"STUDY OF ASSOCIATION OF LEPTIN AND LEUCOCYTE TELOMERE LENGTH WITH BODY MASS INDEX IN ADULT INDIAN POPULATION A ONE YEAR CROSS SECTIONAL STUDY"

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Dr. ARATHI DARSHAN
MD (GENERAL MEDICINE) FICP
Professor and Head,
Department of General Medicine,
J. N. Medical College,
Nehru Nagar, Belagavi-10

Date : 17/12/2021
Place : Belagavi

DR.(Mrs.) N. S. MAHANTSHETTI
MD (PAEDIATRICS)
Principal,
J. N. Medical College,
Nehru Nagar, Belagavi-10

Date : 17/12/2021
Place : Belagavi

KAHER, BELAGAVI, KARNATAKA

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JAWAHARLAL NEHRU MEDICAL COLLEGE
(Recognized by Medical Council of India, New Delhi)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA
0831 - 2471350 0831 - 2470759 www.jnmc.edu principal@jnmc.edu

Ref No: MDC/PG/

Date: 15-11-2021

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Dr. (Mrs.) N.S. Mahantashetti.
Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

To,
Reg. No. BG0119005.
Postgraduate Student,
2019-20 Batch,
Department of General Medicine,
J. N. Medical College, Belagavi.

ABSTRACT

Background: Obesity is a leading preventable cause of death and a growing health problem worldwide with increasing rate in both adults and children. Obesity is an important factor causing accelerated aging and various metabolic syndromes. Leptin's role as proinflammatory adipokine in obesity is well established. Telomere length acts as an biological clock and a marker for cellular senescence. This study is aimed to quantify leucocyte telomere length & its association with biochemical and anthropometric surrogates of obesity.

Material & Method: This cross-sectional study was conducted for a duration of 1yr on patients admitted in the wards or attending OPD at KLES Dr. Prabhakar Kore Hospital, Belagavi fulfilling the inclusion criteria. After a written informed consent and a thorough history, patient's anthropometric measurements were taken following all guidelines. On the basis of the values obtained the participants were equally divided into categories on basis of age and BMI. Blood samples are collected for the assessment of Leucocyte Telomere length through qPCR technique, Leptin through ELIZA method and HBA1c through HPLC method.

Result: In our present study, a total of 90 patients were included. These patients are equally divided in age groups of 25-39yrs, 40-54yrs and >=55yrs of age. The mean age of the patients was 48.84±16.84yrs. The patients were further categorized in each age group into normal, overweight and obese. Out of the 90 subjects, 30 (33.3%) belonged to normal BMI group, 30 (33.3%) belonged to overweight group and 30 (33.3%) belonged to obese category. The mean BMI seen in patients was 24.20 ± 3.32 kg/m^2.Age is found to have a negative correlation with Telomere length (r=-0.205) which is statistically significant. A significant negative correlation of BMI with telomere length is observed (r=-0.20, $p<0.05$). No significant correlation between Leptin with Telomere length (r=0.092, p=0.386) or other

anthropometric variables is observed. Waist circumference was found to have a statistically significant positive correlation with waist/hip ratio (r=0.281) (p=0.007), BMI (r=0.640), weight (r=0.677) and neck circumference(r=0.687). Whereas Telomere length was found to have inverse relationship with waist circumference (r=-0.171) and neck circumference (r=-0.2266) (p=0.0318) and positive correlation with waist/hip ratio (r=0.043).In our research a negative association was observed between waist height ratio and Telomere length. Waist hip ratio has a positive association with BMI (r = 0.138) and telomere length (r = 0.232).

Conclusion: The Telomere length showed a negative correlation with all anthropometric measures except WHR which had a positive association. Leptin did not show any significant relationship with telomere length or anthropometric measures in our present study. Our study results show WHR as better marker of central obesity than BMI. The notion of metabolically healthy obese also holds true in our study results.

Keyword: Obesity, Telomere length, Leptin, BMI, WHR.

ABBREVIATIONS

BMI	Body Mass Index
CAD	Coronary Artery Disease
CNS	Central Nervous System
CRP	c - Reactive protein
DEXA	Dual energy X-Ray absorptiometry scan
DM	Diabetes Mellitus
FFA	Free Fatty Acids
HC	Hip Circumference
IHD	Ischemic Heart Disease
PAI-1	Plasminogen Activator Inhibitor-1
VAT	Visceral Adipose Tissue
VLDL	Very Low Density Lipoprotein
PCOS	Polycystic Ovarian Syndrome
TNF	Tumor Necrotic Factor
WC	Waist Circumference
WHR	Waist Hip Ratio

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INTRODUCTION

Obesity is a primary avoidable cause of mortality and a rapidly expanding health concern in both adults and children throughout the world. WHO data shows that there are 650 million obese adults in the world in 2016 and has tripled since 1975 showing an alarming increase in obesity rate. Overall, around 39% of world's adult population aged 18 years and over were overweight and 13% among them were obese in 2016. Almost half of the children under 5 who were overweight or obese in 2019 lived in Asia. As of 2016 India has 3.9% obese population.

An excess of adipose tissue mass is called as obesity. A higher risk of medical co-morbidity, institutionalisation, and early mortality is linked to excess adiposity[1]. Adipose tissue is also an endocrine organ releasing hormones, peptides, and cytokines that affect metabolism and the immune system. One potential mechanism that explains Telomere attrition in obesity and in aging process is the pro-inflammatory state that is associated with them. Obesity-associated adipokines (leptin) and pro-inflammatory cytokines, including IL-6 and TNF-α lead to pro inflammatory state and directly cause oxidative damage to DNA.[1]

Leptin is a hormone that regulates body fat content and has pro-inflammatory qualities that lead to an increase in oxidative stress. This may suggest that there is a direct relationship between leptin and obesity and exploring this relationship is warranted.

Telomere segments are non- transcriptional segments of DNA that protect chromosomes from degradation. Yet, telomeres themselves are not invulnerable to such damage, leading to their shortening which is known to be inversely related to aging.[1]

When telomeres in a cell shorten beyond the critical threshold, the cell stops dividing. The telomere length of a cell represents how many times the cell has replicated, and thus can be regarded as a indicator of cellular senescence and telomere shortening is accelerated by inflammation and oxidative stress. As a result, research into the process of telomere length loss in disorders including hypertension, obesity, and diabetes will give a wealth of information on the biological importance of telomeres.[2] It's been proposed that leptin may be implicated in the underlying process of telomere shortening in obesity. Several studies also showed that Leptin and Telomere length were independently correlated with each other and with BMI.[1]

In numerous cross-sectional epidemiological researches,[3] telomere shortening has been connected to BMI, waist-to-hip ratio, visceral and weight gain. Calorie-restricted diets and consequent weight loss have consistently been linked to increased telomere length in obese people, showing a link between obesity and telomere length.

A number of studies have found a link between telomere length and obesity, but the correlation between telomere shortening and obesity still remains equivocal due to contradictory results. Our study aims to provide additional information in this regard and add strength to this relationship.

This study is aimed to quantify leucocyte telomere length & its association with leptin and anthropometric parameters of obesity.

AIMS & OBJECTIVES

Aim

To assess the relationship of Telomere length with Anthropometric and Laboratory surrogate markers of Obesity.

Objective

To correlate biological and anthropometric surrogates of obesity with Telomere length

To assess the serum level of Leptin and its association in the study groups.

To measure the Leucocyte Telomere length and its association in the study groups.

REVIEW OF LITERATURE

Incidence of obesity

Obesity is defined as an excess of adipose tissue mass. More than 1.9 billion adults are overweight and 641 million are obese. Approximately 2.8 million deaths are reported as a result of being overweight or obese.

Overweight and obesity have become a major health problem in developing and developed countries. India is a developing country which is battling malnutrition due to poverty and obesity due to industrialization and rapid urbanization. In India, more than 135 million individuals are affected by obesity.[4]

Many studies argue that food intake, including our dietary choices and, in particular, increased overall food consumption, is the primary driver of the obesity epidemic, despite the fact that time spent exercising has been relatively consistent over the previous three to five decades. There is also adjustment in occupational physical activity levels that might be particularly significant, given most rises in adiposity are thought to be the result of a chronic positive energy balance.[5]

Although higher adiposity is commonly associated with increased body weight, this is not always the case; muscular persons might be overweight by numerical measures without having increased adiposity. Because body weights fluctuate in communities, deciding on a medically significant distinction between lean and obese is somewhat arbitrary.

Classification of Obesity

Android obesity is defined as the accumulation of adipose tissue in the "abdomen above the waist." It is also known as ‘central obesity or apple type obesity' and is associated with a high prevalence of CAD, diabetes, and hypertension.

Gynoid obesity is defined as the accumulation of adipose tissue in the ‘hips and buttocks or below the waist.' Pear-shaped obesity is another name for it. Obesity of this type is linked to a lower risk of diabetes and heart disease, but a higher risk of mechanical problems such as varicose veins and arthritis.

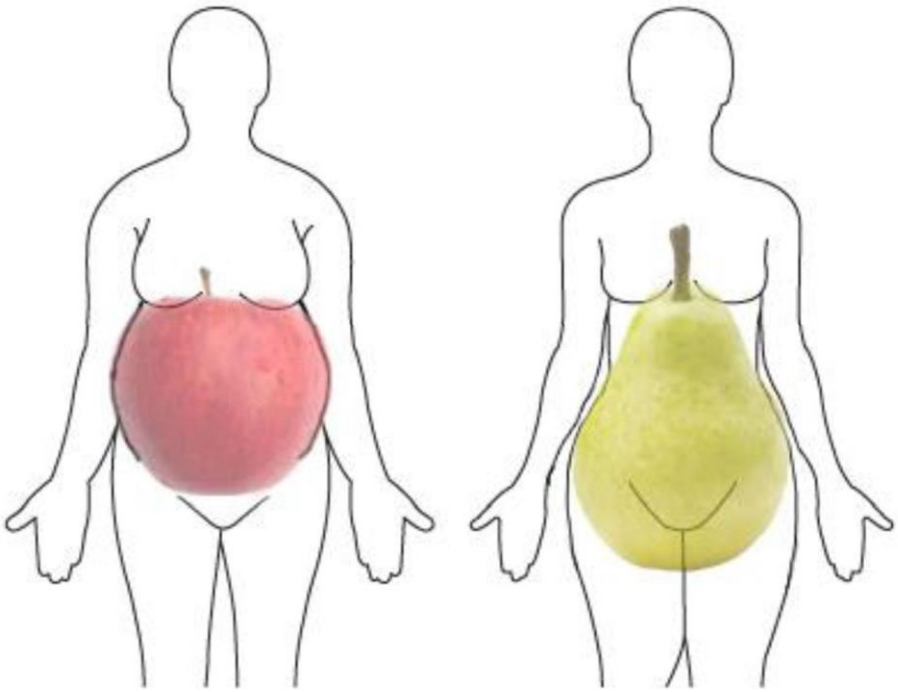


Figure 1: Showing the Android and Gynoid obesity

Obesity may not always mean a higher risk of cardiovascular disease. Individuals with a gynoid or "pear" distribution of subcutaneous fat had a reduced heart related risk for a given BMI than those with a centripetal android or "apple" shape linked with visceral adiposity. Few obese people do not develop insulin resistance or other metabolic

syndrome related diseases. The concept of the "fit fat" arose as a result of this observation. As a result, 'BMI may not be as good in predicting additional cardiovascular risk as the measures of systemic inflammation.' All individuals with metabolic syndrome components should implement and maintain a balanced lifestyle, as well as initiate appropriate treatment for specific risk factors.[5]

Waist hip ratio as a measure of central obesity.

The ‘waist hip ratio' is the most often used measure of central obesity. Women's optimum waist hip ratio is lower than men's because additional fat is concentrated in the hip in women and the waist in men. A waist hip ratio of more than 0.88 in men and more than 0.81 in women is considered abnormal. It is related with a higher risk of CAD.

BMI	Classification
<18.5	Underweight
18.5-22.9	Normal range
23-24.9	Overweight
>25.0	Obese

In addition to BMI, it is recommended to measure the waist circumference in patients who are obese evaluate for central obesity. Waist circumference of >85 cm (men) and (>80cm) women is considered abnormal and indicates high risk of cardio metabolic diseases. Waist circumference measurement is unnecessary in patients with a BMI of 30 kg/m2 because almost all people with this BMI have an abnormal waist circumference and are already at high risk due to their adiposity.[6]

Causes of obesity

In emerging nations like India, the adoption of the Western diet is the leading cause of obesity among adolescents and young people. Many non-communicable diseases, such as cardiovascular problems, diabetes, hypertension, osteoarthritis, stroke, obstructive sleep apnea, hepatobiliary diseases, endocrine disorders, and various forms of cancer, are caused by the presence of saturated fats and simple carbohydrates in the Western diet.[7] Aside from that, decreased cognition is linked to an increase in BMI.[8]

Asian Indians have a higher proclivity for abdominal obesity and visceral fat accumulation, which has been labelled the "Asian Indian phenotype."[9,10]. The rise in obesity prevalence in countries like India can be attributed to increased urbanisation, use of mechanised transportation, increased availability of processed and fast foods, increased television viewing, adoption of less physically active lifestyles, and consumption of more "energy dense, nutrient poor" diets.[11,12]

Iatrogenic causes: drugs, hypothalamic surgery

Dietary obesity: Infant feeding practices, Progressive hyperplastic Obesity, Frequency of eating, overeating.

Neuroendocrine Obesities: Hypothalamic Obesity, Hypothyroidism, Seasonal affective Disorder, Cushing's syndrome, polycystic ovary syndrome, Hypogonadism, growth hormone deficiency.

Social and Behavioural factors: Socioeconomic status, Ethnicity, Night eating syndrome, Binge eating

Sedentary lifestyle

Genetic obesities: Autosomal recessive traits, Autosomal dominant traits, other Chromosomal abnormalities.

Visceral adipose tissue

The development of metabolic syndrome is complicated by central obesity. The fat cells in the abdominal cavity are referred to as visceral adipose tissue (VAT), which comprises Omental, Mesenteric, Retroperitoneal, and Perinephric adipose tissue. In lean individuals, VAT amounts for 20% of fat in males and 6% of fat in women. Obese persons have more fat cells in their bodies which is known as visceral adiposity.

Despite accounting for just a tiny fraction of total body glucose disposal, adipose tissue is crucial in maintaining "body glucose homeostasis through the generation of free fatty acids (FFA)." Small increases in plasma insulin have a substantial 'antilipolytic effect,' lowering plasma FFA levels significantly. The drop in 'plasma FFA levels' promotes an increase in glucose absorption in muscle and hepatic glucose production.

Visceral fat cells show a high lipolytic rate and are particularly resistant to the effects of insulin. Increased fat lipolysis increases plasma FFA levels, leads to insulin resistance in muscle and liver, and suppresses insulin production. FFA levels in the blood are greater in obese persons. FFAs are stored as triglycerides in muscle and liver, and a greater fat content in these tissues corresponds to insulin resistance. Finally, FFAs released into the portal circulation enter the liver, where they cause the production of VLDL particles. FFA, along with other pro-inflammatory indicators, has been linked to shortened telomeres in studies.[13,14,15]

Visceral fat cells are active endocrine cells that create leptin, interleukin 6, tumour necrosis factor alpha, plasminogen activator inhibitor-1 (PAI-1), angiotensinogen, resistin, and CRP, among others. These adipokines go into the portal circulation, lowering insulin sensitivity in the peripheral organs.

VAT also contains anti-inflammatory and anti-atherosclerotic adipokines including adiponectin, which is linked to improved insulin sensitivity.

Adiponectin levels are thought to be lower in obese people. Non-diabetic south Asians exhibit adiponectin–insulin sensitivity axis abnormalities, which may play a role in thermogenesis in this population.

Asian Indians exhibited lower levels of adiponectin.[16] Increased VAT can lead to higher cortisol levels, which can worsen insulin resistance. The size of fat cells is a good indicator of diabetes risk. Insulin response is better in small, freshly established adipocytes than in big, lipid-rich fat cells. Smaller cells are more capable of absorbing glucose and storing fats. Larger cells, on the other hand, have lower insulin-stimulated glucose uptake, lower lipolysis suppression, and greater cytokine generation rates. Subcutaneous fat cells are smaller and have lower metabolic activity than visceral fat cells.

We can conclude from the preceding explanation that “obesity is a key risk factor for the development of all metabolic syndromes and atherosclerotic cardiovascular disease (ASCVD)”. As a result, estimating visceral adipose tissue is critical in view of its pro inflammatory nature which leads telomere attrition which in turn leads to metabolic syndromes and ASCVD.

Epicardial adipose tissue is a ‘true visceral fat deposit' (EAT). The atrioventricular and interventricular grooves are usually the only places where it can be found. It interacts locally by regulating the coronary arteries via paracrine or vasocrine adipokine production.

Obesity and coronary artery disease

The most important complications of obesity such as insulin resistance diabetes, hypertension and hyperlipidaemia are linked more strongly to intraabdominal fat or upper body fat than to overall adiposity. The mechanism underlying this connection is unknown, however it may be related to the fact that adipocytes from intraabdominal depots are more lipolytically active than those from other depots. The release of free fatty acids into the portal circulation has negative metabolic effects, particularly on the liver. Adipokines and cytokines produced variably by adipocyte depots may play a role in obesity-related systemic problems.[14]

The approaches to measure the obesity include

- Visceral adiposity index
- Densitometry
- Anthropometry
- Computed tomography
- MRI
- Electrical impedance

Anthropometric measures in obesity

Indirect techniques

- BMI (Quetelet index)

- Waist circumference and Hip circumference
- Waist Hip ratio
- Skin Fold thickness
- Body Fat Percentage

Direct techniques

- Radiological methods
- Other methods

BMI (Quetelet Index)

Body fat is deliberated using the most basic anthropometric measurements.

BMI = Weight (kg)/ height^2 (m)

Waist circumference and Hip circumference

The person should be upright and relaxed, with his arms by his sides and his feet near together. The tape shall be parallel to the floor for all measurements. All measurements will be taken in centimetres (cm) and will be accurate to within 0.1cm.[17]

Waist circumference is an approximate measure of total body fat and intra-abdominal fat mass. It's a frequently used metric, and it's the simplest technique to measure central obesity. A non-stretchable measuring tape is used to measure the waist circumference in centimetres. The waist circumference is measured at the point where the horizontal girth between the costal margins and the upper border of the iliac crest is the smallest after normal expiration. Men with a waist circumference of 85 cm and women with a waist circumference of 80 cm are more susceptible to have complications.[18]

When comparing participants with larger waists to subjects with narrower waists, a French physician discovered that those with thicker waists have a greater threat of heart disease and mortality.[19] Even when BMI levels were statistically controlled, long-term

follow-up studies revealed that abdominal obesity was related with an increased risk of type 2 diabetes, heart disease, and death.

Waist - Hip ratio

"Waist Hip Ratio (WHR) is the ratio of waist circumference to hip circumference." Abdominal fat deposition is indicated by a WHR of > 0.88 in men and > 0.81 in women.[18] It's a metric for central obesity.

Skin fold thickness

Thickness of the skin folds measures subcutaneous fat, which correlates with total body fat. Skin callipers are used to measure skin fold thickness in the mid triceps, biceps, supra iliac, and supra scapular regions. Obesity is defined as a sum of these measurements that is greater than 40 mm in males and greater than 50 mm in females.

Body fat percentage

"Body fat percentage is the total weight of body fat divided by body weight". Obesity is defined as having a Body fat percentage of more than 23% in men and 29% in women. The equation below may be used to compute Body Fat Percentage (BF %) from BMI in adults.

BF% = (0.23 x Age) + (1.2 x BMI) - (10.8 x Sex) - 5.4

Where, BMI is in Kg/m^2; Sex=0 for female and 1 for male; Age is in yrs

Direct techniques

Radiological Methods

CT, MRI, and Dual energy X-ray absorptiometry - DEXA scan are used to precisely assess abdominal fat.[20]

Other methods

Other methods include densitometry, total body water estimate, neutron activation techniques, and electrical impedance.

Pathophysiology of obesity

Insulin resistance, a primary cause of metabolic syndrome and heart disease, is directly connected to the buildup of ectopic fat around organs. Obesity also causes a rise in reactive oxygen species and cytokines, both of which contribute to inflammation. These activities are important in host defence, immunology, and injury response, and may explain the association between obesity and telomere length. Adipocyte hyperplasia and hypertrophy, which can lead to adipose tissue hypoxia, may be involved in the process of a proinflammatory state linked with obesity. Prostaglandins, C-reactive proteins (CRPs), and cytokines like interleukin-6, tumour necrosis factor alpha, and leptin, as well as proinflammatory biomarkers, are secreted when adipose tissue is dysfunctional. Anti-atherosclerotic adipokines such as adiponectin are also reduced. Hyperinsulinemia lowers insulin sensitivity and produces type 2 diabetes, whereas increased circulation free fatty acids enhance insulin production to manage glucose metabolism.

Type 2 diabetes, hyperlipemia, and cardiovascular disease are all caused by aberrant adipose tissue production. Obesity, metabolic syndrome, and cardiovascular disease all activate pathways that cause senescence and programmed cell death, which prevent malignant transformation. These response pathways are important in the increased inflammation caused by DNA damage, transcription factor activation, and telomere failure.[21]

Overview pathophysiologic effects of obesity

Weight-Related Changes: Degenerative joint disease, Dermal pressure changes, Restrictive pulmonary physiology.

Increased intra-abdominal pressure: effects Mobility, Physiologic Changes, Hyperkinetic systemic circulation Myocardial hypertrophy, Elevated systemic pressure Diastolic dysfunction, Increased circulating blood volume Metabolic syndrome

Proinflammatory Phenotypic Changes

Vascular intimal atherosclerotic changes

Prothrombotic state with: Increased fibrinogen, Decreased fibrinolysis, Increased antithrombin-III levels, Increased plasmin activator inhibitor levels Increased blood viscosity.[22]

Obesity and adipokines

Adipokines such as adiponectin, retinol binding protein, leptin, IL-6, TNF-, and PAI-1 are linked to obesity and its metabolic implications.

