually months or years). This permits information about body composition at various levels to be derived from anthropometric measurements made at the whole body levels. Both aging and diseases affect these quantitative relationships, and anthropometry provides a mean of detecting the resultant changes.10

In sports medicine, we are often concerned about the optimum body composition for different people. Gymnasts should have drastically different proportions of muscle, fat and bone than football linebackers. Furthermore, we are interested in what is healthy for fitness enthusiasts, weekend warriors and non-athletes as well.

9 Ibid.
10 Ibid.
Many people determine their body composition status by body weight alone. While this is indeed an important parameter, it is by no means a complete way to determine whether or not you have the correct body composition. Consider the examples of a 300 pound football linebacker with 15% body fat and the 5'2'' small-framed woman who has 35% body fat.

Some practical and direct methods of measuring body composition include Skinfolds, Hydrostatic Weighing, Bioelectrical Impedance, and Near-Infrared Interactance. Indirect ways to assess body composition are Body Mass Index (BMI), Body Surface Area (BSA), Waist Circumference, and Waist-to-Hip Ratio (WHR). Other advanced methods for research are Isotope Dilution, Neutron Activation Analysis, Magnetic Resonance Imaging, and Dual-Energy X-Ray Absorptiometry.\textsuperscript{11}

OVER WEIGHT & OBESITY

Total weight is a combination of bone, ligament, tendon, organs, fluids, muscle and fat. When you lose or gain weight due to either optimal fitness programs or not taking care of yourself, then both your overall weight will probably change, as well as the ratio of these components to one another. Exercise scientists have coined the term "body composition" to define the relationship between all the lean

\textsuperscript{11} Len Kravitz and Vivian H. Heyward, “Getting Grip on Body Composition”, Cited in http://www.unm.edu/~lkravitz/Article%20folder/underbodycomp.html
tissues in the body and fat. One of the most difficult yet important concepts that help on wellness and fitness journey is the relationship of lean mass to fat mass. How a person looks has a strong correlation with how much muscle he has and not the weight. Muscle weighs three times more than fat per unit of volume. Muscles gained by exercise could be smaller physically in view, but weigh more.\textsuperscript{12}

Technically, a normal-sized person has between 30 and 35 billion fat cells. When a person starts losing weight, the fat cells decrease in size but the number of fat cells generally stays the same. Once weight is gained, it is difficult to lose because the fat cells essentially shrink in size. However, some studies imply that fat cells can be destroyed as a result of certain medications and that a decrease in fat cell number may occur if a lower body weight is maintained for a prolonged period of time.\textsuperscript{13}

Excess fat not only impact on the health but it also lowers self esteem. Being over-fat or having a higher than desirable ratio of fat to muscle has a negative effect on health. A person with more fat percentage will have difficulty with basic exercise, such as walking or performing domestic chores. High body composition levels also impact injury potential, the incidence of injuries and maladies to knees, backs,

\textsuperscript{12} Neil Wolkodoff, \textit{Body Composition: Health Under The Skin}, Cited from website http://www.bodytrends.com/articles/body_comp/bodycompomronnw.htm
\textsuperscript{13} Ibid.
and ankles, the major support structures, is almost three times that of people with just average body fat percentages. The impact of excess body fat is important to health as both a direct and indirect cause of serious medical conditions.\textsuperscript{14}

Being significantly over-fat is demonstrated as a single risk factor for Coronary Heart Disease (CHD), still the number one killer. Being over-fat is also a significant risk factor in type II diabetes, which is a significant and debilitating health problem. Being over-fat relates to general lifestyle and activity patterns, as the exercise patterns of individuals in this group are generally significantly less than those with just average body fat. If you don't get regular and vigorous exercise, you simply don't build your HDL or good cholesterol, which in turn leads to a reduction of the risk of heart disease. Without regular exercise, stress levels don't decrease, and not only is that a risk factor for heart disease, but other stress-related diseases and conditions such as high blood pressure and cancer.\textsuperscript{15}

