ASSESSMENT OF RISK OF NON COMMUNICABLE DISEASES (NCDS) AMONG HYPERTRIGLYCERIDEMIC WAIST PHENOTYPE ADULTS AGED 30-60 YEARS IN URBAN VADODARA

APRIL,2025

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(Dietetics)

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CERTIFICATE

This is to certify that the research work presented in this thesis has been carried out independently by Ms. BHARGAVI BRAHMKHATRI under the guidance of Dr. Swati Dhruv in pursuit of Masters of Science (Faculty of Family and Community Sciences) with major in Foods and Nutrition (Dietetics) and this her original work.

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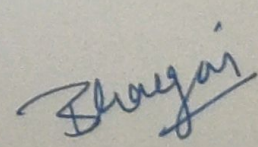

Bhargavi Brahmkhatri

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ABBREVIATIONS :

NCDs – Non-Communicable Diseases

WHO – World Health Organization

DALYs – Disability-Adjusted Life Years

BMI – Body Mass Index

WC – Waist Circumference

WHR – Waist-to-Hip Ratio

SAD – Sagittal Abdominal Diameter

APAD – Anterior-Posterior Abdominal Diameter

HTWP – Hypertriglyceridemic Waist Phenotype

VAT – Visceral Adipose Tissue

CVD – Cardiovascular Disease

COPD – Chronic Obstructive Pulmonary Disease

NAFLD – Non-Alcoholic Fatty Liver Disease

T2DM – Type 2 Diabetes Mellitus

LDL – Low-Density Lipoprotein

HDL – High-Density Lipoprotein

TG – Triglyceride

HT – Hypertension

FBS – Fasting Blood Sugar

GFR – Glomerular Filtration Rate

UACR – Urinary Albumin Creatinine Ratio

ABI – Ankle-Brachial Index

baPWV – Brachial-Ankle Pulse Wave

NFHS – National Family Health Survey

ABSTRACT

Non- Communicable Diseases (NCDs) are on rise globally posing significant public health threat, particularly in urban population where sedentary lifestyle and poor diets exacerbate their prevalence. Early detection and prevention are crucial in addressing their growing burden. Hypertriglyceridemic Waist Phenotype (HTWP), defined by the coexistence of elevated waist circumference (WC) and Triglycerides (TG) recognized as a simple, reliable and cost- effective marker and by integrating these two indicators Hypertriglyceridemic Waist Phenotype (HTWP) offers a comprehensive approach for early detection individuals at risk of metabolic disorder.

Thus this cross sectional study assesses the prevalence of Hypertriglyceridemic Waist Phenotype (HTWP) and its association with the risk of Non communicable Diseases (NCDs). A sample size of 342 (M = 136 , F=206) subjects aged 30-60 years were enrolled from the Vadodara city. Data concerning the Socio-economic status, medical history, anthropometry, biochemical analysis, physical activity, dietary pattern , food frequency and three days 24 hour recall on sub sample). Biochemical Analysis included Fasting Blood Sugar (FBS) and Triglycerides levels (TG).

The prevalence of Hypertriglyceridemic Waist Phenotype (HTWP) was found to be 27.5%. It was distributed almost equally across genders, with 13.9% of males and 13.6% of females exhibiting this phenotype. Participants with HTWP exhibited significantly higher BMI (28.1 ± 4.40 kg/m² vs. 25.2 ± 3.86 kg/m²), waist circumference (94.8 ± 7.53 cm vs. 84.4 ± 10.26 cm), and triglyceride levels (193.5 ± 62.92 mg/dL vs. 104.5 ± 45.69 mg/dL) compared to non-HTWP individuals ($p<0.001$). Additionally, fasting blood sugar (101.7 ± 21.88 mg/dL vs. 93.9 ± 20.35 mg/dL, $p=0.005$) and diastolic blood pressure (85.3 ± 5.19 mmHg vs. 83.4 ± 5.18 mmHg, $p=0.007$) were significantly elevated in the HTWP group, indicating a higher metabolic risk. A gender-wise comparison revealed distinct patterns, with fasting blood sugar (FBS) levels increasing with waist circumference in both genders. In males, FBS was found to be 71.0 mg/dl among normal waist whereas 80.8 mg/dLin larger waist, while in females, it was 75.1 mg/dL among normal waist followed by 84.0 mg/dl in larger waist.. Similarly, triglyceride (TG) levels increased from 90.7 mg/dL to 119.3 mg/dL in males and from 87.0 mg/dL to 118.5 mg/dL in females with increasing waist circumference. The association of HTWP with key risk factors was statistically significant. Obesity, abdominal obesity, and prehypertension were more common in the HTWP group, emphasizing its strong link to cardiometabolic risk. When the HTWP group compared to other phenotypic groups, significant differences emerged. HTWP individuals showed the highest mean values for BMI (28.1 ± 4.43 kg/m²), waist circumference (94.9 ± 7.48 cm), diastolic blood pressure (85.2 ± 5.22 mmHg), and fasting

blood sugar levels (102 ± 21.9 mg/dL) compared to other phenotypes. Triglyceride levels were also notably elevated (195 ± 61.4 mg/dL), emphasizing the distinct metabolic dysregulation associated with HTWP.

This study underscores the utility of HTWP as a simple, reliable, and cost-effective marker for identifying individuals at heightened risk of Non-Communicable Diseases (NCDs). By offering a practical and accessible approach, HTWP proves to be a valuable tool for early detection. These results highlight the significance of integrating HTWP screening into public health strategies, aiming to alleviate the NCD burden through proactive prevention and effective management measures.