Factors expressed by Adipose tissue in modulation of adipogenesis.

Insulin-like growth factor-1, Transforming growth factor-β, Tumor necrosis factor-α, Macrophage colony-stimulating factor, Angiotensin-2, Autotaxin–lysophosphatidic acid, Leptin, Resistin.

Leptins

Leptin is a hormone discovered by J.M. Friedman in 1994. In humans, the Ob (Lep) gene is found on chromosome. Leptin is made up of 167 amino acids and has a molecular weight of 16 kDa.[23] Leptin is a hormone generated largely by white adipose tissue adipocytes.[24,25] Brown fat, bone marrow, placental syncytiotrophoblasts, ovaries, mammary gland epithelial cells, skeletal muscle, and stomach fundic glands, particularly the lower section, all generate leptin.

Role of leptin in obesity

Despite the fact that leptin decreases hunger, obesity causes leptin resistance, which is analogous to insulin resistance in type 2 diabetes. Obese people have higher circulatory levels of leptin because the body fat is on the higher side.[26] Obese persons have larger amounts of leptin in their blood, but owing to leptin resistance, they are unable to reduce appetite and regulate weight gain. Consumption of a high-fructose diet from birth lowers leptin levels in the blood and diminishes mRNA expression for leptin receptors. When a high fructose diet is consumed for an extended period of time, triglyceride levels rise and insulin and leptin resistance develops.[27]

Oxidative stress, inflammation, thrombosis, arterial stiffness, angiogenesis, and atherogenesis are all increased by leptin, an appetite suppressor that controls food intake. These leptin-induced changes might be a risk factor for the development of cardiovascular disease. Elevated leptin levels have also been linked to the onset and progression of Chronic Kidney Disease (CKD), as well as insulin resistance, T2DM, and micro- and macro vascular diabetic complications.

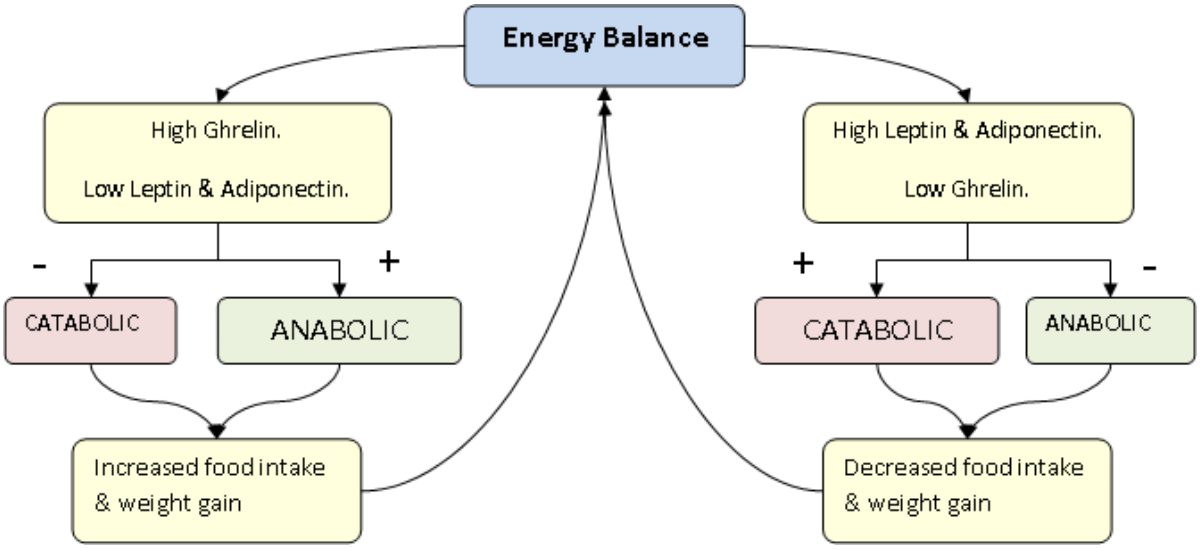


Figure 2: Energy balance

BMI and body fat are strongly related to both leptin production and circulating concentrations. Leptin concentrations communicate the proportion of adipose tissue and the status of energy reserves to the brain (and other organs) under conditions of regular food intake.[28]. Leptin circulates in the bloodstream in both free and bound forms. The binding protein is the extracellular cleaved product of the leptin receptor. Free leptin has unrestricted access to areas of the central nervous system (CNS) not protected by the blood brain barrier, whereas its access to other areas of the CNS is dependent on the expression of the short form of the leptin receptor, which functions as a leptin transporter into the CNS and is saturable at high circulating leptin levels.

Overeating raises serum leptin levels by nearly 40% within 12 hours, well before any changes in body fat stores. Fasting, on the other hand, reduces serum leptin concentrations in normal-weight and obese subjects by 60 to 70% in 48 hours and by approximately 80% in three days, indicating that leptin functions not only as an indicator of long-term energy stores but also as a marker of acute changes in energy intake.[29–32]

There is a fall in leptin levels during fasting times and following a reduction in body fat mass, which causes a reduction in total energy expenditure. While the consequences of low leptin levels are intended to enhance survival chances under starvation, a drop in leptin levels can cause severe immunosuppression as well as other neuroendocrine changes affecting the HPA axis and reproductive function in both men and women.

The immune system's response to leptin is inherently proinflammatory. Indeed, leptin increases Th1 responses and facilitates the production of additional proinflammatory cytokines including TNF-a, IL-1, and IL-6.[33]

In humans, it's been shown that leptin levels are linked to immunological response in malnourished neonates with low plasma leptin and a weakened immune system. It's important to note that a lack of leptin signalling hampers both humoral and cellular immune responses. B and T cells express the long form of the leptin receptor Ob-Rb (the only form capable of transducing the signal), implying that leptin modulates B- and T-cell responses directly.[33]

Telomere length

Aging is defined as the accumulation of cellular damage that leads to a loss of cellular and organismal fitness in general. Several cell types, including immune cells and skeletal muscle cells, lose their ability to regenerate as they age.[34]

Hermann Müller discovered telomeres, which are evolutionary conserved DNA sequences, in 1938. Following that, Nobel Laureates Müller and McClintock discovered the protective role of telomeres. Moyzis et al. isolated the first human telomeres in 1988.[35]

Telomeres are repetitive DNA sequences ($5^{\square}$-TTAGGG$_n$-$3^{\square}$) at the ends of linear chromosomes. With each cell division, telomeres shorten by about 60 base pairs due to the inability of DNA polymerase to fully replicate the chromosome end, a phenomena referred to as the end-replication problem. In this sense, telomeres act as a mitotic clock that “records” the number of divisions a cell has undergone.

When telomeres shorten to a critical length, the chromosome ends are recognized as DNA-double-strand breaks by the DNA damage response system causing the cell to enter senescence.

Senescent cell proliferation, which may be seen in response to significantly shortened telomeres, is a fundamental aspect of tissue failure with age and is linked to age-related phenotypes (hair greying, Alzheimer's disease).[34]

The average LTL at birth is 11 kbp, but it drops to less than 4 kbp in the elderly. Gender, physical activity, smoking, BMI, alcohol use, hormone replacement treatment, dietary antioxidants, vitamins, trace elements, chronic inflammation, socioeconomic status, perceived stress levels, and paternal age have all been linked to LTL.[35]

Psychological stress is associated with indicators of accelerated cellular and organismal aging: oxidative stress, telomere length, and telomerase activity in PBMCs.[36]

Women's telomeres, for example, are longer as a result of increased oestrogen levels, which promote telomerase activity and have antioxidant properties. Similarly, oxidative stress and telomerase activity effect cellular ageing in the same way as psychological stress does.

Telomerase processivity (i.e., telomerase's capacity to add TTAGGG repeats to telomere ends in a sequential manner) is influenced by a number of variables, the most significant of which are the proteins that make up the shelterin telomere binding protein complex.

Shelterin is a positive and negative telomere length regulator, as well as a negative regulator of telomerase enzyme activity. Shelterin protein components bind double and single-stranded telomere DNA and govern telomerase access to telomeres, regulating telomere length. Shelterin also aids in the end-protection problem by blocking DNA damage detecting kinases from reaching telomere ends and disguising the ends of chromosomes from being detected as DNA double-strand breaks.[34]

The most significant methods by which these dietary nutrients delay telomere attrition are anti-oxidant action, DNA methylation, and DNA damage avoidance.

Serial measurements are not possible due to the intrusive sample collection. The measurement of LTL in blood leukocytes has been proposed as a surrogate marker to overcome these limitations. Telomeres shorten at a rate of 30–35 bp each year in blood leukocytes. Because leukocytes are found in the midst of all tissue types, it has been suggested that LTL might be a good proxy marker for telomere shortening across the body.[35]

Many studies have also reported that shortened telomeres in leukocytes increase the prevalence and risk of disease due to aging. Short telomeres are involved in disease pathogenesis because senescent cells increase the secretion of proinflammatory cytokines and extra-cellular matrix-degrading enzymes, which promotes disease progression. Thus, telomere attrition may occur with risk factors and conditions that cause disease, and shortened telomeres may be responsible for promoting diseases caused by aging and increasing premature mortality.[21]

In a cross-sectional meta-analysis of 87 observational studies which showed the association of BMI and telomere length across the lifespan. It showed that higher BMI are correlated with shorter telomere length, particularly in younger subjects and it warranted for further studies. The researchers have also inferred that tackling the obesity epidemic might be a starting point to delay telomere shortening and the onset of age-related diseases, thereby contributing to slower biological aging of the population.[37]

A Study observed that shorter TL may be a risk factor for increased adiposity. They add that whether telomere shortening is a cause or consequence of increased adiposity could

not be determined based on their data alone, although it may be possible that Telomere length shortening is a consequence of increased adiposity due to elevated levels of oxidative stress and other factors. The study also suggests their relationship may be more complicated and the possible biological mechanism for these associations deserves further investigations.[38]

Obese girls and boys had considerably shorter leukocyte telomeres than their non obese counterparts, highlighting a possible harmful effect of early onset obesity on future health. Telomere length was inversely associated with age and height. In either the cases or controls, or in the group as a whole, the mean LTL of girls and boys was not substantially different.[39]

Telomere length in vivo measures cellular turnover and exposure to oxidative and inflammatory stress. A cross sectional study showed the difference in telomere length between being lean and being obese corresponds to 8·8 years of ageing. The study also showed that Telomere length was inversely correlated with the serum concentration of leptin a marker and regulator of body fat that itself may have some pro-inflammatory properties known to increase oxidative stress.[40]

A relationship between certain alleles at the ApoB, LPL, and Leptin loci with hypertension and obesity in the Indian population is observed. When compared to other populations throughout the world, the leptin locus of the Indian population showed considerable diversity, with a large number of alleles (15 alleles) in the samples. Because telomere length regulation is important for human cell maintenance and shorter telomeres can cause a variety of problems, including impaired cell division, more research into the mechanism of telomere length attrition in diseases like hypertension, obesity, and diabetes will help us better understand its biological role.[41]

A research is performed to understand the association between telomere length and indicators of obesity, insulin resistance, and inflammation. Obese males telomere length was considerably shorter than their thin counterparts (p=0.049), but not in girls. Insulin resistance, adipocytokines, and inflammatory indicators were not linked to it. Waist circumference explained 24 percent of the variance in telomere length in females (p=0.041), whereas SBP explained 84 percent of the variance in boys (p=0.01). Boys childhood obesity is linked to shorter leucocyte telomere length, but girls telomere length is not affected. The relationship between leucocyte telomere length, blood pressure, and waist size in children raises clinical concerns regarding these measures role in premature ageing.[42]

In a cross-sectional study[43] to evaluate the relationship of anthropometric measure and visceral fat and the leptin, adiponectin with telomere length. 54.9 percent of the participants were female, 58 percent were non-Hispanic white (NHW), and 42 percent were non-Hispanic Black (NHB). 76 percent of the people in the study were overweight or obese. Linear regressions showed no association between the anthropometric measures (BMI (kg/m^2), visceral fat (cm^2), adiponectin ($\mu g ml^1$), leptin ($ng ml^1$) or adiponectin to leptin ratio ($\mu g ng^1$)) assessed in a continuous manner and telomere length assay ratio, either for the whole sample or when stratified by race or by gender. In a population of NHB and NHW men and women, there are no linear relationships between telomere length and numerous indicators of obesity. More research is needed to determine the factors that impact telomere length in various populations.

Obesity and telomere length have a negative connection, according to a research[44]. The papers that were chosen for analysis revealed a modest to moderate association between obesity and telomere length, with significant variability. As a result, the causal

association between obesity and telomere shortening is still unknown, and more controlled longitudinal studies are needed to study it.

In a meta-analysis[45] done to assess the association between BMI and leukocyte telomere length a negative relationship between BMI and telomere length is observed. The pooled estimates for correlation and regression coefficients in cross-sectional studies were 0.057 (95 percent confidence interval [CI]: 0.102 to 0.012) and 0.008 kBP kg/m^2 (95 percent CI: 0.016 to 0.000), respectively. The two longitudinal studies were small (70 and 311 subjects, respectively), covered different age ranges, and produced inconclusive results. There was no indication of a difference in gender. Despite considerable study variance and limited data from longitudinal studies, the findings of this meta-analysis suggest that BMI and LTL in adults have a physiologically plausible negative association. The relationships, however, must be elucidated, particularly through large longitudinal studies that rigorously account for potential confounding variables in age and gender-specific analyses.

A study[46] concluded that telomere length in IHD patients with type 2 DM was significantly low compared with IHD patients without type 2 DM with the influence of age on the telomere length being statistically significant. The diabetes fraction had significantly higher RBS, serum creatinine (p 0.013), and serum urea (p 0.04) than the nondiabetic subset. No significant relationship was observed between age and the telomere length ($p = 0.813$); however, the mean telomere length was significantly high among the patients without type 2 DM than those with type 2 DM ($p = 0.005$). The logistic regression analysis showed that the telomere shortening ($p = 0.00019$) and RBS ($p < 0.0001$) were the significant risk factors for type 2 DM in patients with IHD. They

also hypothesised that in individuals with IHD, shorter telomeres accelerate the establishment of type 2 diabetes.

A study[47] showed the association of short telomeres with insulin resistance (as measured by HOMA-IR) and cholesterol to HDL ratio suggests that telomere shortening could probably be used as an additional marker of atherosclerosis. In support of this, coronary artery disease patients have been shown to exhibit telomere shortening.

MATERIAL & METHOD

The present study was conducted in the Department of General Medicine, KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

Study design: Hospital based Cross sectional study

Period of study: 1 ST January 2020 to 31 ST December 2020

Source of data: Patients admitted in the wards or attending OPD at KLE'S Dr.Prabhakar Kore Hospital, Belagavi fulfilling the inclusion and exclusion criteria.

Inclusion criteria

1. Above 18 years of age

2. Non Diabetic adult Indian population

Exclusion criteria:

1 Patients with edema

2 H/O: Renal Failure

3 H/O: Cardiac failure

4 H/O: Liver failure

5 H/O Suggestive of Secondary cause of Obesity

6 H/O Cigarette Smoking

Sample size:

The minimum sample size formula based on mean and standard deviation is

$$n = \frac{(z_\alpha + z_\beta)^2(s_1^2 + s_2^2)}{(\bar{X}_1 - \bar{X}_2)^2}$$

where z_α is linked with the level of significance and $z_\beta$is linked with the power of the test. For 5% level of the significance z_α =1.96 and z_β =0.84 for 80% power of the test.

Ref:

$\bar{x}_1$ is the mean of the first group (1.22) and $\bar{x}_2$ is the mean of the second group (1.20).

s_1 is the standard deviation of the first group (0.014) and s_2 is the standard deviation of the second group (0.023).

With the above values the sample size obtained is 14.

There will be three groups with minimum 14 cases in each group.

To make the study more confirmative, the sample size will be raised to 30 in each group.

There will be three groups of normal, overweight and obese individuals with a sample size of 30 in each group.

Ethical Clearance

Prior to the commencement, the study was cleared by the institutional Ethics committee, Jawaharlal Nehru Medical college, Belagavi.

METHODOLOGY

After a written informed consent, a thorough history was taken from the patients. Following physical examination, height and weight was measured twice by standard methods. Participants were weighed to the nearest 0.1 kg on a single calibrated electronic scale. Height was measured to the nearest 0.1 cm on a single calibrated wall-mounted Harpenden stadiometer. BMI of the participants was calculated as weight (in kg) divided

by height (inmeters^2). Waist circumference (WC) measurements were obtained with a plastic tape measured at the level of the iliac crest and umbilicus; the maximum hip circumference (HC) will be measured. HC assessment was also performed using a measuring tape set down horizontally at the place of utmost boundary over the buttocks. BMI, WHR, Neck circumference of each patient was recorded.

Neck circumference: Measured in the midway of the neck, between mid-cervical spine and mid-anterior neck, to within 1 mm, with a plastic tape. In men with a laryngeal prominence, it was measured just below the prominence. All measurements were recorded at the end of expiration with the subject standing.

According to the NHLBI, BMI is calculated as weight in kilograms divided by the square of the height in meters (kg/m^2). BMI is categorized into four groups according to the Asian-Pacific guidelines. The cut-off points are: underweight (<18.5 kg/m^2), normal weight (18.5–22.9 kg/m^2), overweight (23–24.9 kg/m^2), and obese (≥25 kg/m^2). A venous sample will be collected from patients and centrifuged immediately. The Serum collected from these samples are numbered accordingly and transferred in an ice box to the lab for the assessment of Leptin and Telomere length. Telomere length was assessed in leukocytes through qPCR technique and leptin is quantified by ELISA technique.

TELOMERE MEASUREMENT

DNA isolation from Blood

200 microliter blood was taken into microfuge tube and as per instructions (Qiagen, DNeasy Blood Kit) was processed for DNA isolation with a bit of modifications followed by addition of about 20 microliter of proteinase (600 mAU/ml). 180 microliter of buffer AL was added and kept it in water bath for 15 min at 55º C. 200µl Ethanol was added and was mixed by inversion process and incubated for 3 min at room temperature.

Pipetted the mixture into the spin column and centrifuged at >6000 x g for 1 min. Discarded the flow through and 500µl of Buffer AW1 (Wash Buffer) was pipetted into the column. Again centrifuged for 1 min at 6000 x g and discarded the flow through. About 500µl of Buffer AW2 (wash buffer) was pipetted into the column and centrifuged at 6000 x g for 1 min. Discarded the flow through then the spin column was transferred to a clean microfuge tube. Now, incubated for 1 min at room temperature and centrifuged for 2 min at 6000 x g. The DNA was quantified by using a Nanodrop Spectrometer and stored at -20 degree Celsius.[43]

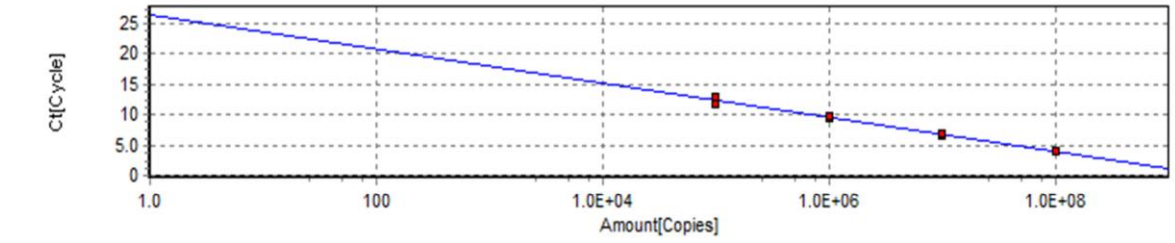
Telomere length Real time PCR procedure:

Standard Curve Generation

The telomere length was calculated using qPCR, as published by O'Callaghan et al. in 2011. The absolute telomere length was calculated using a standard curve. Dilution of recognized quantities of a synthesised 84 mer oligonucleotide containing exclusively TTAGGG repeats was used to create a standard curve (table 1). Using Avogadro's number, the amount of telomere sequence in TEL STD was calculated to be 1X108 kb of telomere sequence in TEL STD. A single copy gene (SCG, 36B4) was utilised as a control for amplification and to determine genome copies per sample for each sample. 1X109 diploid genome copies were computed as the genome copy per response. TEL STD was serially diluted (from 1.0 108 to 1.0 104kb telomere sequences). Simultaneously, a serial dilution of SCG STD was done (1x109 to 1x105dilution). Telomeres were amplified by qPCR for each sample, including TEL STD, using telomere specific primers (TeloF and TeloR) to get kb/reaction of telomere for each sample. To determine the diploid genome copy number for each sample, single copy

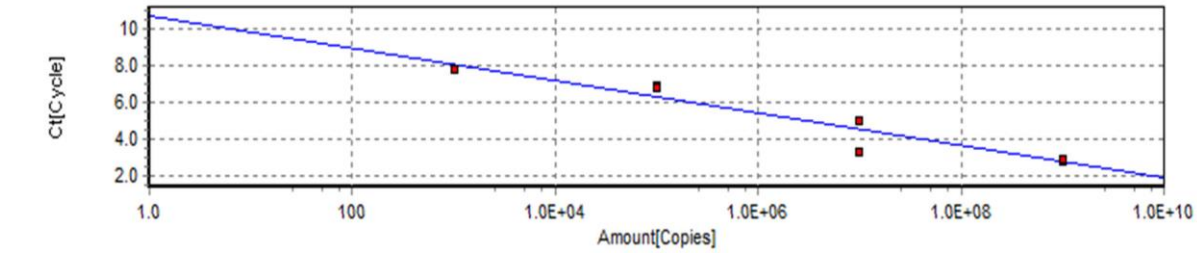
gene (36B4) was amplified by qPCR using single copy gene specific primers (36B4F and 36B4R).