According to the report of the World Health Organization\textsuperscript{16} body weight consists of water, protein and mineral with the fat free body mass in the average proportions 0.725, 0.195 and 0.08 respectively;

\textsuperscript{14} Ibid.
\textsuperscript{15} Ibid.
glycogen is variable at 0.01 to 0.02; 50 to 55% of water is intracellular, with the remainder in the extracellular space. This is represented in the figure below:

![Figure 2: The Major Components of Body Weight](image)

It is important to realize that the term obesity refers to overfatness, not over-weight. A well-muscled athlete who is extremely fit may be considered overweight on a height and weight table but may actually be quite lean.17

The distribution of fat is also an important indicator of future health. People who tend to gain weight in the abdominal area have a risk of coronary heart diseases, high blood pressure, diabetes and stroke twice as high as do those who tend to gain weight in the hip area. In general, men tend to gain weight in the abdominal area and

women in the hip area, but women who exhibit male pattern of fat distribution face increased health risks associated with it. A person doesn’t have to be technically over-fat, to have the waist-hip ratio a risk factor, nor do all over-fat people face this increased risk. However, individual’s in the obese range should not be complacent about their body composition, regardless of their fat distribution; all obesity has serious health consequences.\textsuperscript{18}

Obesity can occur at any age. It is one of the most deterrent health hazards in the world, affecting more than 30% of the global population. Obesity is perhaps the most prevalent form of malnutrition in modern world, both among adult and children. It is significantly correlated with various diseases, which are responsible for increased morbidity and mortality. Efforts should be made to make the people more aware regarding the importance of maintaining the body weight at a desire level.\textsuperscript{19}

A 10 years study has shown that people who carry their excess weight around the middle are at higher risk of high blood pressure. The findings released in the American Journal of Hypertension showed those with an apple' shaped figure were at higher risk for heart disease


and Type 2 diabetes. The researchers studied a group of 2,377 people over 30 years to find that as the waistline increases so does blood pressure.\textsuperscript{20}

A study by researchers at the University of Florida has found that morbid obesity in toddlers is linked to lower IQ scores, cognitive delays and brain lesions similar to those seen in Alzheimer’s disease patients. The researchers suspected that the metabolic disturbances that obesity causes could be taking a toll on young brains, which are still developing and not fully protected. Daniel Driscoll\textsuperscript{21}, Professor of pediatrics and molecular genetics and microbiology in the college of medicine and the lead author of the study, said that though it is well known that obesity is associated with medical problems such as diabetes and hypertension, the new study showed a link to low IQ.

When attempting to understand performance capability in a physical activity, it is important to distinguish fat and lean weights from total body weight. Total body weight, usually expressed in pounds or kilograms which do not provide us with enough helpful information. Two individuals may be comparable in height, weight and skeletal construction and yet, because the proportions of their body


weights devoted to fat storage and muscle tissue differ, their performance in physical activity would be expected to vary. The person with more fat and less muscle (but the same total weight as the other person) would probably perform less efficiently or effectively in an activity requiring strength. There are body composition differences between males and females. Females store significantly more body fat than males and have considerably less muscle tissue. These differences contribute to advantages and disadvantages in certain physical activities, but in some sport contexts they are virtually meaningless, such as archer, rifle and pistol shooting, bobsledding, bowling, golf putting.\footnote{Jerrold S. Greenberg and David Pargram, \textit{Physical Fitness A Wellness Approach.} (New Jersey: Prentice-Hall Inc. Englewood Cliffs, 1986), p.150.}

Anthropometric and body composition techniques allow the body's size and shape and the masses and proportions of its constituents to be described. This information is helpful in acquiring a greater understanding of those attributes, which contribute to performance in sports. Physical performance, for example speed, strength and endurance, depends strongly on the amount of force-producing tissue, the application of forces through the levers of the limbs and the adaptations of training. The significance of information about the size, shape and body composition of athletes is that it correlates with performance and may also indicate condition and
potential. Indices of body fatness can contribute to the assessment of the state of training of an athlete.\textsuperscript{23}