The cycle number at which a fluorescence signal is generated is known as the CT (cycle threshold). CT values were plotted against the quantity of telomere sequence in kb per reaction to create a telomere standard curve (Figure 1A). CT values were plotted against 36B4 genome copies to create the SCG standard curve (Figure 1B). Realplex software was used to create the standard curves and graphs (Eppendorf, Hamburg, Germany). Each sample's telomere kb per response and diploid copy number were exported into an excel spreadsheet. The value of telomere kb per reaction was divided by the diploid genome size.[44]



Slope: -2.790
Y-Intercept: 26.29
Efficiency: 1.28
R^2: 0.991

Figure 1A: Telomere standard curve



Slope: -0.881
Y-Intercept: 10.74
Efficiency: -
R^2: 0.923

Figure 1B: SCG standard curve

Table 1: Oligomers used for aTL assay in human and rodent

	Oligomer Name	Species	Oligomer sequence (5'-3')	Amplicon size
Standards	Telomere standard	Human/rodent	(TTAGGG)14	84 bp
	36B4 standard	Human	CAGCAAGTGGGAAGGTGTAATCCGTC TCCACAGACAAGGCCAGGACTCGTTT GTACCCGTTGATGATAGAATGGG	
PCR Primers	teloF	Human/rodent	CGGTTTGTTTGGGTTTGGGTTTGGGTT TGGG TTTGGGTT	>76 bp
	teloR	Human/rodent	GGCTTGCCTTACCCTTACCCTTACCC TTACCCTTACCCT	>76 bp
	36B4F	Human	CAGCAAGTGGGAAGGTGTAATCC	75 bp
	36B4R	Human	CCCATTCTATCATCAACGGGTACAA	75 bp
	b-globinF	Human	GCTTCTGACACAACTGTGTTCACTAGC	
	b-globinR	Human	CACCAACTTCATCCACGTTCACC	

Master Mix preparation:

Table 2 shows the master mix solution formulation in detail. No template control (NTC), standards, and enough preparation for samples to run in triplicate (which should be run on every plate). Mix well, centrifuge briefly, then pipette the needed amount of master mix (16 ul in our case) into each well of the PCR plate. Because the power SYBR Green contains a lot of detergent, pipette the master mix carefully to evade forming undesired bubbles. Pipette the necessary amount of DNA into each sample well. Pipetted the requisite volumes of standards, positive control, and NTC water into their

corresponding wells, sealed the plate with optical clear film, centrifuged briefly, and started the procedure. Cycling conditions (for both telomere and 36B4 amplicons) were: 10 min at 95°C, followed by 40cycles of 95°C for 15 sec, 60°C for 1 min, followed by a dissociation (or melt) curve. Once PCR has completed - remove plate and discarde.[44]

Table 2: Representation of master mix preparation

Reagents	**Volumes for one Sample (µl)**	**Final Concentration**
Power SYBR Green master mix (2x)	10	1x
Primer (telomere-fwd(2µM)	1	0.1 µM
Primer (telomere-rev(2µM)	1	0.1 µM
H_2O	4	
DNA (5 ng/µl DNA)	4	20 ng total

Leptin Sample collection and preparation:

LEPTIN MEASUREMENT

Serum or plasma can be used in this assay. Hemolytic, icteric or lipemic specimens are not used.

Specimen Collection (Serum): Blood is collected by venipuncture and allowed to clot, and serum is separated by centrifugation at room temperature. Samples are centrifuged only after clotting. Anticoagulant treatment patients may require a longer clotting time. Plasma: Whole blood should be taken and centrifuged immediately after

collection into centrifuge tubes containing anticoagulant (e.g., Sarstedt Monovette with the appropriate plasma preparation).

Specimen Storage and Preparation:

Prior to assaying, specimens should be sealed and held at 2 ℃ - 8 ℃ for up to 24 hours. Specimens that have been frozen for a long period should only be frozen once at -20 °C before being assayed. Prior to testing, thawed samples should be inverted many times.

Specimen Dilution in initial assay: If a specimen has more than the highest standard, it can be diluted with Standard 0 and re-tested. A dilution factor must be taken into consideration when calculating the concentrations.

Example: a) dilution 1:10: 10 µL sample + 90 µL Standard 0 (mix thoroughly) b) dilution 1:100: 10 µL dilution a) 1:10 + 90 µL Standard 0 (mix thoroughly).

ASSAY PROCEDURE

Before used, all reagents and specimens must be brought to room temperature. All reagents must be well mixed to avoid foaming. All stages should be done without interruption after the exam has begun. To eliminate cross contamination, each standard, control, and sample receives a new disposable plastic pipette tip. The incubation period and temperature have an effect on the absorbance. All reagents should be ready, caps should be removed, and all essential wells should be secured in the holder before performing the test. This will ensure that each pipetting phase takes the same amount of time without interruption. The enzymatic reaction is directly related to time and temperature in general.

Test Procedure, Each run must include a standard curve.

1. Secure the desired number of Microtiter wells in the frame holder.

2. Dispense 15 µL of each Standard, Control and samples with new disposable tips into appropriate wells.

3. Dispense 100 µL Assay Buffer into each well. Thoroughly mix for 10 seconds. It is important to have a complete mixing in this step.

4. Incubate for 120 minutes at room temperature.

5. Shake the contents of the wells vigorously. Rinse each well three times with 300 mL of diluted Wash Solution. To eliminate any remaining drops, strike the wells hard on absorbent paper.

6. Fill each well with 100 mL Antiserum.

7. Allow 30 minutes to incubate at room temperature.

8. Shake the contents of the wells vigorously. Rinse each well three times with 300 mL of diluted Wash Solution. To eliminate any remaining drops, strike the wells hard on absorbent paper.

9. Fill each well with 100 mL Enzyme Complex.

10. Allow 30 minutes to incubate at room temperature.

11. Shake the contents of the wells vigorously. Rinse each well three times with 300 mL of diluted Wash Solution. To eliminate any remaining drops, strike the wells hard on absorbent paper.

12. Fill each well with 100 mL of Substrate Solution.

13. Allow for a 15-minute incubation period at room temperature.

14. Add 50 mL of Stop Solution to each well to stop the enzymatic process.

15. Using a microtiter plate reader, determine the absorbance (OD) of each well at 450 nm.

Calculation of Results

1. The average absorbance values for each set of standards, controls and patient samples.

2. Using linear graph paper, a standard curve is constructed by plotting the mean absorbance obtained from each standard against its concentration with absorbance value on the vertical (Y) axis and concentration on the horizontal (X) axis.

3. Using the mean absorbance value for each sample the corresponding concentration from the standard curve is determined.

4. Automated method: The results in the Instructions for Use have been calculated automatically using a 4-Parameter curve fit.

5. The concentration of the samples can be read directly from this standard curve. Samples with concentrations higher than that of the highest standard have to be further diluted or reported as > 100 ng/ml.

STATISTICAL ANALYSIS

The study is focused on comparison of three groups. For the continuous quantitative variables mean and standard deviation was calculated. The inter group continuous variables was compared using suitable tools of statistics like one way ANOVA, pair-wise comparisons using unpaired student's t test. The categorical data was expressed in terms of rates, ratios and percentages. The association between the outcome, clinical and demographic characteristics was tested using Chi-square test or Fisher's exact test. Nonparametric tests were used for discrete variables. Discrete variables were represented by median. Suitable graphs were used to depict the comparison. For all the tests the value of p less than 5% (0.05) was considered significant and analysed using SPSS v21 operating on windows 10.

RESULTS

Table 1: Age and BMI wise distribution

Variable	No. of subjects n	Percentage %
Age groups		
25-39yrs	30	33.33
40-54yrs	30	33.33
>=55yrs	30	33.33
Mean	48.84	
SD	16.84	
Obesity		
Normal	30	33.33
Overweight	30	33.33
Obese	30	33.33
Mean	24.20	
SD	3.32	
Total	90	100.00

The study population consisted of 90 patients who were admitted in the wards or attended out-patient department of KLE'S Dr. Prabhakar Kore Hospital and MRC. They were further stratified into three groups according to their age namely, 25-39 years, 40-54 years and≥55 years. Out of the 90 subjects, 30 (33.3%) of them belonged to 25-39 years' age group, 30 (33.3%) belonged to 40-54 years' age group and 30 (33.3%) belonged to ≥55 years' age group. The mean age of the study subjects was 48.84±16.84 years.

With regard to BMI the study participants were categorized in to 3 groups namely normal, overweight and obese. Out of the 90 subjects, 30 (33.3%) of them belonged to normal BMI group, 30 (33.3%) belonged to overweight group and 30 (33.3%) belonged to obese group. Mean BMI of the study subjects was 24.20± 3.32kg/m^2

Table 2: Normality of different parameters by Kolmogorov Smirnov test

Parameters	Z-value	P-value
Weight (in kgs)	1.0010	0.2690
BMI	0.8090	0.5300
Waist/Hip ratio	1.2610	0.0830
Neck circumference	1.1040	0.1750
HbA1c	0.5550	0.9180
Telomere Length	2.5090	0.0001*
Leptin	2.2260	0.0001*

*p<0.05

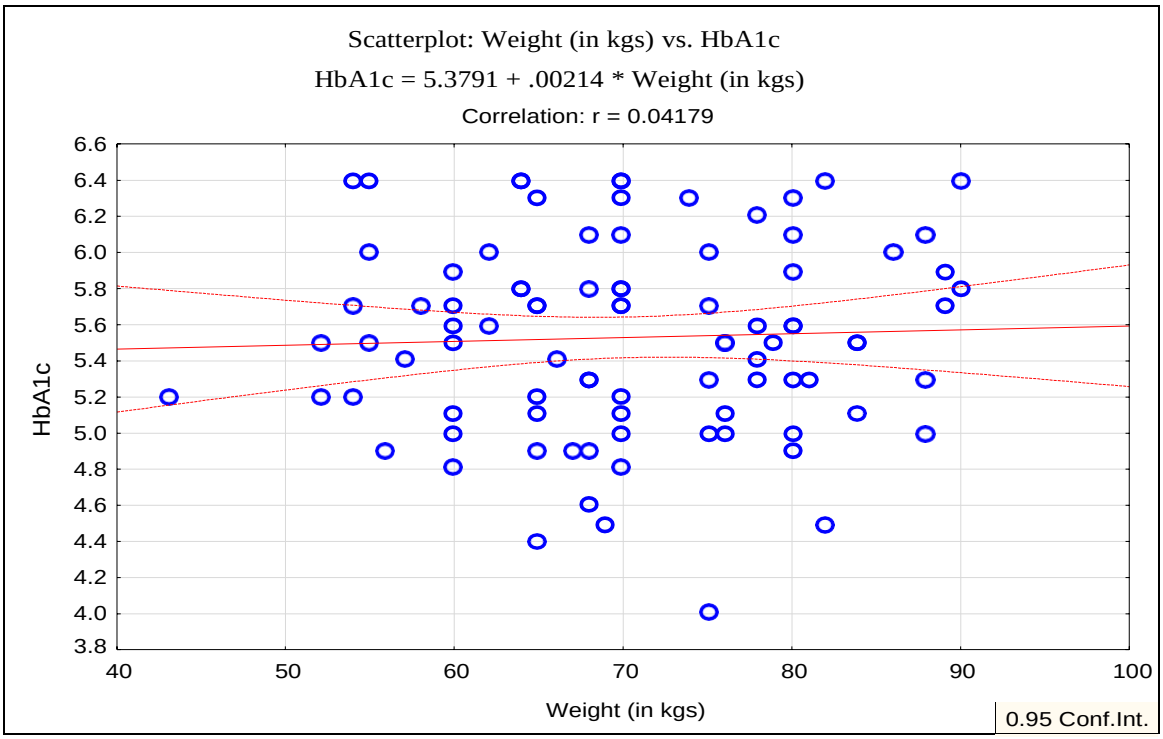
Note that, the scores of Telomere Length and Leptin are not following normal distribution. Therefore, the non-parametric tests were applied. Otherwise parametric tests were applied

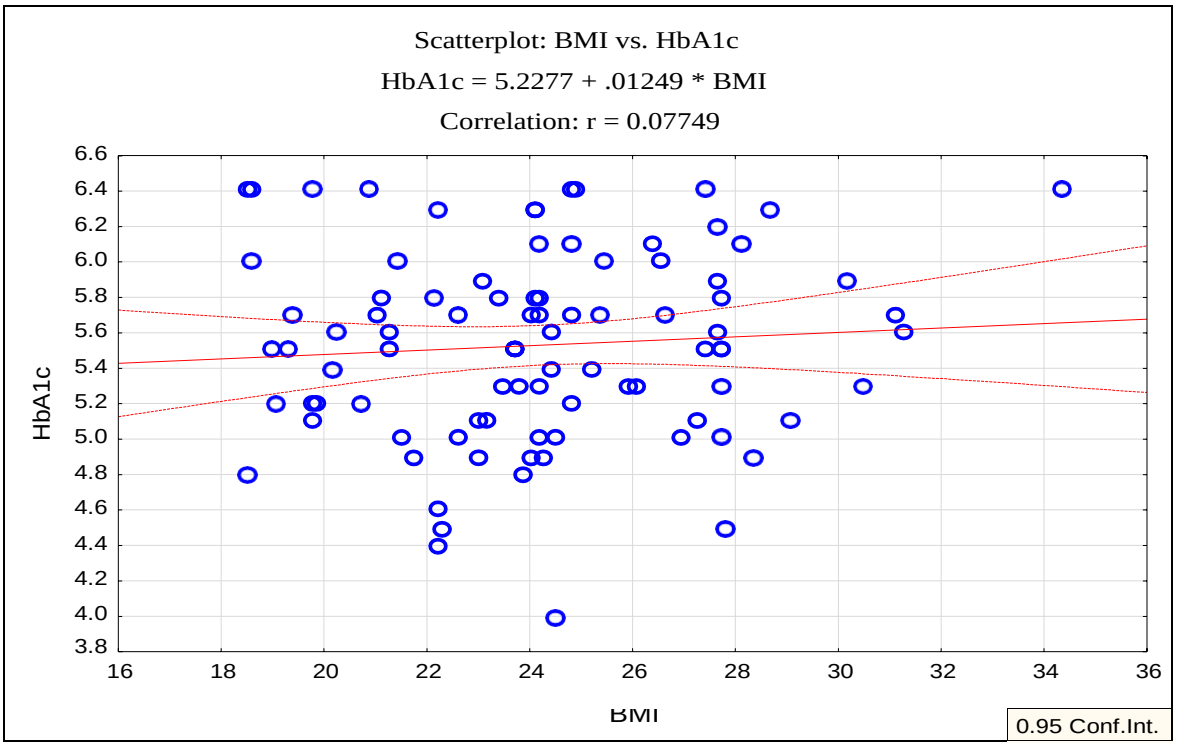
Table 3: Correlation between weight, BMI, Waist/Hip ratio and neck circumference with HbA1c by Karl Pearson's correlation coefficient method

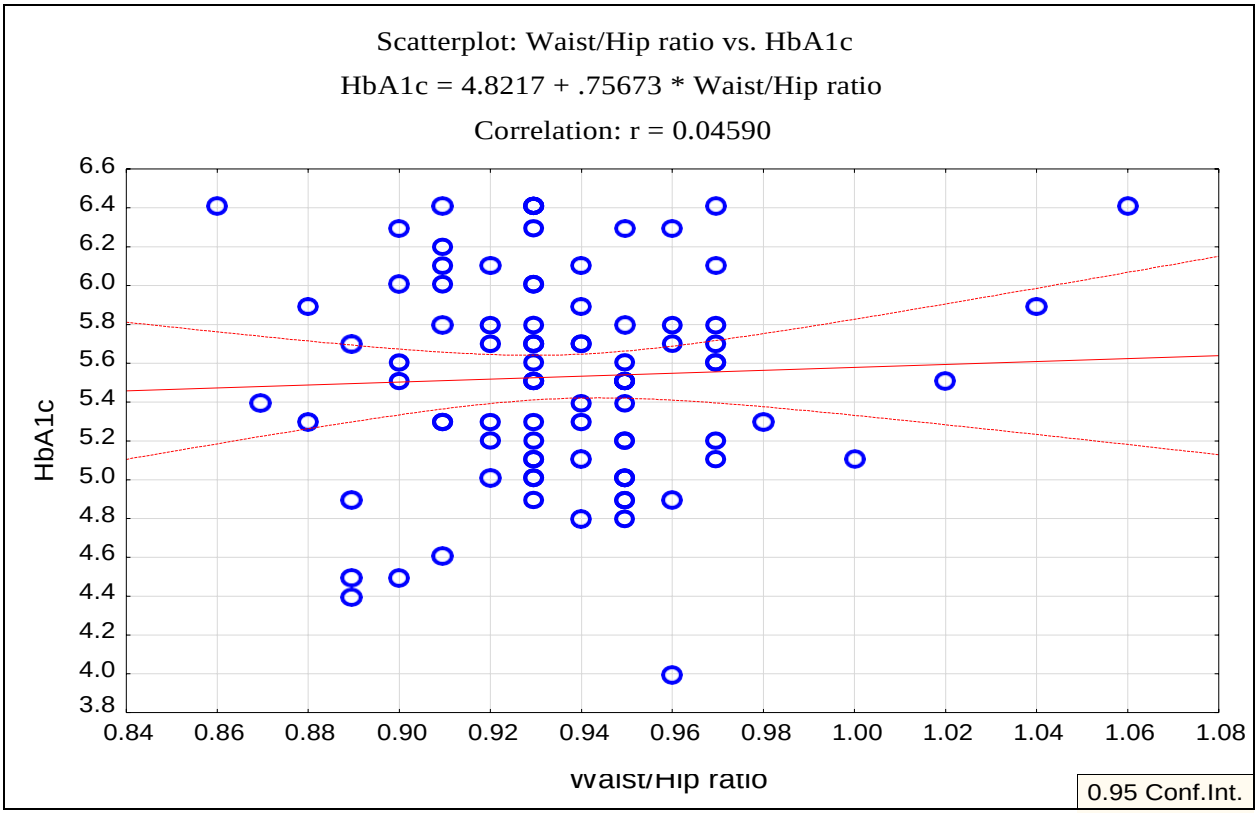
Variables	Pearson's r-value	p-value
Weight (in kgs)	0.0418	0.6958
BMI	0.0775	0.4679
Waist/Hip ratio	0.0459	0.6675
Neck circumference	-0.0897	0.4003

HbA1c was found to have a direct correlation with weight (r=0.0418), BMI (r=0.0775), Waist/Hip ratio (r=0.0459) and negligible negative correlation with neck circumference (r=-0.0897). However, none of these correlations were found to be statistically significant (P>0.05).

Graph 3,4,5.6: Scatter diagrams showing the correlation between weight, BMI, Waist /Hip ratio and neck circumference with HbA1c




Scatterplot: BMI vs. HbA1c
HbA1c = 5.2277 + .01249 * BMI
Correlation: r = 0.07749
HbA1c
BMI
0.95 Conf.Int.


Scatterplot: Waist/Hip ratio vs. HbA1c
HbA1c = 4.8217 + .75673 * Waist/Hip ratio
Correlation: r = 0.04590
HbA1c
Waist/Hip ratio
0.95 Conf.Int.