Physical educators have long realized that the performance of boys and girls is greatly influenced by such factors as age, height, weight and body structure. It is also acknowledged that persons of the same age will vary considerably in body size and shape. Individuals with the same height will differ greatly in body weight. Persons may weigh the same, but the relative proportion of muscles, fat and bone will be different.\textsuperscript{24}

Athletes in a variety of sports seemingly have different objectives when it comes to weight control and proper body composition. For some, gaining lean body weight (muscle) is the goal; looking slim or making weight is a goal. The non-athlete may have a simple concern: how to avoid obesity. Common among these goals is an inadequate knowledge base concerning nutrition and obesity. In any case, the do’s and don’ts of body weight control must be learned and thoroughly understood by the physical educator, coach and ultimately the athlete.\textsuperscript{25}

Body weight is determined by many factors, such as genetic, behavioral, cultural, socioeconomic, psychosocial, and psychological mechanisms. Many of these factors influence health independently or through mechanisms other than body weight. Excess body weight is a risk factor for a variety of health hazards, but it is also a marker of other factors that are directly or indirectly related to health, such as physical activity, diet, socioeconomic status, and smoking.

Fat people tend to have higher blood pressure than thin people. Even after taking into account the confounding effects of obese arms and inappropriate cuff size on blood pressure measurement, there is still a positive relationship between body mass index (BMI) and blood pressure. Clearly this association is related to an increased caloric intake, although other dietary factors may also be implicated (for example, obese people may have a higher sodium intake). It has been postulated that obese people can have an increased tendency to exhibit insulin resistance and research is continuing into whether insulin resistance is involved in the pathogenesis of hypertension. There is a strong association between obesity and hypertension. Several studies have shown that a reduction in systolic and diastolic pressures occurs with weight loss: reduction in weight of 3kg produces an estimated fall in blood pressure of 7/4 mm Hg; one of 12 kg gives a fall of 21/13 mm Hg. Every attempt should be made to encourage obese patients to diet
so that their weight falls to within the norm for their height and build. Available evidence suggests that the results achieved with the help of dietitians are better than those achieved by medical staff alone.²⁶

With waistlines increasing rapidly around the world, a study predicts that by 2030, almost 58% of the world’s population will be overweight or obese. This is the issue which will be difficult to ignore here in Gujarat, too. When it comes to food, Gujarat offers a wide and fatty palette. Gujarati’s are known for their indulgence in farsaan (namken) which is high on oil content and with fast food joints becoming an integral part of urban landscape, there will be an increase in number of overweight people. According to survey, 20% of women and 15.4% of men are obese in Gujarat. The number of people facing heart related problems; diabetes and serum cholesterol has increased drastically. There has been increase in cases of cardiac arrests, hypertension and other lifestyle diseases.²⁷

**BLOOD PRESSURE**

The heart pumps oxygen enriched blood, to all parts of the body through blood vessels called the arteries. The pressure generated by the column of blood in these vessels is called ‘blood pressure’ or simply

---


²⁷ Janki Dave, “Weight boom: With a large number of people in Gujarat falling prey to bulging waist size and increased health problems, BT looks into the matter”, *The Times of India*, Ahmedabad Edition, July 18, 2008, Baroda Times Page 1, Col. 5.
BP. To make it more simple, blood pressure is the force that pushes blood to all the parts of the body. This pressure is higher when that heart is contracting and actively ejecting blood into the arteries and is called the ‘systolic’ blood pressure. It is lower when the heart is relaxed and is then called the ‘diastolic’ blood pressure. So, if the blood pressure is 120/80, the upper number is the systolic BP while the lower number is the diastolic BP. Both of these are equally important for the body. Most parts of the body get their blood supply during the systolic phase but the heart itself gets its own supply during the diastolic phase.\(^{28}\)

Blood pressure is essential for (1) the return of blood to the heart, after making its way through more than 60,000 miles long blood vessels of human body, (2) the exchange of nutrient and waste products between the various cells of the body and the blood capillaries, (3) the filtering (purification) of blood.\(^{29}\)

Blood pressure is the result of the interaction between the cardiac output and the peripheral resistance. This can be expressed in the equation form as:

\[
\text{Blood Pressure} = \text{Cardiac Output} \times \text{Peripheral Resistance}
\]


It can be easily understood that cardiac output and peripheral resistance are inversely proportional, i.e., if one increases, the other correspondingly decreases to maintain the blood pressure at normal values. If one of these two factors increases and the other does not decrease proportionately or if both increases, the blood pressure goes up. If such condition persists for a long time, the person is said to suffer from high blood pressure.\textsuperscript{30}

Heart is a wonderful natural pump, made up of special muscles. It incessantly and rhythmically beats, thereby maintaining the blood circulation. Usually, it beats 72 times a minute. This number is termed, the ‘heart rate’. At every contraction, the heart pumps about 70 ml (half a cup) of blood into arteries. This quantity is termed, the ‘stroke volume’. Thus it pumps about 5 liters of blood every minute. This quantity is termed, the ‘cardiac output’.

\[
\text{Cardiac Output} = \text{Stroke Volume} \times \text{Heart Rate}
\]

The main artery, the aorta, arising from the heart divides into branches. These branches, in turn, give rise to smaller and smaller arteries. Such branching finally gives rise to extremely small arteries called ‘arterioles’. The walls of the arterioles possess muscle fibers. The arterioles can, therefore, contact or expand as per the bodily needs. Usually the arterioles possess a tone i.e., they remain in a partially

\textsuperscript{30} Ibid.
contracted state, thus slowing down the flow of blood. Such resistance to the flow of blood by the arterioles is called ‘peripheral resistance’.\textsuperscript{31}

What is White Coat Hypertension?

An interesting observation has been made which is called the “White Coat Hypertension”. The pressure is high when measured in the clinic and lower when measured at home. Blood pressure is usually at its lowest during sleep, when the body is at rest. On waking up, the body starts getting ready to face the day. Various hormones are pumped into the body which increases the BP, pulse rate, blood glucose, blood clotting tendency etc. The BP is considerably increased. This is the “morning surge” of blood pressure. In most people the highest BP readings of the day are recorded between 5am and 10am. Many of the heart attacks and paralytic strokes occur during early morning hours for this reason.\textsuperscript{32}

Blood Pressure is a very common term used casually even in everyday conversations. People often advise others to check anger in order to prevent the blood pressure from going up, but forget it when they are themselves angry. Any declaration of high blood pressure by a physician immediately brings a lot of worries to the patient. However, blood pressure is most important for maintaining blood flow through

\footnotesize{\textsuperscript{31} Ibid.  
\textsuperscript{32} Ibid.}
tissues. Thus blood pressure is a necessary evil for survival. So long as it is with normal limits, it does not bother us: in fact, it keeps us alive.  

Most people are not even aware, till their doctor tells them that their blood pressure is high. This is because high blood pressure (HBP) frequently exists without any apparent symptoms. For this reason this disease came to be known as The Silent Killer. There are 600 million hypertensive’s in the world, according to the World Health Report, 2002. The report says that blood pressure is the top most risk factor for death and disability in the world.  

In 2000, it was estimated that, 26.4% of the adult population had hypertension—defined as systolic pressure 140 mmHg or diastolic pressure 90 mmHg—and the total number of adults with hypertension was approximately 1 billion worldwide. This number was predicted to increase to a total of 1.56 billion in 2025. It is well documented that blood pressure gradually and progressively rises with increasing age so that the percentage of people with high blood pressure in any country varies with age, e.g. approximately 20% of 20-year olds, 40% of 40-year olds, 60% of 60-year olds, and 80% of 80-year olds.  