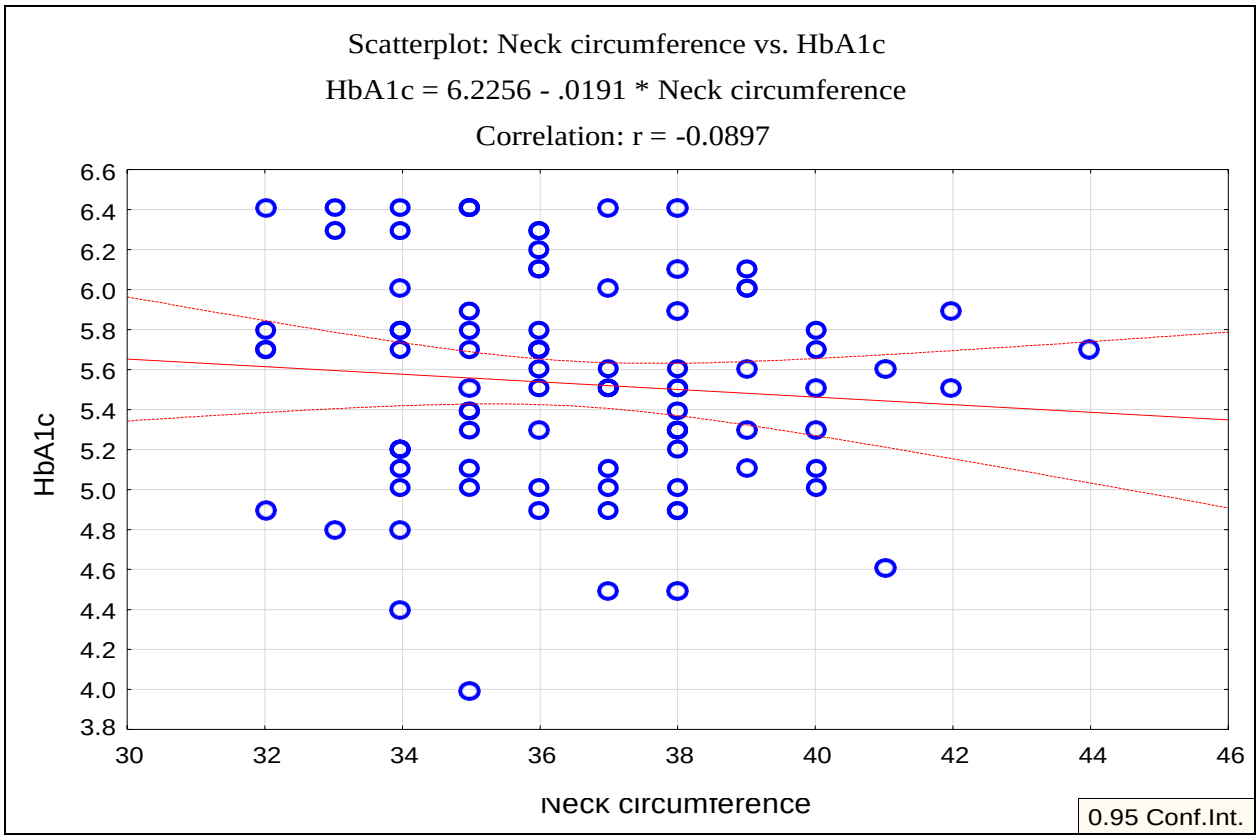


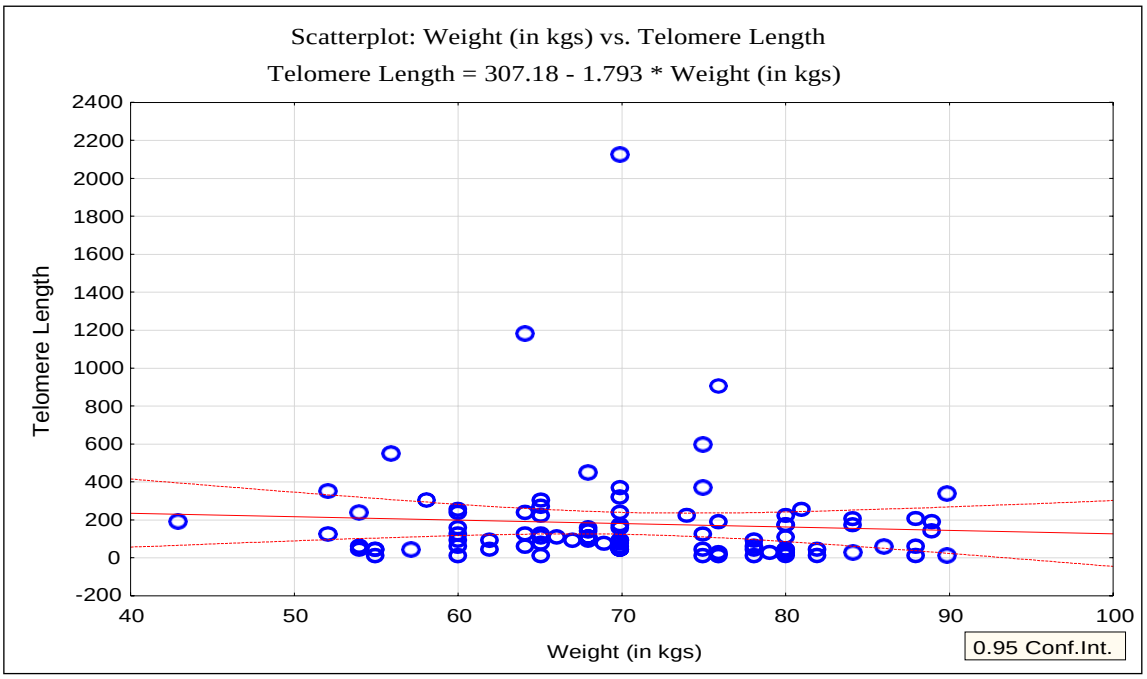
Table 4: Correlation between weight, BMI, Waist /Hip ratio and neck circumference with Telomere Length scores by Spearman's rank correlation coefficient method

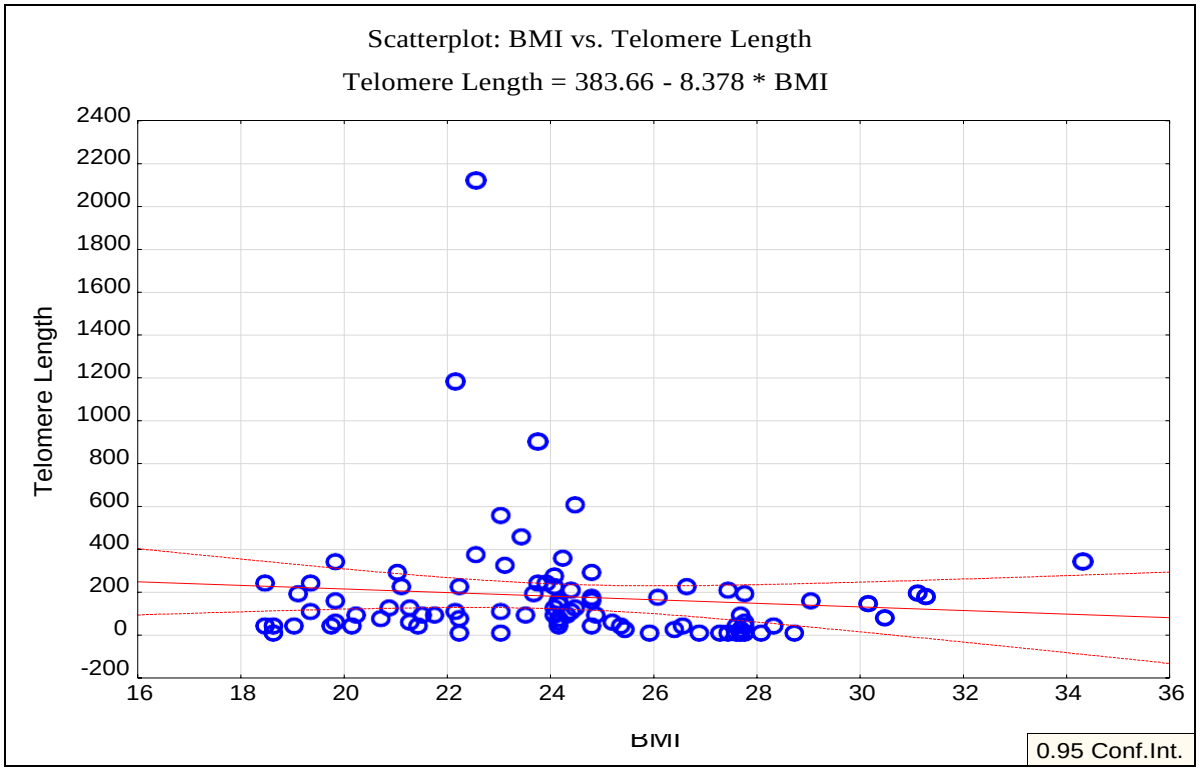
Variables	Spearman's r-value	p-value
Weight (in kgs)	-0.1584	0.1360
BMI	-0.2052	0.0470*
Waist/Hip ratio	0.2325	0.0275*
Neck circumference	-0.2266	0.0318*

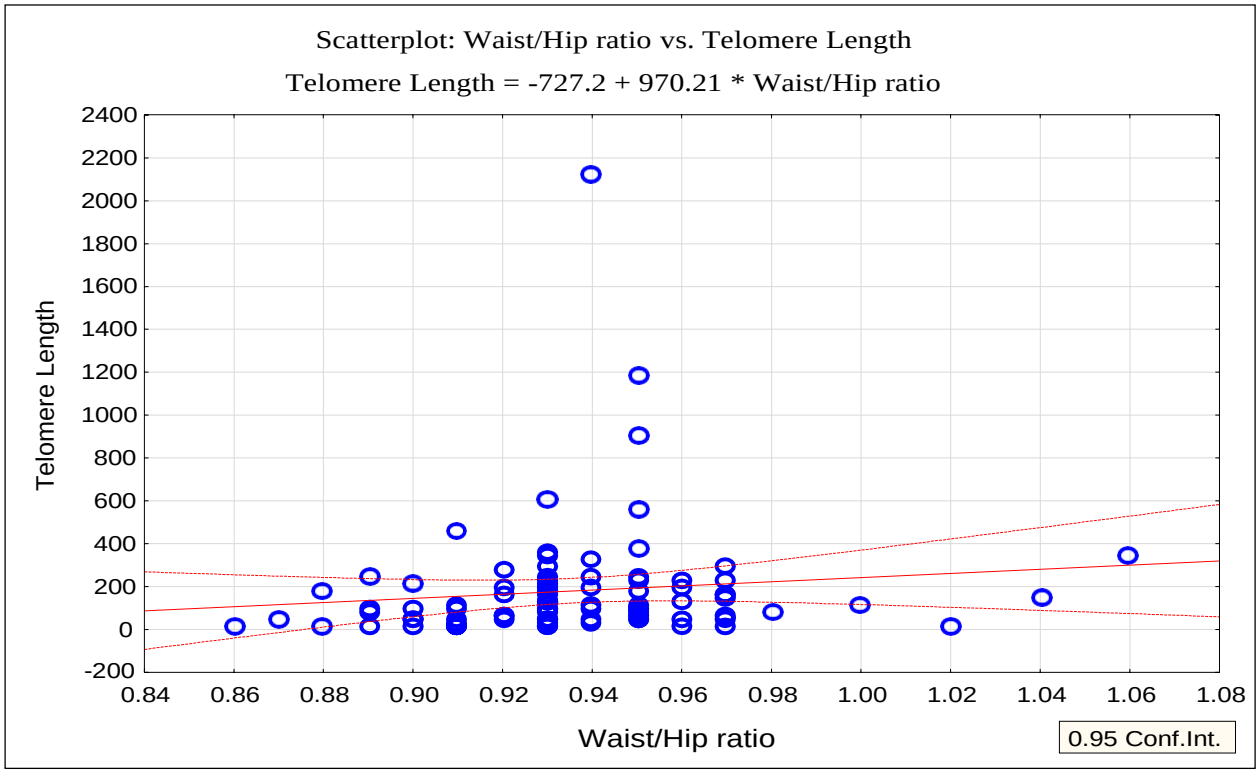
*p<0.05

Telomere length was found to have negative correlation with BMI (r=-0.2052) which is statistically significant and negative correlation with weight (r=-0.1584) which was not statistically significant. A statistically significant positive correlation was observed with waist/hip ratio (r=0.2325) (p=0.0275) and negative correlation with neck circumference (r=--0.2266) (p=0.0318).

Graph 7,8,9,10: Scatter diagrams showing the correlation between weight, BMI, Waist /Hip ratio and neck circumference with Telomere length scores






Scatterplot: Waist/Hip ratio vs. Telomere Length
Telomere Length = -727.2 + 970.21 * Waist/Hip ratio
Telomere Length
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
0.84
0.86
0.88
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
Waist/Hip ratio
0.95 Conf.Int.

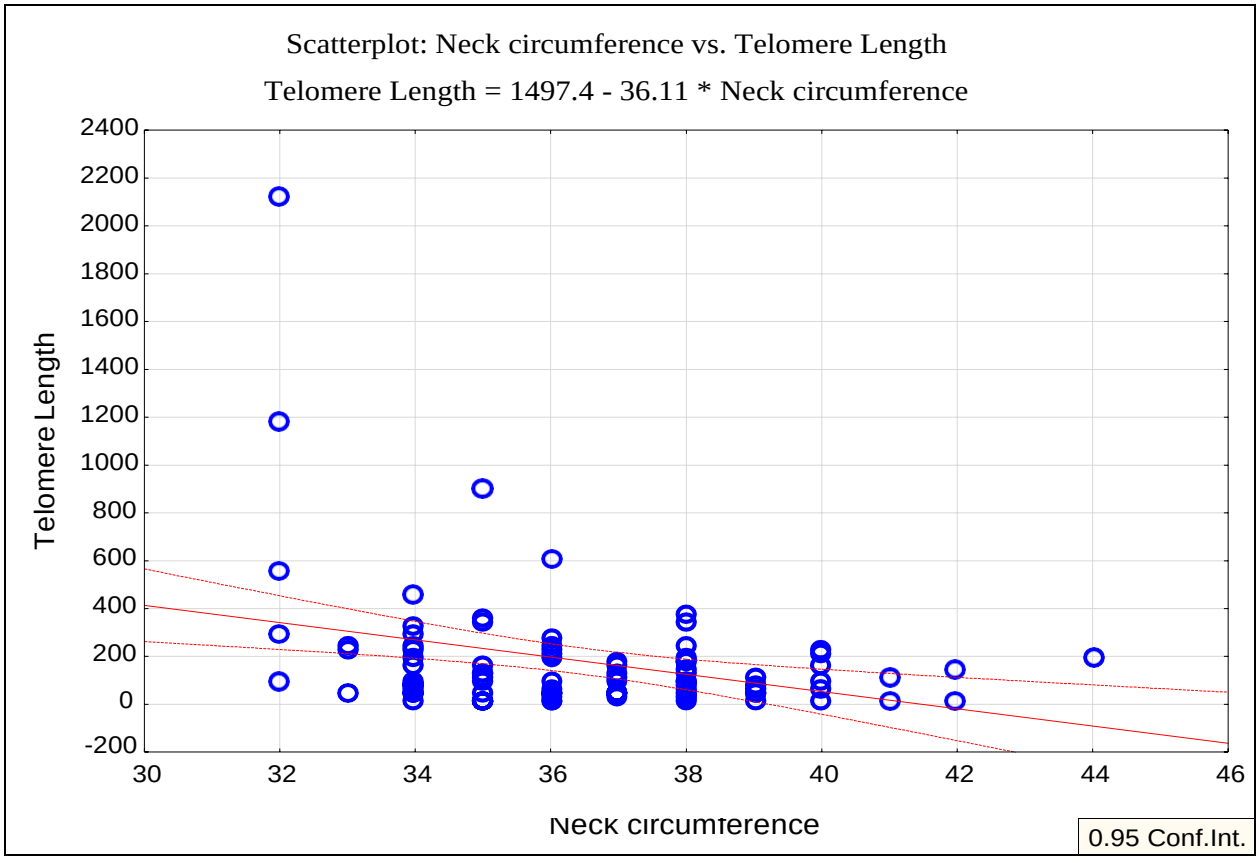
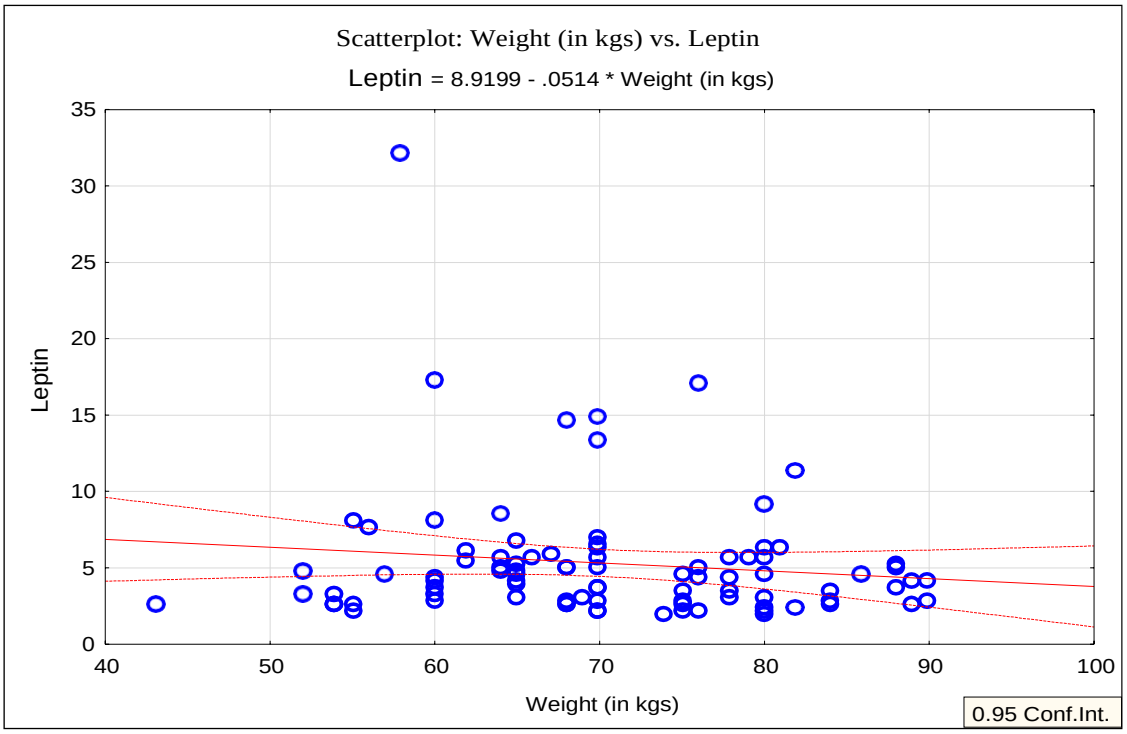

Scatterplot: Neck circumference vs. Telomere Length
Telomere Length = 1497.4 - 36.11 * Neck circumference
Telomere Length
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
30
32
34
36
38
40
42
44
46
Neck circumference
0.95 Conf.Int.

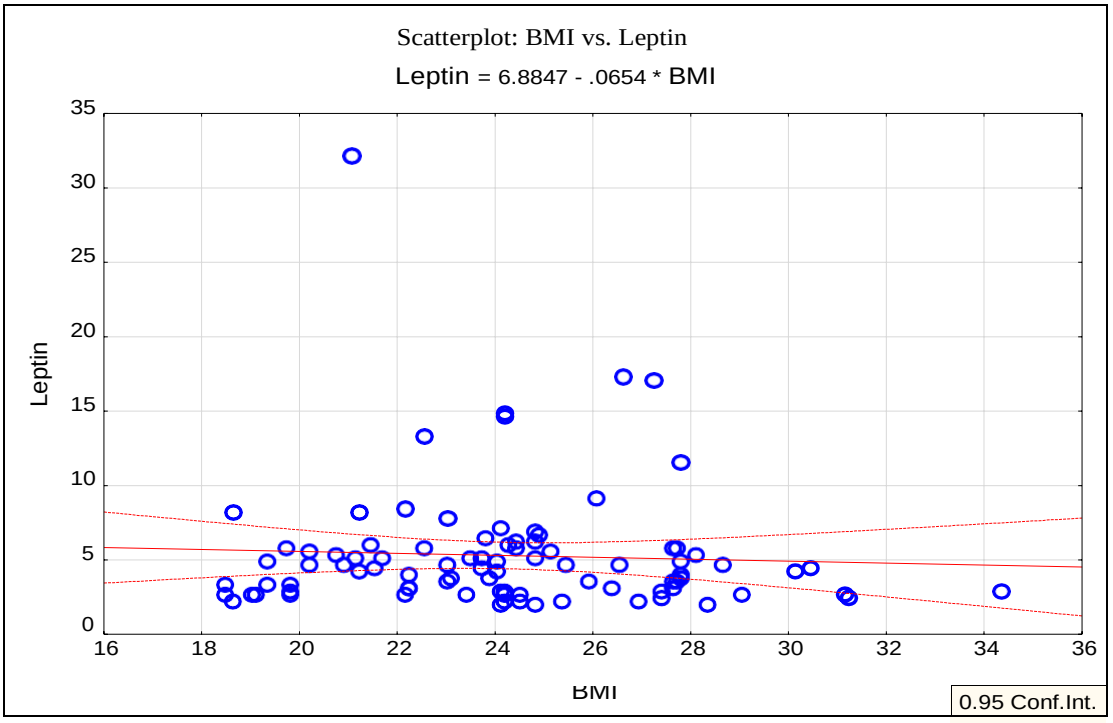
Table 5: Correlation between weight, BMI, Waist /Hip ratio and neck circumference with Leptin scores by Spearman's rank correlation coefficient method

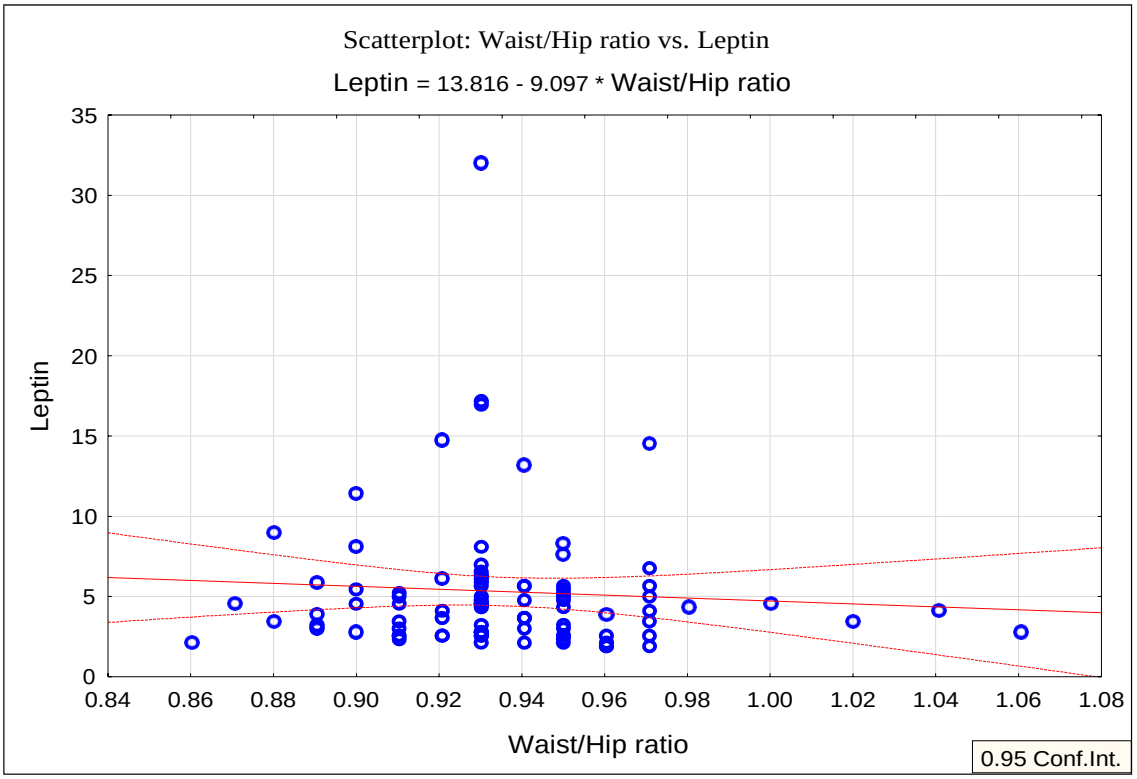
Variables	Spearman's r-value	p-value
Weight (in kgs)	-0.1034	0.3320
BMI	-0.0561	0.5996
Waist/Hip ratio	-0.1095	0.3044
Neck circumference	-0.0383	0.7201

Leptin scores were found to have inverse correlation with BMI (r=-0.0561), neck circumference (r=-0.0383); negative correlation with weight (-0.1034) andwaist/hip ratio (r=-0.1095). However, none of these correlations were found to be statistically significant (P>0.05).

Figure 11,12,13,14: Scatter diagrams showing the correlation between weight, BMI, Waist /Hip ratio and neck circumference with Leptin scores






Scatterplot: Waist/Hip ratio vs. Leptin
Leptin = 13.816 - 9.097 * Waist/Hip ratio
Leptin
Waist/Hip ratio
0.95 Conf.Int.

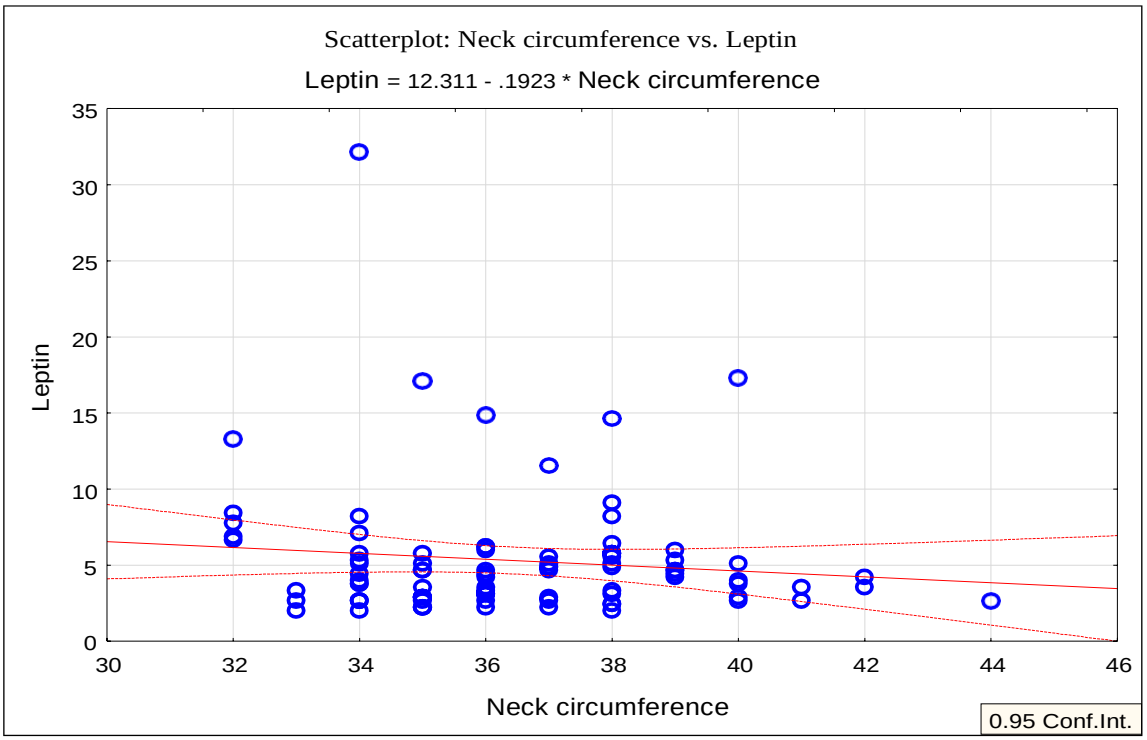

Scatterplot: Neck circumference vs. Leptin
Leptin = 12.311 - .1923 * Neck circumference
Leptin
Neck circumference
0.95 Conf.Int.

Table 6: Correlation between Telomere Length with Leptin scores by Spearman's rank correlation coefficient method

Variable	Spearman's r-value	p-value
Leptin	0.0924	0.3865

Telomere length was found to have positive correlation with Leptin scores but is not statistically significant.

Graph 15: Scatter diagrams showing the correlation between Telomere Length with Leptin scores

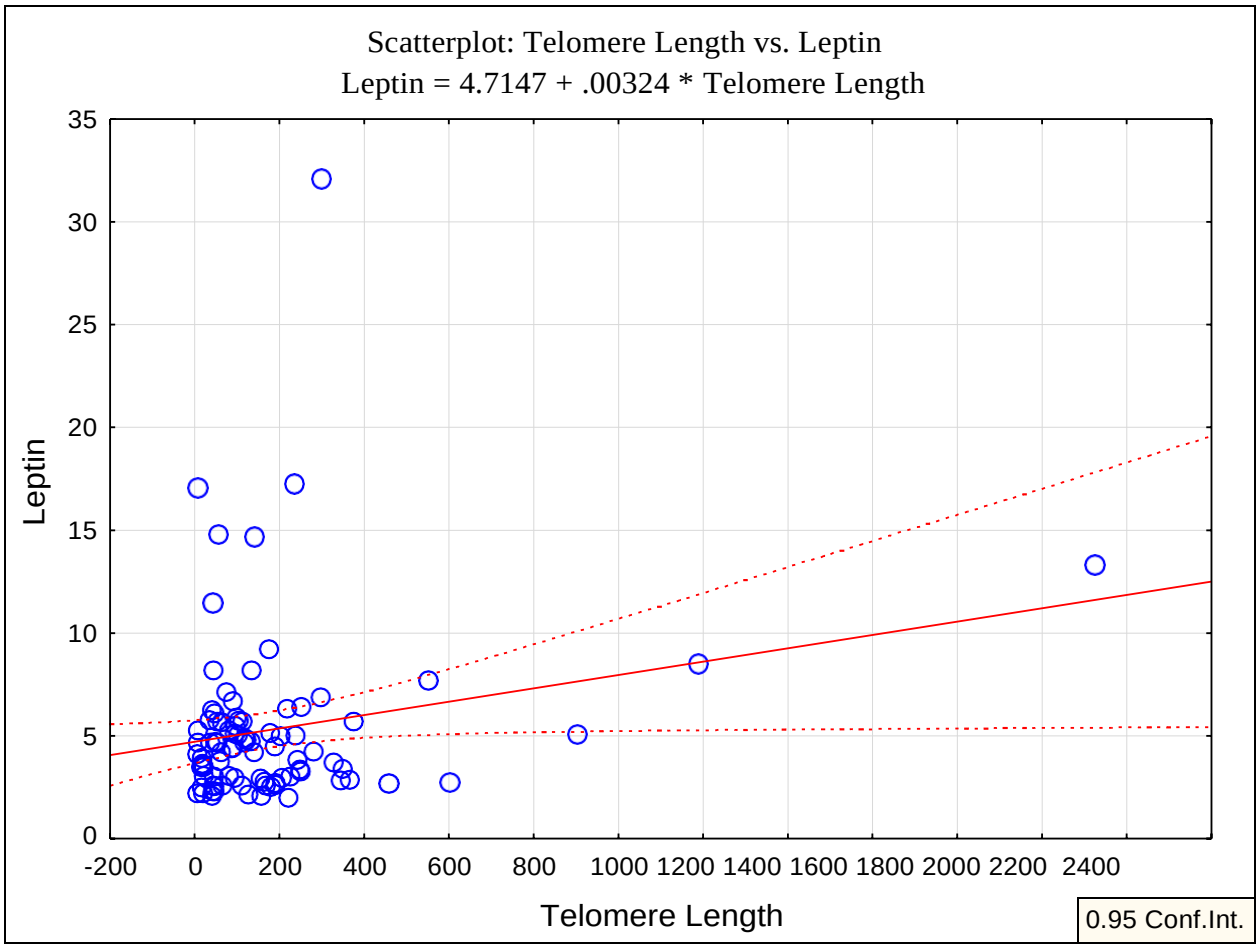


Table 7: Summary of Telomere Length in three age groups and three groups of BMI

Interactions	n	Mean	SD	P value
25-39yrs with normal	10	291.34	333.66	0.2099
25-39yrs with OW	10	312.47	260.11	
25-39yrs with obese	10	89.34	76.44	
40-54yrs with normal	10	77.11	56.30	
40-54yrs with OW	10	228.08	164.34	
40-54yrs with obese	10	103.47	82.26	
≥55yrs with normal	10	334.42	635.98	
≥55yrs with OW	10	123.29	82.76	
≥55yrs with obese	10	68.70	104.44	

The mean telomere lengths among subjects aged 25-39 years with normal BMI, overweight and obese were 291.34±333.66, 312.47±260.11, and 89.34±76.44 respectively. The mean telomere lengths among subjects aged 40-54 years with normal BMI, overweight and obese were 77.11±56.30, 228.08±164.34, and 103.47±82.26 respectively. The mean telomere lengths among subjects aged ≥55 years with normal BMI, overweight and obese were 334.42±635.98, 123.29±82.76, and 68.70±104.44 respectively.

Figure 16: Summary of mean telomere length in three age groups and three groups of BMI

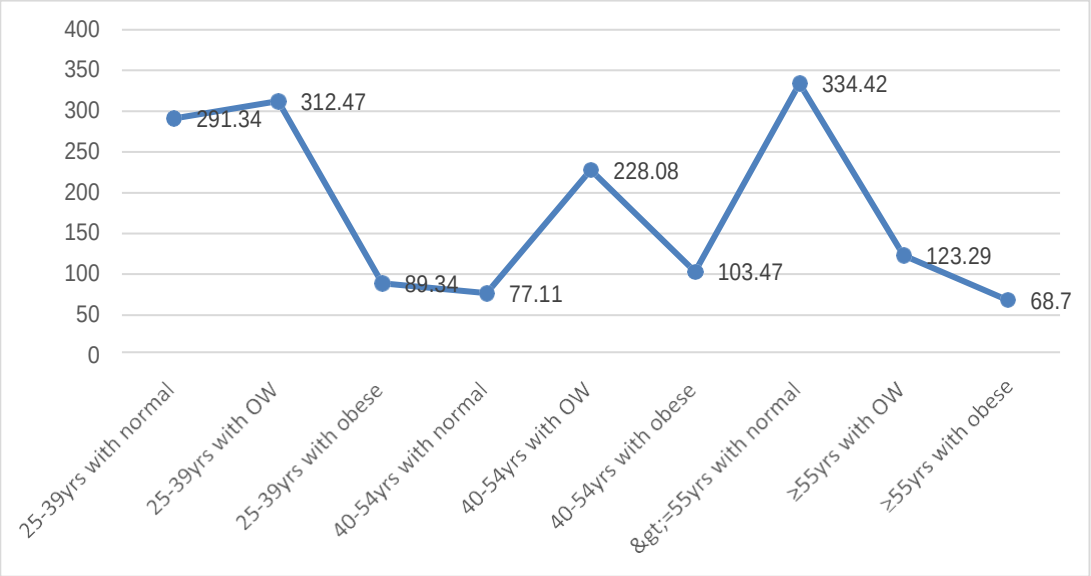


Table 8: Comparison of mean telomere length among subjects in different age groups

Age group	Mean±SD	p-value
25-39	231.05±260.43	0.3903
40-54	136.22±126.29	
≥55	175.47±380.28	

The mean telomere length was higher among subjects in 25-39 years' age group (231.05±260.43) followed by ≥55 years group (175.47±380.28), and 40-54 years age group (136.22±126.29).

Table 9: Comparison of mean telomere length among subjects in different BMI categories

BMI category	Mean±SD	p-value
Normal	234.29±417.32	0.0679
Overweight	221.28±194.16	
Obese	87.17±86.65	

The mean telomere length was higher among subjects in normal BMI group (234.29±417.32) followed by overweight group (221.28±194.16), and obese group (87.17±86.65).

Table 10: Pair wise comparisons of interactions of three age groups and three groups of BMI with Telomere Length by Tukeys multiple posthoc procedures

Interactions	25-39yrs with normal	25-39yrs with OW	25-39yrs with obese	40-54yrs with normal	40-54yrs with OW	40-54yrs with obese	>=55yrs with normal	>=55yrs with OW	>=55yrs with obese
Mean	291.34	312.47	89.34	77.11	228.08	103.47	334.42	123.29	68.70
SE	105.51	82.26	24.17	17.81	51.97	26.01	201.11	26.17	33.03
25-39yrs with normal	-								
25-39yrs with OW	p=1.0000	-							
25-39yrs with obese	p=0.7517	p=0.6391	-						
40-54yrs with normal	p=0.6880	p=0.5701	p=1.0000	-					
40-54yrs with OW	p=0.9998	p=0.9986	p=0.9625	p=0.9393	-				
40-54yrs with obese	p=0.8178	p=0.7158	p=1.0000	p=1.0000	p=0.9805	-			
>=55yrs with normal	p=1.0000	p=1.0000	p=0.5151	p=0.4473	p=0.9930	p=0.5952	-		
>=55yrs with OW	p=0.8929	p=0.8120	p=1.0000	p=1.0000	p=0.9937	p=1.0000	p=0.7046	-	
>=55yrs with obese	p=0.6419	p=0.5224	p=1.0000	p=1.0000	p=0.9186	p=1.0000	p=0.4024	p=0.9999	-

No statistically significant difference was observed for pair wise comparisons of interactions of three age groups and three groups of BMI with telomere length by Tukeys multiple posthoc procedures ($p>0.05$).

Figure 17: Comparisons of interactions of three age groups and three groups of BMI with Telomere Length

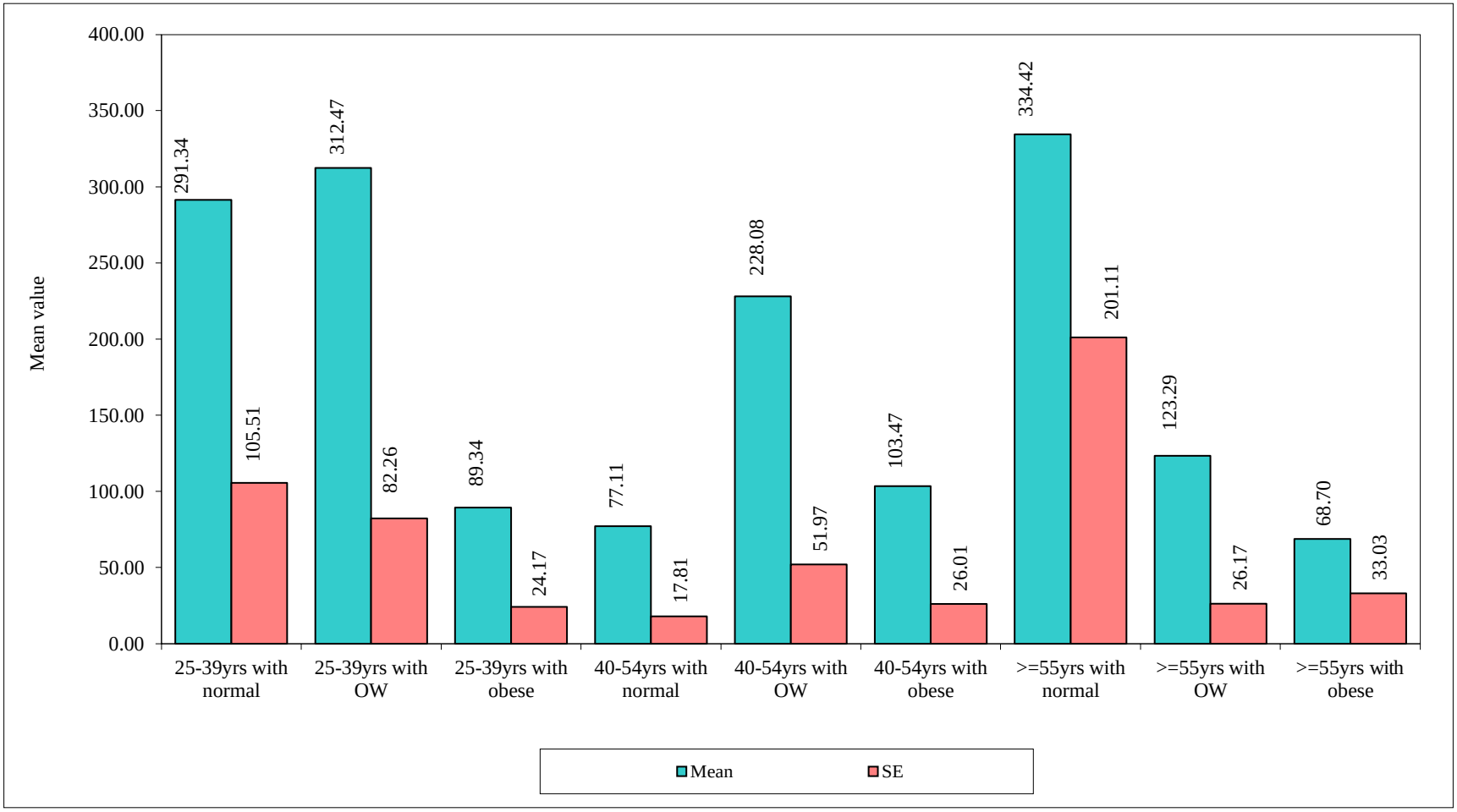


Table 11: Summary of Leptin in three age groups and three groups of BMI

Age groups with BMI	n	Mean	SD	P value
25-39yrs with normal	10	4.89	1.58	0.3017
25-39yrs with OW	10	5.43	3.63	
25-39yrs with obese	10	4.08	2.19	
40-54yrs with normal	10	4.61	2.26	
40-54yrs with OW	10	4.29	1.98	
40-54yrs with obese	10	6.82	6.06	
>=55yrs with normal	10	7.44	9.23	
>=55yrs with OW	10	5.83	3.48	
>=55yrs with obese	10	4.31	1.12	

The mean leptin score among subjects aged 25-39 years with normal BMI, overweight and obese were 4.89±1.58, 5.43±3.63, and 4.08±2.19 respectively. The mean telomere lengths among subjects aged 40-54 years with normal BMI, overweight and obese were 4.61±2.26, 4.29±1.98, and 6.82±6.06 respectively. The mean telomere lengths among subjects aged ≥55 years with normal BMI, overweight and obese were 7.44±9.23, 5.83±3.48, and 4.31±1.12 respectively.

Table 12: Comparison of mean leptin score among subjects in different age groups

Age group	Mean±SD	p-value
25-39	5.91±4.21	0.6306
40-54	6.44±10.49	
≥55	5.37±5.73	

The mean leptin score was higher among subjects in 40-54 years age group (6.44±10.49) followed by 25-39 years' age group (5.91±4.21), and ≥55 years group(5.37±5.73).

Table 13: Comparison of mean leptin score among subjects in different BMI categories

BMI category	Mean±SD	p-value
Normal	6.43±6.36	0.8572
Overweight	7.19±10.38	
Obese	4.10±2.73	

The mean leptin score was higher among subjects in overweight group (7.19±10.38) followed by normal BMI group (6.43±6.36), and obese group (4.10±2.73). However, this difference was not statistically significant (p>0.05).

Table 14: Pair wise comparisons of interactions of three age groups and three groups of BMI with Leptin by Tukeys multiple posthoc procedures

Interactions	25-39yrs with normal	25-39yrs with OW	25-39yrs with obese	40-54yrs with normal	40-54yrs with OW	40-54yrs with obese	>=55yrs with normal	>=55yrs with OW	>=55yrs with obese
Mean	4.89	5.43	4.08	4.61	4.29	6.82	7.44	5.83	4.31
SE	0.50	1.15	0.69	0.72	0.63	1.92	2.92	1.10	0.36
25-39yrs with normal									
25-39yrs with OW	p=1.0000								
25-39yrs with obese	p=1.0000	p=0.9986							
40-54yrs with normal	p=1.0000	p=1.0000	p=1.0000						
40-54yrs with OW	p=1.0000	p=0.9996	p=1.0000	p=1.0000					
40-54yrs with obese	p=0.9844	p=0.9984	p=0.8817	p=0.9635	p=0.9228				
>=55yrs with normal	p=0.9189	p=0.9795	p=0.7085	p=0.8614	p=0.7771	p=1.0000			
>=55yrs with OW	p=0.9999	p=1.0000	p=0.9915	p=0.9994	p=0.9965	p=0.9999	p=0.9952		
>=55yrs with obese	p=1.0000	p=0.9997	p=1.0000	p=1.0000	p=1.0000	p=0.9251	p=0.7814	p=0.9968	

No statistically significant difference was observed for pair wise comparisons of interactions of three age groups and three groups of BMI with Leptin by Tukeys multiple posthoc procedures ($p>0.05$).