---

As per extensive survey carried out in a number of countries, almost 25 percent of population is trapped in the clutches of high blood pressure and the incidence is rapidly rising. History has noted that renowned physician Dr. William Harvey, internationally acclaimed scientist Edward Jenner, Richard Bright and Louis Pasteur and many other public figures had to leave this world due to high blood pressure. Our beloved leader Jawaharlal Nehru, towering scientist Dr. Vikram Sarabhai, world famous social worker Mother Teresa, one of the leading Indian businessmen Dhirubhai Ambani and many others were also victims of high blood pressure.36

However, it should not be inferred that high blood pressure affects only public figures. In fact, it makes no distinction between a king and pauper, a public figure and layman, a male and a female, the young and the aged. It strikes persons from all walks of life. It is precisely for this reason that a clear understanding of the disease should be obtained. Only then can it be prevented or successfully controlled.37

37 Ibid.
Figure 3: Shows the induction of hypertension by numerous hormones

symptoms of Blood Pressure

High blood pressure typically has no symptom that is why we
can call it as Silent killer. Although there are many coincidental
symptoms that are widely believed to be associated with high blood
pressure. These include headaches, nosebleeds, dizziness, a flushed
face and fatigue. If a person has high blood pressure that is severe or
longstanding and left untreated, symptoms such as headache, fatigue,
nausea, vomiting, shortness of breath, restlessness, and blurred vision
can occur as a result of damage to the brain, eyes, heart and kidneys. In
rare cases, high blood pressure may cause brain swelling, which can
lead to drowsiness and coma. The only way to find out the existence of
high blood pressure is to have blood pressure measured.\(^38\)

In most cases of hypertension, the cause is only vaguely known
in terms of old age, familial tendency, emotional stress, sedentary life,
overeating, etc.\(^39\)

Effects of Blood Pressure

High blood pressure damages the heart muscle over a period of
time and leads to decreased pumping ability of the heart. This can
gradually cause breathlessness or fatigue on exertion or even fluid

\(^{38}\) Armughan Riaz, Symptoms of High Blood Pressure or Hypertension, (2006), cited
online: highbloodpressuremed.com.

\(^{39}\) RL Bijlani, Understanding Medical Physiology: A Text Book for Medical Students,
etention in the body (heart failure). As the heart “fails” to pump effectively the blood pressure may even fall in later stages and appear to become “normal” on its own. This is not a sign that there is improvement, rather an indication that it has become worse.\(^{40}\)

Causes of Blood Pressure

An elevated arterial pressure (High Blood Pressure) is the most important public health problem in developed countries. It is common, asymptomatic, readily detectable, usually easily controllable, and often leads to lethal complications if left untreated. A number of environmental factors have been implicated in the development of hypertension, including salt intake, obesity, occupation, alcohol intake, Sleep Apnea, family history etc. these factors have all been assumed to be important in the increase in blood pressure with age in more affluent societies, in contrast to the decline in blood pressure with age in less affluent groups. Factors that modify the cause of essential hypertension are age, race, sex, smoking, alcohol intake, serum cholesterol, glucose intolerance and weight all may alter the prognosis of this diseases. The younger the patient when hypertension is first noted, the greater is the reduction in life expectancy if the hypertension is left untreated.\(^{41}\)


Statement of the Problem

The purpose of this study was to assess Body Composition, Body Surface Area and Waist-Hip Ratio among varying levels of Blood Pressure Groups.

Objectives of the Study

1. To assess and compare the Body Composition in various levels of Blood Pressure Groups of Male subjects of the age 45 to 55 years.

2. To assess and compare the Body Surface Area in various levels of Blood Pressure Groups of Male subjects of the age 45 to 55 years.

3. To assess and compare the Waist Hip Ratio in various levels of Blood Pressure Groups of Male subjects of the age 45 to 55 years.

Delimitations

1. The study was delimited to Male subjects with age ranging from 45 to 55 years.

2. The study was further delimited to the three Levels of Blood Pressure – High, Normal and Low.

3. The study was also delimited to four major cities of Gujarat state i.e. Ahmedabad, Rajkot, Vadodara and Surat.
Limitations

1. The investigator had procured assistance from a number of experts from Physical Education as well as Medical field for collection of data. Although every attempt was made to standardize the testing procedure, there could have been variations in measuring due to individual differences, which might have affected the study which could be considered as a limitation.

2. Since it was not possible to conduct tests on the same day for all subjects and during the same hours of the day, variations might have occurred in measuring the subjects, which can also be considered as another limitation of the study.

3. Since dietary habits and daily life style of the subjects were not the same, it would also be considered as a limitation for the study.

Hypotheses

On the basis of the knowledge reflected by the available literature, research findings, experts opinion and the scholar's own understanding of the problem it was hypothesized that:

1. there will be no significant difference in Body Composition among varying levels of Blood Pressure Group.
2. there will be no significant difference in Body Surface Area among varying levels of Blood Pressure Group.

3. there will be no significant difference in Waist-Hip Ratio among varying levels of Blood Pressure Group.

**Definition and Explanation of the Terms**

**Body Composition**

1. Body Composition has two components: the amount of fat mass (weight) and the amount of fat-free mass (muscle, bone, skin and organs) in the body.

2. The proportion of fat, muscle, and bone of an individual's body, usually expressed as percentage of body fat and percentage of lean body mass.

3. In physical fitness, body composition is used to describe the percentages of fat, bone and muscle in human bodies. Because muscular tissue takes up less space in our body than fat tissue, our body composition, as well as our weight, determines leanness. Two people at the same height and same body weight may look

---


completely different from each other because they have a different body composition.\textsuperscript{44}

4. Body composition refers to the athlete's body fat. In most sports, the athlete will try to keep his/her levels of body fat to a minimum. In general the higher the percentage of body fat the poorer the performance.\textsuperscript{45}

The Definition suggested by Wikipedia Encyclopedia was found suitable and acceptable for the purpose of this study.

**Body Surface Area (BSA)**

1. In physiology and medicine, the body surface area (BSA) is the measured or calculated surface of a human body. For many clinical purposes BSA is a better indicator of metabolic mass than body weight because it is less affected by abnormal adipose mass. Estimation of BSA is simpler than many measures of volume.\textsuperscript{46}

\textsuperscript{44} Electronic Wikimedia Foundation, Wikipedia, the Free Encyclopedia, U.S., cited online: http://en.wikipedia.org/wiki/Body_composition


2. Body Surface Area: A measure of the overall size of a person calculated from height and weight. Body surface area is expressed as meter squared or m$^2$.\(^{47}\)

3. The total surface area of the human body. The BSA is used in many measurements in medicine, including the calculation of drug dosages and the amount of fluids to be administered IV.\(^{48}\)

The Definition given by Haycock, Schwartz, Wisotsky was found suitable and acceptable for the purpose of this study.

Waist Hip Ratio (WHR)

1. Waist-Hip Ratio (WHR) is the ratio of the circumference of the waist to that of the hips. It is calculated by measuring the waist circumference (located just above the upper hip bone) and dividing by the hip circumference at its widest part (waist/hip).\(^{49}\)

2. Waist-to-hip ratio is a measurement that compares the size of your waist in inches to that of your hips. Risk for developing heart disease is typically measured by waist-to-hip ratio.\(^{50}\)

\(^{47}\) People With AIDS (PWA) Health Group, Women's Treatment News (Pediatric Antiviral Glossary), (New York: Body Health Resources Corporation), cited online: http://www.thebody.com/content/treat/art4774.html


\(^{50}\) Jennifer R. Scoot. Glossary: Waist-to-hip ratio, About.com Health's Disease and Condition, Updated: August 10, 2008, cited online: http://weightloss.about.com/od/glossary/g/whr.htm
3. Ratio of the abdominal circumference at the navel to maximum hip and buttocks circumference.\textsuperscript{51}

The Definition given by Devendra Singh was found suitable and acceptable for the purpose of this study.