Figure 18: Comparisons of interactions of three age groups and three groups of BMI with Leptin

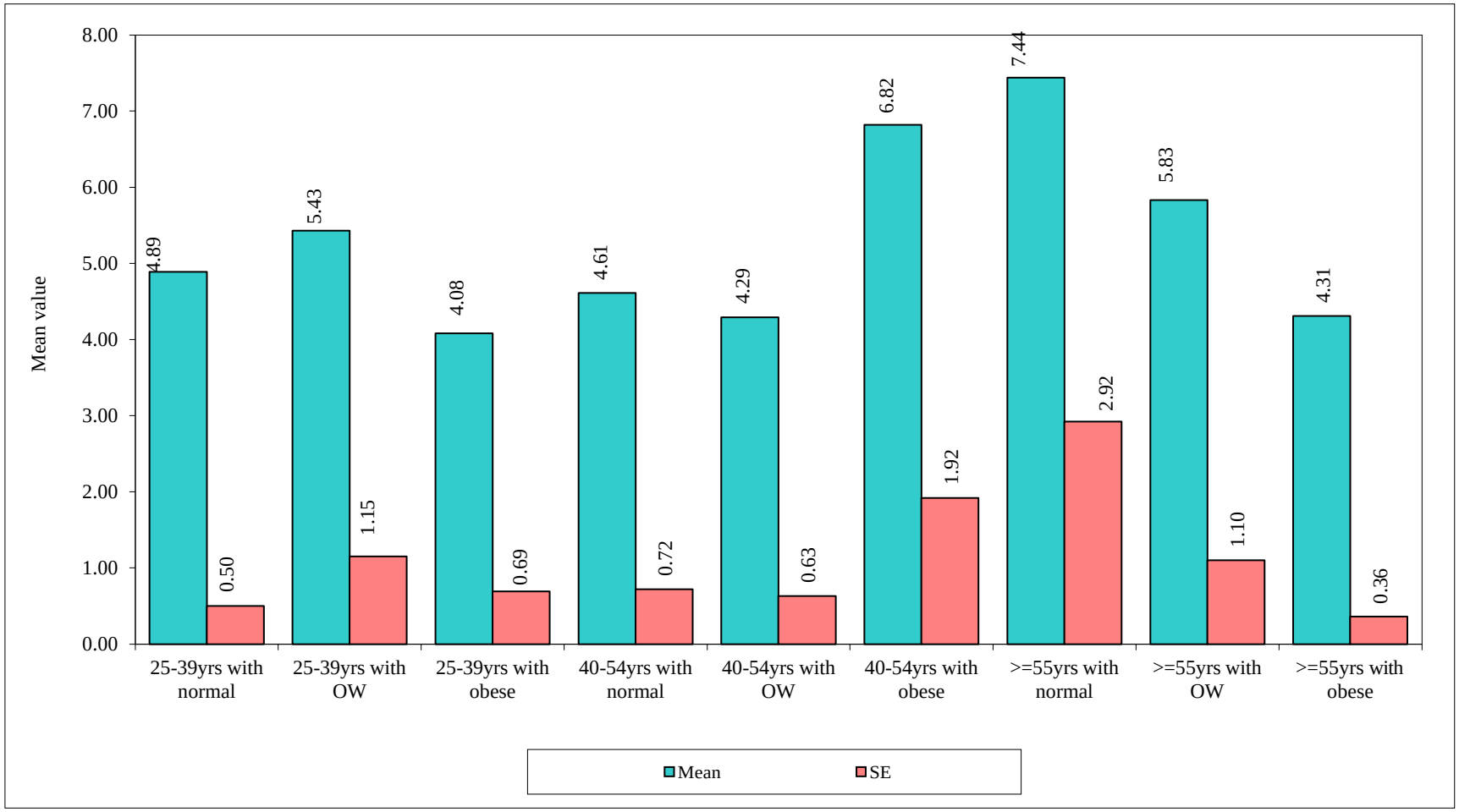


Table 15: Correlation between various parameters

Variable	Waist circumference		Hip circumference		Waist/hip ratio	
	R-value	**p-value**	**R-value**	**p-value**	**R-value**	**p-value**
Age	**0.034**	**0.748**	**-0.009**	**0.931**	**0.119**	**0.266**
Height	0.137	0.199	0.120	0.261	-0.022	0.838
Weight	0.677	<0.001*	0.662	<0.001*	0.140	0.187
BMI	0.640	<0.001*	0.640	<0.001*	0.138	0.194
Waist circumference			0.923	<0.001*	0.281	0.007*
Hip circumference					-0.032	0.763
Neck circumference	0.687	<0.001*	0.690	<0.001*	0.043	0.689
Telomere length	-0.171	0.107	-0.269	0.010*	0.232	0.027*
Leptin	-0.080	0.453	-0.066	0.535	-0.109	0.304

Height of the subjects was found to positive correlation with waist circumference (r=0.137) and hip circumference (r=0.120); negative correlation with waist/hip ratio (r=-0.022).

Weight of the subjects was found to have statistically significant direct correlation with waist circumference (r=0.640) (p<0.001) and hip circumference (r=0.640) (p<0.001). It was also found to have direct correlation with WHR (r=0.138).

BMI of the subjects was found to have statistically significant positive correlation with waist circumference (r=0.677) (p<0.001) and hip circumference (r=0.662) (p<0.001). It was also found to have positive correlation with WHR (r=0.140) and is not statistically significant (p>0.05).

Waist circumference has a statistically significant positive correlation with hip circumference (r=0.923) (p<0.001) and with waist/hip ratio (r=0.281) (p=0.007). Hip circumference was found to have a negative correlation with waist/hip ratio (r=-0.032).

Neck circumference was found to have statistically highly significant direct association with waist circumference (r=0.687) (p<0.001) and hip circumference (r=0.690) (p<0.001). It was also found to have positive correlation with WHR (r=0.043) .

Telomere length was found to have negative correlation with waist circumference (r=-0.171). A significant inverse correlation was found with hip circumference (r=-0.0269) (p=0.010) and positive correlation with waist/hip ratio (r=0.232) (p=0.027).

Leptin score was found to have inverse correlation with waist circumference (r=-0.080) and hip circumference (r=-0.066); negative correlation with waist/hip ratio (r=-0.109). However, these correlations were not found to be statistically significant (p>0.05).

Table 16: Correlation of age with waist circumference, hip circumference, waist /hip ratio, neck circumference, telomere length and leptin scores

Variables	r-value	p-value
Waist circumference	0.034	0.748
Hip circumference	- 0.009	0.931
Waist/ Hip ratio	0.119	0.266
Neck circumference	- 0.023	0.829
Telomere length	-0.205	0.049
Leptin score	-0.014	0.894

Age has a positive correlation with waist circumference (r=0.034), positive association with waist/hip ratio (r=0.119), negative correlation with hip circumference (r=-0.009), neck circumference (r=-0.023), leptin score (r=-0.014).None of these correlations were found to be statistically significant (p>0.05). Age is found to have a negative correlation with telomere length (r=-0.205) which is statistically significant.

Table 17: Correlation between various parameters

Variable	Telomere length r-value (p value)	Leptin r-value (p value)
Waist/height	-0.185 (0.081)	-0.021 (0.841)
Telomere length		0.084 (0.433)

A weak negative association was observed amongst waist to height ratio and telomere length, negligible negative correlation between waist/height ratio and leptin scores. Telomere length was found to have negligible positive correlation with leptin scores. However, all these correlations are not statistically significant.

Table 18: Mean telomere length and leptin scores among subjects based on WHR

Waist hip ratio		TELOMERE LENGTH	LEPTIN
Normal	Mean	86.9448	4.4945
	N	8	8
	Std. Deviation	85.23808	2.19852
	Median	64.7475	3.7725
Obese	Mean	190.0798	6.0505
	N	82	82
	Std. Deviation	286.12504	7.55597
	Median	115.2804	4.4560
Total	Mean	180.9123	5.9122
	N	90	90
	Std. Deviation	275.59252	7.24839
	Median	108.1749	4.4085

The mean telomere lengths were high in subjects with obese Waist hip ratio190.0798±286.12504 than subjects with normal waist to hip ratio 86.9448±85.23808. The mean leptin score was high in subjects with obese Waist hip ratio 6.0505±7.55597 than subjects with normal waist to hip ratio 4.4945±2.19852.

Table 19: Correlation between waist to hip ratio with Telomere length and leptin by Kendall's correlation coefficient method

			TELOMERE LENGTH	LEPTIN
Kendall's tau_b	Waist hip ratio	Correlation Coefficient	.131	0.23
		Sig. (2-tailed)	.133	0.778
		N	90	90

Waist to hip ratio was found to have weak positive correlation with Telomere length (r=0.131) and Leptin (r=0.23) which is not statistically significant (p>0.05).

Table 20: Mean telomere length and leptin score among subjects having normal BMI score but obese waist/hip ratio

Variable	No. of subjects	Mean	Standard deviation
Telomere length	25	265.08	450.47
Leptin score	25	8.29	12.51

The mean telomere length and leptin score among subjects having normal BMI score but obese waist/hip ratio (n=25) were 265.08 ±450.47 and 8.29 ±12.51.

Table 21: Mean Telomere length and leptin score among subjects having obese or overweight BMI score but normal waist/hip ratio

Variable	No. of subjects	Mean	Standard deviation
Telomere length	3	97.99	77.76
Leptin score	3	6.24	2.79

The mean telomere length and leptin score among subjects having obese or overweight BMI score and normal waist/hip ratio (n=3) were 97.99 ±77.76 and 6.24 ±2.79.

Table 22: Mean telomere length and leptin score among subjects having obese or overweight BMI score and obese waist/hip ratio

Variable	No. of subjects	Mean	Standard deviation
Telomere length	57	157.18	166.83
Leptin score	57	5.06	3.50

The mean telomere length and leptin score among subjects having obese or overweight BMI score and obese waist/hip ratio (n=57) were 157.18 ±166.83 and 5.06 ±3.50.

DISCUSSION

Obesity is a prominent avoidable cause of mortality and a growing health concern in both adults and children throughout the world. The telomere length of a cell represents how many times the cell has replicated and telomere shortening to less than 4kb leads to cellular senescence. Our study explores the concept of inflammation due to obesity and the role of leptin in this process ultimately leading to telomere shortening. In this cross – sectional study we have quantified leucocyte telomere length and analysed its association with biochemical and anthropometric surrogates of obesity.

The study population consisted of 90 patients who were admitted in the ward or attended out-patient department of KLE'S Dr. Prabhakar Kore Hospital and MRC. They were further stratified into three groups according to their age namely, 25-39 years, 40-54 years and ≥55 years. Out of the 90 subjects, 30 (33.3%) of them belonged to 25-39 years' age group, 30 (33.3%) belonged to 40-54 years' age group and 30 (33.3%) belonged to ≥55 years' age group. The mean age of the study subjects was 48.84±16.84 years.

With regard to BMI, the study subjects were divided into three groups namely normal, overweight and obese. Out of the 90 subjects, 30 (33.3%) of them belonged to normal BMI group, 30 (33.3%) belonged to overweight group and 30 (33.3%) belonged to obese group. The mean BMI of the study subjects was 24.20±3.32 kg/m^2

Age is found to have a negative correlation with telomere length (r=-0.205) which is statistically significant. Our study results are in accord with previous studies which observed telomere shortening with age. This study is supported by various previous studies[21,45,46]. Telomere shortening is a hallmark of both cellular senescence and organismal aging. The telomere length of adult cells decreases due to loss of base pairs during every cell division.

Telomeres are also influenced by tissue oxidative stress and inflammation, and chronic inflammation increases white blood cell replenishment, which promotes telomere attrition. By lowering the activity of telomerase, the polymerase responsible for TL maintenance, oxidative stress promotes TL attrition in cells. Telomerase regulates the length of telomeres (TL) in response to ageing. Between the ages of 4 and 39, telomerase activity drops steadily, and after the age of 40, telomerase activity is absent in 35% of the population.[21,47]

Our study results are in consonance with the theory that aging causes telomere attrition which is proved by the inverse association of telomere length with age as described in various studies.[1,34,35]

Using spearman's rank correlation method, Telomere length was found to have a statistically significant negative association with BMI (r=-0.2052). The mean telomere length was higher among subjects in normal BMI group (234.29±417.32) followed by overweight group (221.28±194.16), and obese group (87.17±86.65). In our study we found BMI is having a negative correlation with telomere length which was observed in various systematic reviews.[48,49] Majority of the published articles have found a significantly inverse association of telomere length and BMI. Even though studies were showing inverse relationship between telomere length and obesity, heterogeneity still exists about this inverse relationship and also of a notion that adiposity and telomere length association is more stronger in women, especially at younger ages and men have shorter telomere length due to more degenerative diseases. Our study gives strength to the hypothesis that obesity increases oxidative stress and causes chronic systemic inflammation which leads to shortening of telomere.

Our study also shows a decreasing trend of telomere length as the BMI increases, mean telomere length found in normal BMI category is 234.29 and a decrease in telomere length is seen in overweight category with a mean TL of 221.28 and the mean telomere length in obese category is 87.17. It can be assumed that the greater fall in mean telomere length in obese category can be due chronic inflammation, lack of physical activity, psychological stress or unhealthy diet which again increase adiposity or vice versa. Although associations between obesity and TL is weak to moderate, many studies did not reach a statistical significance. There is a trend toward demonstrating an inverse correlation between TL and obesity.

The mean telomere lengths among subjects aged 25-39 years with normal BMI, overweight and obese were 291.34±333.66, 312.47±260.11, and 89.34±76.44 respectively. The mean telomere lengths among subjects aged 40-54 years with normal BMI, overweight and obese were 77.11±56.30, 228.08±164.34, and 103.47±82.26 respectively. The mean telomere lengths among subjects aged ≥55 years with normal BMI, overweight and obese were 334.42±635.98, 123.29±82.76, and 68.70±104.44 respectively. Incidentally, it is also observed that the mean telomere length in overweight BMI when stratified as per age groups, was comparatively higher to the mean telomere length of normal BMI in 25-39 and 40-54 year age group. This can be attributed to the concept of Obesity paradox. The term ‘obesity paradox’ is used for the phenomenon that shows a better prognosis in overweight and grade I obese patients than in non-obese patients.

‘Obesity paradox’ shows better health outcomes for overweight and mildly obese individuals. Studies have shown that obese patients showed a better survival rate than

underweight patients during a chronic disease including heart failure, chronic obstructive lung disease, and cancer.

According to a study[50], there is a positive link between telomere length and the obesity markers, with the longer telomere length indicating a higher level of obesity. In metabolically healthy overweight or mildly obese people, there was a positive association between obesity indices and telomere length. This contradicts earlier research, and the findings of our study strengthened the case for the obesity paradox.

Obesity is associated with a low-grade inflammatory response as well as endocrine alterations. To raise the inflammatory burden, central or visceral fat generates more pro-inflammatory adipokines than subcutaneous fat. As a result, it's possible that a robust inflammatory or immunological response will aid in the long-term recovery from an infectious episode.

Obesity, on the other hand, may be favourable in terms of metabolic reserve in a cachexia state. In several conditions, lack of appetite and resultant unintended weight loss has a deleterious impact on immunological function and can lead to malnutrition.

BMI of the subjects was showing a statistically significant positive correlation with waist circumference ($r=0.677$) ($p<0.001$). These results from our study are in accordance with the previous studies.[48]

Leptin levels were found to have negligible negative correlation with BMI ($r=-0.0561$), neck circumference ($r=-0.0383$), weak negative correlation with weight (-0.1034) and waist/hip ratio ($r=-0.1095$). Telomere length was found to have negligible positive correlation with leptin scores and none these correlations are statistically significant ($p>0.05$).

When the mean of leptin is compared in 3 age groups and 3 BMI categories the mean leptin score among subjects aged 25-39 years with normal BMI, overweight and obese were 4.89±1.58, 5.43±3.63, and 4.08±2.19 respectively. The mean telomere lengths among subjects aged 40-54 years with normal BMI, overweight and obese were 4.61±2.26, 4.29±1.98, and 6.82±6.06 respectively. The mean telomere lengths among subjects aged ≥55 years with normal BMI, overweight and obese were 7.44±9.23, 5.83±3.48, and 4.31±1.12 respectively. However, these differences were not found to be statistically significant ($p>0.05$). The mean leptin score was higher among subjects in overweight group (7.19±10.38) followed by normal BMI group (6.43±6.36), and obese group (4.10±2.73). However, this difference was not statistically significant ($p>0.05$). Leptin score was found to have negligible negative correlation with waist circumference ($r=-0.080$) and hip circumference ($r=-0.066$); weak negative correlation with waist/hip ratio ($r=-0.109$). However, these correlations were not found to be statistically significant ($p>0.05$).

We found that leptin, the protein product of the *ob* gene, is detectable in serum and that obese subjects have higher serum leptin concentrations than normal- weight subjects. Although several factors may contribute to the elevation of serum leptin concentrations in obesity, the values were most closely correlated with the percentage of body fat It therefore appears that, in humans, serum leptin concentrations reflect the amount of adipose tissue in the body.[51]

Studies[48] have shown high levels of leptin is associated with increased BMI and Obesity , In a study[42], it was observed that there was no significant association between the physical parameters with serum levels of leptin in the study. Our results are consistent with previous reports that have not found an association between TL and

inflammatory cytokines. Cellular hypoxia and cell size of adipocytes were negatively related to adiponectin secretion and synthesis.

Adipocyte hypertrophy (in both visceral and subcutaneous adipose tissue) was linked to shorter telomeres in obese and T2DM individuals, according to a research[33]. After accounting for adipocyte cell size, the strong relationship between TL and hypoadiponectinemia was gone. Even after adjusting for race and gender, a study[52] showed no linear correlations between TL and leptin and adiponectin. In children aged 5–12 years, TL was not linked to adipocytokines. Race, gender, obesity, adipokines (leptin and adiponectin), and physical exercise had no effect on TL in 667 teenagers (aged 14–18 years, 48 percent black, 51 percent females) investigated in a study[53]. Similarly, in a study[54] found no significant association between TL and leptin or adiponectin in 295 individuals with Barrett's oesophagus. In the same line, leptin and adiponectin biochemical assays measure different oligomeric forms of these adipokines (i.e. low, medium, and high molecular weight forms) that might exert different function

In the study[52] the Linear regressions showed no association between the anthropometric measures, visceral fat, adiponectin, leptin or adiponectin to leptin ratio assessed in a continuous manner and telomere length assay ratio, either for the whole sample or when stratified by race or by gender.

A study[40] showed that Telomere length was inversely correlated with the serum concentration of leptin a marker and regulator of body fat that itself may have some pro-inflammatory properties known to increase oxidative stress. Further studies are needed to identify factors that influence telomere length in diverse populations.[47]

In our study, Waist circumference was found to have a statistically significant positive correlation with waist/hip ratio (r=0.281) (p=0.007), BMI (r=0.640), weight (r=0.677)

and neck circumference(r=0.687). Whereas Telomere length was found to have a negative correlation with waist circumference (r= -0.171). These findings are in concordance with the results published in various studies[55] and a similar trend of results was observed in the meta analysis study[3]

Telomere length is found to have a high negative correlation with central obesity, a hypothesis which is supported by a number of studies showing a negative relationship between waist circumference a marker of central obesity and telomere length regardless of age. It has also been observed that BMI, blood pressure, and hyperlipidemia have a favourable association with subcutaneous and visceral adipose tissue. As a result, metabolic illnesses linked to obesity appear to be linked to the amount of fat tissue present, which in the Indian population is more likely to be visceral adipose tissue, and WC serves as a good predictor of central obesity.[47]

In our study Telomere length was found to have a negative relationship with neck circumference (r=--0.2266) (p=0.0318) and statistically significant positive correlation with waist circumference (r=0.687) (p<0.001) and positive correlation with waist/hip ratio (r=0.043).

Our results are comparable to those found in the studies[56,57] which noted, neck circumference a marker of central obesity as an independent predictor of telomere attrition and obesity. In a study[56] they concluded that nuchal sat appears to be a robust predictor of telomere attrition providing information beyond metabolic and inflammatory biomarkers. Several prospective studies[52] have reported that cardiovascular patients with increased neck circumference have increased cardiovascular related mortality than compared to low or normal neck circumference.

The accumulation of visceral and nuchal fat depots often coincides in obese patients and may represent 'overflow phenomenon' where storage capacity of SAT is exceeded so that fat has to be stored in ectopic depots like neck. If this process starts in the young and remains over time, the per durability of 'overflow' may create serious obesity related clincal sequelae.[56]

In a study[57] to distinguish metabolically healthy from unhealthy overweight and obese patients showed metabolically benign phenotype of obesity to have less nuchal subcutaneous fat deposition compared to unhealthy obese.

In our study a negative correlation was seen between waist/height ratio and telomere length and a negative correlation between waist/height ratio and leptin scores. However, these correlations were not found to be statistically significant.

In a study [58], they have observed that waist height ratio was inversely related to telomere length especially when its < 0.5. Recently, waist height ratio has been suggested as an index of abdominal obesity and a better anthropometric measure of cardiovascular risk assessment. This study concluded that waist circumference and waist height ratio as better anthropometric measures of obesity than others. It has been suggested that waist height ratio be kept within <0.5 to reduce cardiovascular diseases.

In meta analytical study [3], they observed Telomere length was inversely related waist to height ratio and showed a very high homogeneity in its results.

In our study, it was observed that waist hip ratio had a positive correlation with waist circumference (r=0.281), BMI (r= 0.138), and neck circumference (r=0.043). It had a negative correlation with hip circumference (r= -0.032).

In our study, we observed a positive correlation between waist hip ratio and telomere length (r=0.232) with spearman's rank correlation method which was statistically significant, but again using kendall correlation coefficient method, it show positive correlation which was not significant. Our study results showed the mean telomere lengths to be high in subjects with obese Waist hip ratio190.0798±286.12504 than subjects with normal waist to hip ratio 86.9448±85.23808. The mean leptin score was high in subjects with obese Waist hip ratio6.0505±7.55597 than subjects with normal waist to hip ratio 4.4945±2.19852. The total obese individuals as per waist hip ratio were 82 of the 90 participants and the rest 8 participants had normal waist hip ratio. This is in stark contrast to the number of obese and overweight individuals calculated as per BMI, which is only 60 of the 90 participants. Hence a total of 22 participants who were identified as obese according to waist hip ratio had a normal BMI. The observations in our study can be explained by using the Y-Y paradox.