Blood Pressure

1. The pressure exerted by the blood on the vessel walls.\textsuperscript{52}

2. Blood pressure is a measurement of the force with which blood presses against the walls of a blood vessel. Blood pressure values vary appreciably depending on age, sex, and ethnicity.\textsuperscript{53}

3. BP (blood pressure): The force of the blood on blood vessel walls as the heart beats and relaxes.\textsuperscript{54}

4. The force of circulating blood on the walls of the arteries. Blood pressure is taken using two measurements: systolic (measured when the heart beats, when blood pressure is at its highest) and diastolic (measured between heart beats, when blood pressure is at its lowest). Blood pressure is written with the systolic blood


\textsuperscript{54} Krames, \textit{Online Health Sheets Medications}, (Georgia: Gwinnett Medical Center, 2007), cited online: http://gwinnettmilitarycenter.kramesonline.com.
pressure first, followed by the diastolic blood pressure (for example 120/80).\textsuperscript{55}

The Definition given by National Cancer Institute was found suitable and acceptable for the purpose of this study.

Varying Levels of Blood Pressure

For the present study, varying levels of Blood Pressure meant three levels which are High Blood Pressure, Normal Blood Pressure and Low Blood Pressure.

High Blood Pressure

1. That level of blood pressure above which investigation and treatment do more good than harm.\textsuperscript{56}

2. High blood pressure is usually referred to as hypertension.
   a. Primary or essential hypertension, of unknown causation.
   b. Secondary hypertension, due to phaeochromacytoma or to renal or endocrine diseases.\textsuperscript{57}

3. When the pressure at which blood is pumped through the arteries by the heart is above an average range, it is called high blood pressure, or hypertension.58

4. When the pressure of the blood is too high, causing stress on blood vessels.59

The Definition given by Astra Zeneca Pharmaceuticals was found suitable and acceptable for the purpose of this study.

Low Blood Pressure

1. Low blood pressure (hypotension) is pressure that is so low that it causes symptoms or signs due to the low flow of blood through the arteries and veins. When the flow of blood is too low to deliver enough oxygen and nutrients to vital organs such as the brain, heart, and kidney, the organs do not function normally and may be permanently damaged.60

2. Any blood pressure that is below the normal expected for an individual in a given environment. Low blood pressure is also referred to as hypotension.\textsuperscript{61}

The Definition given by India Development Gateway was found suitable and acceptable for the purpose of this study.

**Significance of the Study**

There is a growing body of medical research documenting that undesirable levels of Body Composition are associated with public health problems. Being overweight is associated with many medical problems, such as hypertension, diabetes and heart diseases. These illnesses lead to increased morbidity and reduce in life span.

The present study was carried out to examine the relationship between different anthropometric indicators and blood pressure levels on population of Gujarat.

1. The results of the study may provide an authentic understanding of Body Composition, Body Surface Area and Waist-Hip-Ratio.

2. An understanding of Body Composition, Body surface Area and Waist-Hip-Ratio which plays an important role in determining Blood Pressure would be of much value particularly for maintaining the Blood Pressure of the general Public.

3. The study of Body Composition, Body Surface Area, Waist-Hip-Ratio and their comparison among the varying levels of Blood Pressure would throw light and open new vistas with providing an insight into some factors that contribute to Blood Pressure.

4. The study would be a yardstick for the middle aged men i.e. 45 to 55 years while preparing a health and fitness programme by Physical Education Experts suited to the different categories according to their level of Blood Pressure.