Body mass index (BMI) which was being used for many years for assessing obesity was discredited by YY paradox. Yajnik and Yudnik[59] the two authors, who proposed the Y-Y paradox had a near identical BMI, but dual X- ray absorptiometry imaging showed that the first author had substantially more body fat than the second author. This gained fame as YY paradox.[59,60]

In a study[61] which measured BMI, body fat percentage, and cardio-metabolic risk factors in 6123 Caucasian participants (69 percent females) aged 18 to 80 years and categorised them as 15.09 percent lean, 26.74 percent overweight, and 58.17 percent obese, according to BMI. They discovered that 29% of people who were considered normal weight and 80% of people who were considered overweight had a body fat percentage in

the obese category. As a result, it was reported that BMI under-estimates a person's adiposity on an individual basis.

Though the above mentioned 22 participants had normal BMI, they fell under obese waist hip ratio, thus indicating that waist hip ratio is a better anthropometric measure of central obesity than BMI.

In our study waist hip ratio and BMI are positively correlated with each other but individually their correlation with telomere length is not the same. BMI is inversely related whereas WHR is positively correlated with telomere length. Hence these two variables together were correlated with telomere length to better understand their association.

The relations examined are as follows: 1)In participants with normal BMI and obese waist hip ratio (n=25)Mean telomere length and leptin were examined and this showed mean telomere length and leptin score among these subjects as 265.08 ±450.47 and 8.29 ±12.51.

The second relation is in subjects having obese or overweight BMI and obese waist/hip ratio (n=57) the mean telomere length and leptin score were analysed and the results are as follows, mean Telomere length is157.18 ±166.83 and Leptin 5.06 ±3.50. Hence, we can infer from the above results that telomere length was more in obese individuals with normal BMI than obese participants (as per BMI and waist hip ratio).

Our study results are similar to various studies[5,55,58,62] done previously. Our study results make us think about the possibility of obesity paradox, which is still being explored. [62]As previously mentioned, the term "obesity paradox" was coined by Gruberg et al. in 2002

to describe their counterintuitive finding that, despite the negative effects of obesity on risk factors associated with cardiovascular diseases and many other chronic diseases, patients with cardiovascular diseases who are overweight or obese often have a better prognosis than patients with similar diagnoses who are leaner (underweight as well as patients with a "normal" BMI). A major meta-analysis of 97 research involving over 2.9 million participants (including >270,000 fatalities) found that those who were overweight had the best chance of surviving. These individuals showed a statistically significant 6 percent decreased death rate than those with a normal BMI. More severe obesity was linked to a higher risk of death, as predicted, although class I obesity was linked to a 5% reduced risk of death than those with a normal BMI.[5]

In a study[63] reported in a 2013 research that overweight was related with considerably lower all-cause mortality and grade 1 obesity was not associated with greater mortality. Our findings are consistent with the previous research, which indicated that obese WHR patients have longer telomeres.[62]

Obesity may not always mean a higher risk of cardiovascular disease. Individuals with a gynoid or "pear" distribution of subcutaneous fat had a reduced cardiovascular risk for a given BMI than those with a centripetal android or "apple" pattern linked with visceral adiposity. Insulin resistance and other metabolic syndrome-related illnesses do not occur in all obese persons. The concept of the "fit fat" arose as a result of this observation.

As a result, ‘BMI may not predict incremental cardiovascular risk effectively as irrespective of the increased BMI the location of fat accumulation appears to play a significant role in telomere attrition. The apple shaped obesity is usually associated with increased risk of diabetes, cardiovascular health risks, hypertension whereas the pear shaped obesity is more associated with mechanical complications like arthritis and

varicose veins. Hence we might also suggest the possibility of the presence pear shaped obesity in the study population, which can be responsible for the positive correlation between telomere and WHR.

Several studies, on the other hand, imply that there is a metabolically benign adipose phenotype, which might explain why some fat people have a low risk of cardiovascular disease. As a result, obesity isn't always and inevitably harmful.[62]

Potential reasons for obesity paradox include: Unintentional weight loss, Younger age at presentation, Lower prevalence of smoking, Greater metabolic reserve, less cachexia, lower levels of atrial natriuretic peptides, attenuated response to hormones involved in the renin–angiotensin–aldosterone system, higher blood pressure, leading to use of more cardiac medications, different aetiology, associated with a better prognosis, Increased muscle mass and muscular strength.

To properly comprehend the intricacy of the obesity paradox, data from long-term prospective trials with more extensive assessments of all patients is needed.

SUMMARY

- The present study population consisted of 90 patients who were admitted in the ward or attended out-patient department of KLE'S Dr. Prabhakar Kore Hospital and MRC, Belagavi during the period of January 2020 to December 2020.
- They were further stratified into three groups according to their age namely, 25-39 years, 40-54 years and ≥55 years. Out of the 90 subjects, 30 (33.3%) of them belonged to 25-39 years' age group, 30 (33.3%) belonged to 40-54 years' age group and 30 (33.3%) belonged to ≥55 years' age group. Various anthropometric variables and leptin scores were observed in the above groups.
- In this study we observed that the telomere length has decreased with the increasing age. Our observations of the association between obesity and telomere length through various anthropometric and laboratory findings revealed a negative correlation between telomere length and BMI, waist circumference, neck circumference and waist to height ratio. A positive correlation was observed between WHR and telomere length. Leptin was found to have no association with any markers of obesity and also with telomere length. A few additional outcomes were the observations that WHR is a better marker of central obesity than BMI and Y-Y paradox holding true in our study.
- Our study results also add additional information to the concepts of obesity paradox, metabolically healthy obese and pear shaped obesity.

CONCLUSION

Obesity is defined as an excess of adipose tissue mass. Excess adiposity is associated with an increased risk of medical co-morbidity, institutionalization and premature death· Obesity and Telomere attrition, both are linked to accelerated aging and premature mortality. Studies on the process of telomere length attrition in illnesses such as hypertension, obesity, and diabetes will give a better understanding of its biological importance, as well as its use as a disease marker.

In our study, 90 patients who were admitted in the ward or attended out-patient department of KLE'S DR. Prabhakar Kore Hospital and MRC have been grouped under various categories and evaluated for association of telomere length with surrogate markers of obesity.

The telomere length among the patients of age 25-39yrs was higher compared to the patients in 40-54yrs and >=55yrs of age ($p>0.05$), that is age is found to have a negative correlation with telomere length ($r=-0.205$) which is statistically significant.

A significant negative association was observed between BMI with telomere length ($r=-0.20$, $p<0.05$). Our study gives strength to the hypothesis that obesity increases oxidative stress and causes chronic systemic inflammation which leads to shortening of telomere.

In our study, we also observed that the mean telomere length in 'overweight BMI' when stratified as per age groups, was comparatively higher to the mean telomere length of 'normal BMI' in 25-39 and 40-54 year age group.

This study results also showed a positive correlation between telomere length and waist hip ratio ($r=0.23$, $p<0.05$). Although as per BMI scores only 60 patients were categorised as overweight and obese, but as per waist hip ratio 82 patients have been identified as

obese indicating that waist hip ratio is a better marker of central obesity than BMI. These results also help in identifying the presence of Y-Y paradox in our study.

It was also observed that patients with normal BMI but obese WHR were having longer telomere length compared to those with obese BMI. These results directed us towards a possibility of Obesity paradox. The 'obesity paradox' argues that persons who are overweight or somewhat obese have superior health results. Obese patients had a higher survival rate than underweight persons among patients with chronic diseases such as heart failure, chronic obstructive pulmonary disease, and cancer, according to several studies.

Based on the results of our study we would also like suggest the possibility of pear shaped obesity in the study population, which explains the positive association of telomere length with WHR.

Based on our study results we would also like to keep the fit fat hypothesis (metabolically healthy obesity) as a possibility, as this explains positive correlation between WHR and telomere length and also the findings of Telomere length scores being more in overweight individuals Only with longitudinal data could the hypothesis be confirmed. As such, our findings should be considered exploratory.

Our study also showed a significant negative strength of association of neck circumference with Telomere length ($r=-0.22$, $p<0.05$) and also negative association between waist height ratio with telomere length.

The following are some of the study's limitations: First, the study focused on a small group of people from a particular ethnic group in a single place, which requires avoiding generalisation to the entire population and race. Second due to shortage of time and

limited financial resources extensive and advanced biochemical workup could not be done.

We suggest a longitudinal and a bigger population study to better understand the association between telomere length and Obesity.

BIBLIOGRAPHY

1. Batsis JA, Mackenzie TA, Vasquez E, Germain CM, Emeny RT, Rippberger P, et al. Association of Adiposity, Telomere Length and Mortality: Data from the NHANES 1999–2002. Int J Obes (Lond) [Internet]. 2018 Feb 1 [cited 2021 Dec 15];42(2):198. Available from: /pmc/articles/PMC5858938/
2. Das B, Pawar N, Saini D, Seshadri M. Genetic association study of selected candidate genes (ApoB, LPL, Leptin) and telomere length in obese and hypertensive individuals. BMC Med Genet. 2009;10(1):99.
3. Mundstock E, Sarria EE, Zatti H, Mattos Louzada F, Kich Grun L, Herbert Jones M, et al. Effect of obesity on telomere length: Systematic review and meta-analysis. Obesity (Silver Spring) [Internet]. 2015 Nov 1 [cited 2021 Dec 15];23(11):2165–74.
4. Ahirwar R, Mondal PR. Prevalence of obesity in India: A systematic review. Diabetes Metab Syndr Clin Res Rev. 2019;13(1):318–21.
5. Lavie CJ, De Schutter A, Milani R V. Healthy obese versus unhealthy lean: the obesity paradox. Nat Rev Endocrinol [Internet]. 2015 Jan 11 [cited 2021 Dec 15];11(1):55–62.
6. Jensen MD, Ryan DH, Apovian CM, Ard JD, Comuzzie AG, Donato KA, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. Circulation. 2014;129(25 Suppl 2):S102-38.
7. Prickett C, Brennan L, Stolwyk R. Examining the relationship between obesity and cognitive function: A systematic literature review. Obes Res Clin Pract. 2015;9(2):93–113.

8. Li Y, Dai Q, Jackson JC, Zhang J. Overweight is associated with decreased cognitive functioning among school-age children and adolescents. Obesity (Silver Spring). 2008;16(8):1809–15.

9. Deepa R, Sreedharan S, Mohan V. Abdominal obesity, visceral fat and Type 2 diabetes - "Asian Indian Phenotype." Type 2 Diabetes South Asians Epidemiol Risk Factors Prev. 2006;138–52.

10. Joshi S. Metabolic syndrome - Emerging clusters of the Indian phenotype. J Assoc Physicians India. 2003;51:445–6.

11. Bell AC, Ge K, Popkin BM. The Road to Obesity or the Path to Prevention: Motorized Transportation and Obesity in China. Obes Res. 2002;10(4):277–83.

12. Misra A, Singhal N, Khurana L. Obesity, the metabolic syndrome, and type 2 diabetes in developing countries: role of dietary fats and oils. J Am Coll Nutr. 2010;29(3 Suppl):289S-301S.

13. Safaei M, Sundararajan EA, Driss M, Boulila W, Shapi'i A. A systematic literature review on obesity: Understanding the causes & consequences of obesity and reviewing various machine learning approaches used to predict obesity. Comput Biol Med. 2021 Sep 1;136:104754.

14. Fitzpatrick AL, Kronmal RA, Gardner JP, Psaty BM, Jenny NS, Tracy RP, et al. Leukocyte telomere length and cardiovascular disease in the cardiovascular health study. Am J Epidemiol [Internet]. 2007 Jan [cited 2021 Dec 15];165(1):14–21.

15. Mukherjee M, Brouilette S, Stevens S, Shetty KR, Samani NJ. Association of shorter telomeres with coronary artery disease in Indian subjects. Heart [Internet]. 2009 Apr [cited 2021 Dec 15];95(8):669–73.

16. Raji A, Seely EW, Arky RA, Simonson DC. Body Fat Distribution and Insulin Resistance in Healthy Asian Indians and Caucasians. J Clin Endocrinol Metab [Internet]. 2001 Nov 1 [cited 2021 Dec 17];86(11):5366–71.

17. Bacopoulou F, Efthymiou V, Landis G, Rentoumis A, Chrousos GP. Waist circumference, waist-to-hip ratio and waist-to-height ratio reference percentiles for abdominal obesity among Greek adolescents. BMC Pediatr. 2015;15:50.

18. Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, et al. Prevalence of generalized & abdominal obesity in urban & rural India--the ICMR-INDIAB Study (Phase-I) [ICMR- NDIAB-3]. Indian J Med Res. 2015;142(2):139–50.

19. Stevens J, Katz EG, Huxley RR. Associations between gender, age and waist circumference. Eur J Clin Nutr 2010 641 [Internet]. 2009 Sep 9 [cited 2021 Dec 16];64(1):6–15.

20. Aronne LJ. Classification of Obesity and Assessment of Obesity-Related Health Risks. Obes Res. 2002;10(S12):105S-115S.

21. Shin YA. How Does Obesity and Physical Activity Affect Aging?: Focused on Telomere as a Biomarker of Aging. J Obes Metab Syndr [Internet]. 2019 [cited 2021 Dec 15];28(2):92–104.

22. Amundson DE, Djurkovic S, Matwiyoff GN. The obesity paradox. Crit Care Clin [Internet]. 2010 Oct [cited 2021 Dec 15];26(4):583–96.

23. Green ED, Maffei M, Braden V V, Proenca R, DeSilva U, Zhang Y, et al. The human obese (OB) gene: RNA expression pattern and mapping on the physical, cytogenetic, and genetic maps of chromosome 7. Genome Res. 1995;5(1):5–12.

24. Cammisotto P, Bendayan M. A review on gastric leptin: The exocrine secretion of a gastric hormone. Anat Cell Biol. 2012;45:1–16.

25. Moffett S, Martinson J, Shriver MD, Deka R, McGarvey ST, Barrantes R, et al. Genetic diversity and evolution of the human leptin locus tetranucleotide repeat. Hum Genet 2002 1105 [Internet]. 2002 Apr 4 [cited 2021 Dec 15];110(5):412–7.

26. Shapiro A, Mu W, Roncal C, Cheng K-Y, Johnson RJ, Scarpace PJ. Fructose-induced leptin resistance exacerbates weight gain in response to subsequent high-fat feeding. Am J Physiol Integr Comp Physiol. 2008;295(5):R1370–5.

27. Considine R V, Sinha MK, Heiman ML, Kriauciunas A, Stephens TW, Nyce MR, et al. Serum immunoreactive-leptin concentrations in normal-weight and obese humans. N Engl J Med. 1996;334(5):292–5.

28. Dardeno TA, Chou SH, Moon H-S, Chamberland JP, Fiorenza CG, Mantzoros CS. Leptin in human physiology and therapeutics. Front Neuroendocrinol. 2010;31(3):377–93.

29. Weigle DS, Duell PB, Connor WE, Steiner RA, Soules MR, Kuijper JL. Effect of fasting, refeeding, and dietary fat restriction on plasma leptin levels. J Clin Endocrinol Metab. 1997;82(2):561–5.

30. Kelesidis T, Kelesidis I, Chou S, Mantzoros CS. Narrative review: the role of leptin in human physiology: emerging clinical applications. Ann Intern Med. 2010;152(2):93–100.

31. Blüher S, Mantzoros CS. Leptin in humans: lessons from translational research. Am J Clin Nutr. 2009;89(3):991S-997S.

32. Chan JL, Matarese G, Shetty GK, Raciti P, Kelesidis I, Aufiero D, et al. Differential regulation of metabolic, neuroendocrine, and immune function by leptin in humans. Proc Natl Acad Sci U S A. 2006;103(22):8481–6.

33. Conde J, Scotece M, Gómez R, Gómez-Reino JJ, Lago F, Gualillo O. At the crossroad between immunity and metabolism: focus on leptin. http://dx.doi.org/101586/eci1048 [Internet]. 2014 Sep [cited 2021 Dec 15];6(5):801–8.

34. Ludlow AT, Ludlow LW, Roth SM. Do telomeres adapt to physiological stress? Exploring the effect of exercise on telomere length and telomere-related proteins. Biomed Res Int [Internet]. 2013 [cited 2021 Dec 15];2013.

35. Herrmann M, Pusceddu I, März W, Herrmann W. Telomere biology and age-related diseases. Clin Chem Lab Med [Internet]. 2018 Jul 26 [cited 2021 Dec 15];56(8):1210–22.

36. Epel ES, Blackburn EH, Lin J, Dhabhar FS, Adler NE, Morrow JD, et al. Accelerated telomere shortening in response to life stress. Proc Natl Acad Sci U S A [Internet]. 2004 Dec 7 [cited 2021 Dec 15];101(49):17312–5.

37. Gielen M, Hageman GJ, Antoniou EE, Nordfjall K, Mangino M, Balasubramanyam M, et al. Body mass index is negatively associated with telomere length: a collaborative cross-sectional meta-analysis of 87 observational studies. Am J Clin Nutr. 2018;108(3):453–75.

38. Njajou OT, Cawthon RM, Blackburn EH, Harris TB, Li R, Sanders JL, et al. Shorter telomeres are associated with obesity and weight gain in the elderly. Int J Obes. 2012;36(9):1176–9.

39. Buxton JL, Walters RG, Visvikis-Siest S, Meyre D, Froguel P, Blakemore AIF. Childhood Obesity Is Associated with Shorter Leukocyte Telomere Length. J Clin Endocrinol Metab. 2011;96(5):1500–5.

40. Valdes A, Andrew T, Gardner J, Kimura M, Oelsner E, Cherkas L, et al. Obesity, cigarette smoking, and telomere length in women. Lancet. 2005;366(9486):662–4.

41. Das B, Pawar N, Saini D, Seshadri M. Genetic association study of selected candidate genes (ApoB, LPL, Leptin) and telomere length in obese and hypertensive individuals. BMC Med Genet [Internet]. 2009 Sep 22 [cited 2021 Dec 15];10:99. Available from: /pmc/articles/PMC2754983/

42. Al-Attas OS, Al-Daghri N, Bamakhramah A, Shaun Sabico S, McTernan P, Huang T-K. Telomere length in relation to insulin resistance, inflammation and obesity among Arab youth. Acta Paediatr. 2010;99(6):896–9.

43. DNA extraction from liquid blood using QIAamp - PubMed [Internet]. [cited 2021 Dec 16].

44. O'Callaghan NJ, Fenech M. A quantitative PCR method for measuring absolute telomere length. Biol Proced Online 2011 131 [Internet]. 2011 Jan 31 [cited 2021 Dec 16];13(1):1–10.

45. Blackburn EH, Epel ES, Lin J. Human telomere biology: A contributory and interactive factor in aging, disease risks, and protection. Science [Internet]. 2015 Dec 4 [cited 2021 Dec 16];350(6265):1193–8. Available from: https://pubmed.ncbi.nlm.nih.gov/26785477/

46. Wolkowitz OM, Mellon SH, Epel ES, Lin J, Dhabhar FS, Su Y, et al. Leukocyte Telomere Length in Major Depression: Correlations with Chronicity,

Inflammation and Oxidative Stress - Preliminary Findings. PLoS One [Internet]. 2011 [cited 2021 Dec 16];6(3). Available from: /pmc/articles/PMC3063175/

47. Diaz VA, Mainous AG, Player MS, Everett CJ. Telomere length and adiposity in a racially diverse sample. Int J Obes. 2010;34(2):261–5.

48. Mundstock E, Sarria EE, Zatti H, Mattos Louzada F, Kich Grun L, Herbert Jones M, et al. Effect of obesity on telomere length: Systematic review and meta-analysis. Obesity. 2015;23(11):2165–74.

49. Müezzinler A, Zaineddin AK, Brenner H. Body mass index and leukocyte telomere length in adults: a systematic review and meta-analysis. Obes Rev. 2014;15(3):192–201.

50. Kim J-H, Ko H-J, Kim A-S, Moon H-N, Choi H-I, Park J-Y, et al. Obesity and Telomere Length: Does the Obesity Paradox Exist? [Internet]. Preprints; 2019 [cited 2021 Dec 15].

51. Considine R V., Sinha MK, Heiman ML, Kriauciunas A, Stephens TW, Nyce MR, et al. Serum immunoreactive-leptin concentrations in normal-weight and obese humans. N Engl J Med [Internet]. 1996 Feb [cited 2021 Dec 15];334(5):292–5.

52. Diaz VA, Mainous AG, Player MS, Everett CJ. Telomere length and adiposity in a racially diverse sample. Int J Obes (Lond) [Internet]. 2010 Feb [cited 2021 Dec 15];34(2):261–5.

53. Zhu Z, Tang Y, Zhuang J, Liu Y, Wu X, Cai Y, et al. Physical activity, screen viewing time, and overweight/obesity among Chinese children and adolescents: An update from the 2017 physical activity and fitness in China - The youth study. BMC Public Health [Internet]. 2019 Feb 15 [cited 2021 Dec 17];19(1):1–8.

54. Hardikar S, Song X, Risques RA, Montine TJ, Duggan C, Blount PL, et al. Obesity and inflammation markers in relation to leukocyte telomere length in a cross-sectional study of persons with Barrett's esophagus. BMC Obes [Internet]. 2015 [cited 2021 Dec 17];2(1). Available from: /pmc/articles/PMC4566310/

55. Kim S, Parks CG, DeRoo LA, Chen H, Taylor JA, Cawthon RM, et al. Obesity and weight gain in adulthood and telomere length. Cancer Epidemiol Biomarkers Prev. 2009 Mar;18(3):816–20.

56. Mangge H, Herrmann M, Almer G, Zelzer S, Moeller R, Horejsi R, et al. Telomere shortening associates with elevated insulin and nuchal fat accumulation. Sci Reports 2020 101 [Internet]. 2020 Apr 22 [cited 2021 Dec 15];10(1):1–9.

57. Weghuber D, Zelzer S, Stelzer I, Paulmichl K, Kammerhofer D, Schnedl W, et al. High risk vs. "metabolically healthy" phenotype in juvenile obesity - neck subcutaneous adipose tissue and serum uric acid are clinically relevant. Exp Clin Endocrinol Diabetes [Internet]. 2013 [cited 2021 Dec 15];121(7):384–90.

58. Cui Y, Gao YT, Cai Q, Qu S, Cai H, Li HL, et al. Associations of leukocyte telomere length with body anthropometric indices and weight change in Chinese women. Obesity (Silver Spring) [Internet]. 2013 Dec [cited 2021 Dec 15];21(12):2582–8.

59. Swinburn BA, Ley SJ, Carmichael HE, Plank LD. The Y-Y paradox. Lancet [Internet]. 2004 Jan 10 [cited 2021 Dec 15];363(9403):163.

60. SENGAR M. YY paradox: Findings from a Community Based Study in North India. Natl J Community Med. 2020;(0):1.

61. Gómez-Ambrosi J, Silva C, Galofré JC, Escalada J, Santos S, Millán D, et al.

Body mass index classification misses subjects with increased cardiometabolic risk factors related to elevated adiposity. Int J Obes (Lond) [Internet]. 2012 Feb [cited 2021 Dec 16];36(2):286–94.

62. Bosello O, Vanzo A. Obesity paradox and aging. Eat Weight Disord [Internet]. 2021 Feb 1 [cited 2021 Dec 15];26(1):27–35.

63. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. JAMA [Internet]. 2013 Jan 2 [cited 2021 Dec 17];309(1):71–82.

ANNEXURE-I
ETHICAL CLEARANCE CERTIFICATE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed - to- be- University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu
Phone: (+ 91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref: MDC/DOME/ 268. **Date: 24/12/2019**

To,
BG0119005
PG student in Medicine,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"STUDY OF ASSOCIATION OF LEPTIN AND LEUCOCYTE TELOMERE LENGTH WITH BODY MASS INDEX IN ADULT INDIAN POPULATION A ONE YEAR CROSS SECTIONAL STUDY",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Anita Dalal)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

ANNEXURE – II
INFORMED CONSENT

TITLE OF RESEARCH AND STUDY: STUDY OF ASSOCIATION OF LEPTIN AND LEUCOCYTETELOMERE LENGTH WITH BODY MASS INDEX

Principal Investigator:-

Post Graduate Student,

Department Of General Medicine,

JNMC, Belagavi.

Guide:-

Associate professor

Department of General Medicine,

JNMC, Belagavi.

Introduction and Purpose:- Telomere length is an indicator of oxidative stress and senescence in a cell. When telomeres in a cell shorten beyond the critical threshold, the cell stops dividing. .Leptin plays an essential role in the regulation of body fat mass and it has some proinflammatory properties which cause increased oxidative stress and Studies show leptin has direct association with obesity. Obesity is a leading non communicable disease causing death by increasing the risk of other diseases like Hypertension, Cardiac diseases, Diabetes etc. Hence evaluating the patient for inflammatory and oxidative stress caused due to obesity is essential for better management of the patients and this study aims to provide telomere length as a marker for identifying these effects of obesity and overweight.

.**Procedure:**

If you agree to be part of the research study, you will be asked the relevant history and relevant clinical examination and investigations will be done. You will also have to give blood samples for the necessary investigations.

Risk and Benefits:

The only risk and possible discomfort you might get is while doing venepuncture for investigations. It may cause pain or slight discomfort. You may/may not be benefitted by these investigations but you will be part of this study which is going to be useful to others in the future.

Alternatives:

Participation in this study is completely optional. You have the option of declining to participate in this study.

You can subsequently change your mind and withdraw from the study if you decide to participate. Your selection will have no impact on the health treatment or other services you get now or in the future. Your participation in this study may be terminated at any time by the study doctor or sponsor. You will get the standard therapy for people with your disease if you choose not to participate in the trial.

Privacy and Confidentiality:

To the degree permissible by law, all information acquired about you throughout the course of this study will be kept secret. You will be identified in this study record by the code digits. This study's findings may be published, but your personal information will be kept private.

Institution / Sponsor's policy:

Does not apply to this research

Financial incentives for participation:

You will not be paid / offered any gifts /incentives for participating in the study.

Authorization to publish the results:

The study's findings will be sent to KLE University in Belgaum as part of the MD program's requirements for completion, evaluation, and publication.

In case of the queries during study or in future you may contact the following persons,

1 Professor of Paediatrics

J.N. Medical College,

KAHER, Belagavi – 10

2. Associate Professor,

Dept of General Medicine,

JNMC,

KAHER Belagavi - 10

3 **.** PG Student

Department of general medicine

JNMC,

KAHER Belgaum

CONSENT FORM

I willingly consent to participate in this study by signing below. I reserve the right to withdraw at any moment. I am not giving up any of my legal rights by signing this form. My signature here shows that I have read this consent form, or it has been read tome and has been explained to me in my vernacular language and all my questions have been answered. A copy of this permission form will be handed to me. The Participant's signature or a legally authorised representative's left thumb print.

Participant’s name :……...

Signature / Left thumb impression :……...

of the participant

Name of the legally authorized :……...

representative / guardian

Signature / Left thumb impression :……...

Witness’ name :……...

Signature / Left thumb impression :……...

Investigator’s name and signature :……...

Date:

Place:

ANNEXURE -III

PROFORMA

STUDY OF ASSOCIATION OF LEPTIN AND LEUCOCYTE TELOMERE LENGTH WITH BODY MASS INDEX IN ADULT INDIAN POPULATION A ONE YEAR CROSS SECTIONAL STUDY

Case number:

Name:

Age:

Sex:

IP Number

Complaints at presentation:

Admission Diagnosis:

Physical Examination

Pulse: BP:

Pallor:

Height: Weight:

BMI:

Neck circumference:

Waist circumference:

Hip circumference: WHR:

Waist to height ratio:

CVS:

RS:

PA:

CNS:

1) HBA1c

2) LEPTIN

3) TELOMERE LENGTH

ANNEXURE – IV
MASTERCHART

CASE NUMBER	NAME	AGE	SEX	IP NUMBER	PULSE	BLOOD PRESSURE	CATEGORY	HEIGHT	WEIGHT	BMI	WAIST CIRCUMFERENCE	HIP CIRCUMFERE	WAIST/HIP RATIO	NECK CIRCUMFERENCE	HBA1C	TELOMERE LENGTH	LEPTIN
1	ANAND HARIJAN HANAMANTH	83	MALE	1029574	76	110/80	C1	176	70	22.59	90	95	0.94	32	5.7	2125.47	13.291
2	SHRIMANT PUJERI SIDDAPPA	47	MALE	1029288	90	120/80	B2	172	68	23.44	82	90	0.91	34	5.8	457.81	2.682
3	PANDURANG MALLAPPA KOTTAL	26	MALE	1029571	88	130/80	A2	173	70	24.2	86	93	0.92	36	5.8	56.37	14.786
4	SIDDARUDH RAMANNA VADDER	39	MALE	1029063	84	120/70	A3	168	76	26.92	86	92	0.93	35	5	21.36	2.22
5	PRAVEEN ANNAPPA KHOT	28	MALE	1029446	72	110/80	A3	170	75	25.95	88	96	0.91	36	5.3	18.94	3.591
6	MALOJI BHAGOJI GAWADE	46	MALE	1029169	64	120/80	B2	162	60	23.07	78	88	0.88	35	5.9	19.12	3.638
7	RAJU APPANNA FUNDE	45	MALE	1029604	72	110/80	B3	167	76	27.25	90	96	0.93	35	5.1	7.42	17.073
8	SHIVAPPA KALLAPPA BANAPPANNAVAR	59	MALE	1028877	58	110/70	C3	180	90	27.77	100	104	0.96	40	5.8	7.59	4.103
9	RAJU SURESH MUNAVALLI	27	MALE	1029862	76	140/70	A2	175	75	24.5	87	90	0.96	35	4.0	126.89	2.164
10	VIJAY SHIVAMURTHY HIREMATH	84	MALE	1030058	82	100/80	C2	168	70	24.8	84	90	0.93	37	6.4	178.38	5.147
11	RAJAHMED RAJASAB GUNAKI	25	MALE	1030079	76	120/80	A1	170	64	22.14	80	84	0.95	32	5.8	1189.07	8.494
12	SUBHASH PARAGOUDA PATIL	43	MALE	1029841	90	120/70	B2	156	56	23.04	76	80	0.95	32	4.9	552.25	7.669
13	DHAREPPA GURUPADAPPA MIRJI	35	MALE	1029839	88	100/70	A3	180	86	26.54	92	98	0.93	39	6.0	54.44	4.682
14	SHABBIR DASTAGIR TAHASILDHAR	26	MALE	1029853	84	130/90	A2	162	65	24.8	82	84	0.97	32	5.7	296.45	6.881
15	SHRINIVAS ACHYUTRAO BETGERI	40	MALE	1029594	72	120/70	B2	183	80	24.42	85	91	0.93	36	5.6	216.76	6.311
16	VARDHAMAN HANAMANT KEDRAPUR	26	MALE	1030096	64	130/90	A2	185	81	23.8	90	96	0.93	38	5.3	249.94	6.412
17	VEERANNA MALLIKARJUN KODOLKI	30	MALE	1027246	72	140/80	A2	171	70	23.9	87	92	0.94	34	4.8	241.48	3.821
18	AMINSAB RAJESAB GODAD	25	MALE	1031655	58	110/80	A1	162	52	19.81	78	83	0.93	38	5.2	346.68	3.374
19	VIJAY ASHOK MOTEKAR	27	MALE	1030822	76	120/80	A1	174	64	21.13	84	86	0.97	34	5.8	236.47	5.008
20	RAVINDRA KARAVEERAPPA ROGANNAVAR	52	MALE	1031054	82	110/70	B2	165	65	24.07	83	90	0.92	36	5.7	279.42	4.225
21	ALLAPPA SIDDAPPA KANKANWADI	39	MALE	1032012	76	120/80	A2	181	76	23.75	80	84	0.95	35	5.5	903.90	5.056
22	SHARANBASAV GANGAPPA GURIKAR	32	MALE	1032541	88	140/80	A2	179	76	23.7	84	90	0.93	36	5.5	188.75	4.49
23	TASHI TSERING NORPHEL	40	MALE	1032820	84	110/70	B3	150	60	26.66	86	92	0.93	40	5.7	236.03	17.256
24	NEELAPPA HUCHAPPA BADIGER	59	MALE	1032937	72	100/60	C2	174	70	23.13	85	90	0.94	34	5.1	326.47	3.701
25	BASANTRAY GANGAPPA ITAGI	33	MALE	1032614	64	120/70	A2	175	75	24.5	86	92	0.93	36	5	602.91	2.739
26	BHARMA APPASHAEB KORI	37	MALE	1032521	72	100/80	A1	176	70	22.59	90	94	0.95	38	5	373.50	5.682
27	SAVARA GOVINDU LINGAYYA	33	MALE	1031855	58	130/80	A2	176	75	24.22	86	92	0.93	35	5.7	363.79	2.869
28	PRAHALAD IRAPPA SUTAR	56	MALE	1033768	76	100/70	C3	167	80	28.69	89	98	0.9	36	6.3	9.28	4.682
29	ASHOK BASALINGAPPA BENAKANNAVAR	56	MALE	1035229	82	110/70	C3	173	82	27.42	90	98	0.91	38	6.4	18.12	2.479
30	MALLESH KADAPPA NAIL	39	MALE	1034132	76	110/80	A3	174	80	26.42	85	90	0.94	36	6.1	23.01	3.054
31	SHIVABASAPPA VEERABHADRAPPA CHINMAD	75	MALE	1035323	90	110/80	C3	177	88	28.11	95	104	0.91	39	6.1	8.37	5.249
32	KAREPPA KAREPPA HALABANNAVAR	63	MALE	1035194	88	110/80	C3	172	75	25.42	88	96	0.91	37	6.0	37.03	4.672
33	SHRINIVAS SOMSEKHAR ALAWANI	37	MALE	1035360	84	120/80	A3	166	70	25.4	83	88	0.94	36	5.7	48.61	2.294
34	SHRIKANT SIDDAPPA SURANNAVAR	26	MALE	1035380	72	120/80	A3	178	88	27.77	100	106	0.94	38	5.3	201.96	4.987
35	VIDHYADHAR MANOHAR PATIL	65	MALE	1035084	64	130/80	C2	168	70	24.8	85	92	0.92	36	6.1	42.31	6.262
36	ANNAPPA SHIVARAI CHOUGALA	97	MALE	1035356	72	110/70	C1	175	64	20.89	80	86	0.93	35	6.4	132.22	4.738

37	GANAPATHI MAHADEV PATIL	78	MALE	1036870	58	110/80	C2	165	65	24.07	82	88	0.93	37	4.9	122.21	4.804
38	SIDDAPPA SHANKARAPPA TALWAR	35	MALE	1036278	82	130/90	A2	170	68	23.52	86	94	0.91	40	5.3	94.26	5.117
39	VINAYA KUMAR NINGAYYA HIREMATH	34	MALE	1037489	76	100/80	A3	170	80	27.68	90	95	0.94	38	5.9	104.14	5.709
40	SHRISAIL MALLAPPA KANKANWADI	67	MALE	1037509	90	110/80	C2	183	80	24.2	86	90	0.95	37	5	44.03	2.294
41	SHANKAR TUKARAM SALUNKE	46	MALE	1035520	88	100/70	B3	178	88	27.77	92	100	0.92	40	5	60.43	3.764
42	BASALINGAYYA CHANNAPARAYYA MATHPATHI	81	MALE	1037308	84	140/70	C3	169	79	27.71	96	103	0.93	38	5.5	36.32	5.758
43	NAGESH VEERAPPA PUNED	74	MALE	1037530	72	110/80	C2	172	70	24.1	86	92	0.93	35	5.8	94.92	2.943
44	KEMPANNA SANNAPPA BASARAGI	59	MALE	1036952	72	100/80	C2	172	70	24.13	82	88	0.93	34	6.3	75.84	7.103
45	GANGAPPA MALLAPPA DURDUNDI	40	MALE	1037490	58	120/80	B3	160	78	30.46	98	100	0.98	39	5.3	87.73	4.395
46	HASSUMUDDIN HUSSAIN INAMDAR	75	MALE	1037389	76	120/80	C3	176	78	25.18	86	90	0.95	38	5.4	63.87	5.649
47	MAHESH SIDDAPPA NEELANNAVAR	40	MALE	1037321	82	110/70	B3	172	82	27.79	89	98	0.9	37	4.5	42.86	11.484
48	MAHADEVGOUDA MALLPATIL YANKANGOUDA	31	MALE	1039658	76	100/70	A1	168	57	20.19	82	94	0.87	35	5.4	48.93	4.708
49	SHIVAJI YASHWANT PATIL	77	MALE	1039645	90	130/90	C2	168	65	23.03	98	98	1	39	5.1	117.68	4.676
50	IRAPPA TIPANNA BIJANNAVAR	46	MALE	1039714	88	130/90	B1	170	62	21.45	87	93	0.93	39	6	48.52	61.1
51	SIDDAPPA RAMAPPA BUDIGOPPA	43	MALE	1039195	84	100/60	B1	167	60	21.52	85	89	0.95	34	5	90.27	4.422
52	MUTTEPPA LAXMAN UPPAR	40	MALE	1038431	64	140/80	B1	177	65	20.74	80	84	0.95	34	5.2	81.73	5.253
53	JAMES SEBASTIAN ANTHONY	32	MALE	1039645	72	100/60	A1	174	60	19.82	91	97	0.93	37	5.1	154.85	2.936
54	SANTOSH RUDRAPPA LAKKAPPANAVAR	28	MALE	1039496	76	140/70	A1	164	52	19.33	89	93	0.95	37	5.5	118.95	4.867
55	IMMAMSAB HASANSAB HADAR	61	MALE	1040420	76	120/80	C1	170	55	19.03	86	90	0.95	37	5.5	47.08	2.559
56	RAM BALRAM NAGINA	33	MALE	1041425	82	100/60	A3	168	80	28.34	96	100	0.96	38	4.9	41.67	2.074
57	DUNDAPPA SHIVABASAPPA MARIHAL	47	MALE	1040748	76	110/70	B2	168	68	24.2	86	93	0.92	35	5.3	164.61	2.761
58	PARAPPA PANAGONNAVAR	80	MALE	1040979	90	110/80	C1	180	60	18.51	78	82	0.95	33	4.8	249.59	3.252
59	AJEET APPASAB DADDE	36	MALE	1039346	88	100/70	A1	175	62	20.24	76	84	0.9	37	5.6	95.90	5.482
60	SURESH DATTU DEVALI	45	MALE	1042339	84	130/90	B2	168	70	24.8	85	89	0.97	34	5.2	156.67	2.092
61	ASHISH ASHOK CHAVAN	30	MALE	1042407	72	110/70	A3	175	84	27.42	92	102	0.9	40	5.5	204.64	2.958
62	AMARAPPA YAMANAPPA SURAPUR	59	MALE	1042353	64	120/80	C2	168	68	24.2	88	90	0.97	38	6.1	140.85	14.691
63	APPASO SIDRAM KHOT	48	MALE	1042241	72	100/80	B3	160	80	31.25	100	105	0.95	38	5.6	179.73	2.525
64	FAKEERAPPA BHAVAPPA KOMATAGI	50	MALE	1042423	58	110/70	B1	150	43	19.11	72	78	0.92	34	5.2	189.60	2.719
65	BHUJABHALI TAVANNAPPA HARAVI	72	MALE	1042354	76	130/80	C2	168	70	24.88	83	89	0.93	32	6.4	90.19	6.682
66	SUNIL SANGRAM RATHOD	33	MALE	1042131	82	110/80	A3	175	80	26.12	94	106	0.88	38	5.3	174.59	9.199
67	EKHANGOUDA YALLAPAGOUDA MUDHAGHOL	42	MALE	1042100	76	140/80	B3	169	89	31.16	106	110	0.96	44	5.7	190.16	2.614
68	YAMANNAPPA TAMANNA KALKUTAGI	70	MALE	1041051	90	110/80	C3	162	90	34.35	104	98	1.06	35	6.4	343.27	2.824
69	BHEMAPPA DUNDAPPA GULBAGI	48	MALE	1040276	88	120/80	B2	175	74	24.1	88	91	0.96	33	6.3	220.98	1.995
70	SHIVANAND MAREPPA BIRJANNAVAR	70	MALE	1041939	84	100/70	C1	166	58	21.05	84	90	0.93	34	5.7	300.83	32.075
71	BHIMRAYYA NAGAPPA NANDAGI	60	MALE	1043186	64	130/80	C3	172	89	30.16	110	105	1.04	42	5.9	140.36	4.192
72	MAHADEV KHACHEU KHUGAJI	78	MALE	1043440	72	110/80	C1	165	54	19.83	85	89	0.95	34	5.2	65.97	2.583
73	DUNDAPPA BIRAPPA KYATANKERI	48	MALE	1042394	58	110/80	B2	165	66	24.44	83	88	0.94	35	5.4	112.88	5.682
74	VISWANATH BASAPPA MUTTAGI	53	MALE	1042590	76	100/60	B1	168	60	21.25	88	94	0.93	38	5.5	133.49	8.17
75	SHANKARAYYA BASAVANAYYA PUJERI	67	MALE	1043503	76	130/80	C1	171	65	22.26	84	88	0.95	36	6.3	225.24	3.007
76	DUNDAPPA GURUPADDAPA TELI	68	MALE	1043605	76	120/80	C1	168	60	21.25	93	95	0.97	39	5.6	63.01	4.192
77	APPASAB MALLAPPA ANURE	48	MALE	1042527	90	110/70	B1	171	54	18.49	76	81	0.93	33	6.4	44.83	2.583
78	SHRIKANT KALLAPPA SIDDHARTH	58	MALE	1043196	84	120/80	C1	180	64	19.75	84	86	0.97	34	6.4	54.18	5.682
79	PRAKASH SHIVRAM METRI	52	MALE	1040166	84	120/80	B1	172	55	18.64	63	70	0.9	34	6	45.77	8.17
80	SANJAY MAHADEV GONDADKAR	45	MALE	1044088	72	110/80	B3	168	78	27.63	85	93	0.91	36	6.2	46.72	3.007
81	SHIVAGOUDA DOULATGOUDA PATIL	60	MALE	1044188	64	110/70	C3	174	84	27.7	106	103	1.02	42	5.5	22.79	3.482
82	ALLAUDDIN NIJAM PATIL	53	MALE	1043961	72	100/60	B3	170	84	29.06	102	105	0.97	40	5.1	167.65	2.574
83	RAGHAVENDRA JUNANA PUJAR	42	MALE	1043726	58	100/70	B1	175	68	22.2	88	96	0.91	41	4.6	112.21	2.573

84	SUBRAYI ANNAPPA MAGADUM	46	MALE	1043808	76	120/70	B2	166	67	24.31	90	101	0.89	36	4.9	100.28	5.889
85	SACHIN VASANT KOLI	36	MALE	1043253	82	110/80	A1	177	68	21.725	89	93	0.95	38	4.9	101.62	5.026
86	SURESH SHIVAPUTRAPPA GUNDAGANI	37	MALE	1043471	76	110/70	A1	167	54	19.36	75	84	0.89	36	5.7	247.38	3.369
87	TUKARAM LAXMAN HANAMAR	56	MALE	1044151	90	100/70	C1	176	69	22.27	90	101	0.89	38	4.5	80.57	3.048
88	SHANMUKH ISHWAR KASARADDI	40	MALE	1044561	84	130/80	B1	171	65	22.22	84	94	0.89	34	4.4	16.95	3.907
89	RAMAGOUDA SATYAPPA JAINAPURE	49	MALE	1044029	72	100/60	B3	168	78	27.63	100	103	0.97	41	5.6	15.98	3.498
90	VITTAL GOVINDA SAMBHOJI	50	MALE	1043909	64	130/80	B1	172	55	18.64	80	92	0.86	35	6.4	7.75	2.198