CHAPTER 1:

INTRODUCTION

Over the past few decades, global health efforts have largely focused on the prevention and control of communicable diseases such as HIV/AIDS, viral hepatitis, malaria, polio, tuberculosis, influenza, and, more recently, COVID-19. These infectious diseases are considered major public health threats due to their rapid transmission across borders and their immediate impact on populations. However, an even more profound yet often overlooked crisis is unfolding—the "invisible epidemic" of non-communicable diseases (NCDs) (Piovani et al., 2022). NCDs now represent the leading cause of morbidity and mortality worldwide, imposing an immense burden on healthcare systems and economies (Thomas-Lange et al., 2024). As per WHO (2023), Non-Communicable Diseases (NCDs) are responsible for 74% of all the deaths worldwide. More than three-quarters (86%) of NCDs are the leading cause of premature deaths in low and middle-income countries.

The four principal categories of NCDs contributing to the highest global mortality rates include cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes. Cardiovascular diseases, encompassing conditions such as heart disease and stroke, are the most prevalent, responsible for approximately 17.9 million deaths annually. Cancer follows as the second leading cause, accounting for an estimated 9.3 million deaths per year. Chronic respiratory diseases, including bronchial asthma and chronic obstructive pulmonary disease, result in approximately 4.1 million fatalities annually. Furthermore, diabetes mellitus contributes to an estimated 2.0 million deaths each year, underscoring the urgent need for robust prevention, early detection, and comprehensive management strategies (Piovani et al., 2022).

Westernization has played a pivotal role in shaping the epidemiological transition in low- and middle-income countries (LMICs), contributing to a sharp rise in non-communicable diseases (NCDs). As these nations experience rapid economic development, urbanization, and globalization, traditional health patterns are increasingly disrupted, leading to a growing prevalence of cardiovascular diseases, diabetes, and metabolic disorders—conditions that were once predominantly observed in high-income countries (Piovani et al., 2021). This shift is largely driven by structural and socioeconomic transformations, including significant alterations in dietary habits, a surge in the consumption of processed and high-calorie foods, and the adoption of sedentary lifestyles influenced by Western norms (Thomas-Lange & Urra-Miguieles, 2023). These lifestyle changes, facilitated by urban environments and industrial advancements, accelerate the transition from communicable to non-communicable disease burdens, making NCDs a leading public health challenge in LMICs.

In India, non-communicable diseases (NCDs) are currently the leading cause of illness, indicating a significant epidemiological shift in the nation. Historically, the main causes of morbidity and mortality were infectious diseases; however, as economic systems, demographic trends, and lifestyles change, noncommunicable diseases (NCDs) have become the leading cause of death in India, accounting for around 65% of all deaths (Menon et al, 2022). Factors including rising life expectancy, fast urbanization, dietary shifts toward processed and high-calorie meals, physical inactivity, and the pervasive use of alcohol and tobacco are major contributors to this increasing burden (Menon et al, 2022).

The ICMR-INDIAB national cross-sectional study provides critical insights into the prevalence of metabolic NCDs in India, highlighting the widespread nature of these conditions. The study reveals that 28.6% of adults suffer from hypertension, 11.4% have diabetes, and 15.3% are affected by obesity (Anjana et al, 2023). Additionally, dyslipidemia, a major risk factor for cardiovascular diseases, is prevalent in 24% of the population, while high central obesity is observed in 40.3% of adults (Anjana et al.). Cardiovascular diseases remain the foremost cause of NCD-related mortality, followed by chronic respiratory diseases, cancers, and metabolic disorders. Chronic respiratory diseases, including chronic obstructive pulmonary disease (COPD) and asthma, affect 7.0% of the adult population, while cancers, though less prevalent, contribute significantly to the mortality burden (Anjana et al, 2023). According to the systematic review and meta-analysis by Daniel et al. (2021), the overall prevalence of chronic obstructive pulmonary disease (COPD) among adults in India is estimated at 7.4% (95% confidence interval: 5.0%–9.8%).

According to the study by Jena et al. (2024), the cancer prevalence rate in India has shown a significant increase from 1990 to 2021. The age-standardized prevalence rate (ASPR) rose from 1,162.2 per 100,000 population in 1990 to 1,785.0 per 100,000 in 2021. The Health Dossier 2021: Reflections on Key Health Indicators - Gujarat states that morbidity and disability make up 33.8% of the state's overall disease burden, while premature deaths make up 66.2%. In Gujarat, Type 2 diabetes mellitus, chronic obstructive pulmonary disease (COPD), and ischemic heart disease are the main causes of Disability-Adjusted Life Years (DALYs). Non-communicable diseases (NCDs) together account for 59.77%.

Non-communicable diseases (NCDs), including cardiovascular diseases, diabetes, chronic respiratory diseases, and cancers, are primarily caused by a combination of behavioral and metabolic risk factors. Behavioral risk factors such as poor dietary habits, physical inactivity,

tobacco use, and excessive alcohol consumption play a significant role in triggering metabolic disturbances, including hypertension, obesity, hyperlipidemia, and insulin resistance, which in turn accelerate the development of NCDs. Addressing both these categories of risk factors is crucial for reducing the global burden of chronic diseases (Rahelić et al., 2024; Sharma et al., 2024; Onishchenko et al., 2024).

Behavioral Risk Factors and Their Impact on NCDs

Unhealthy dietary patterns are a key contributor to NCDs. Diets high in processed foods, refined sugars, and saturated fats increase the risk of obesity, hypertension, and cardiovascular diseases, whereas diets rich in whole grains, fruits, vegetables, and lean proteins have protective effects (Sakaria & Indongo, 2025; Rahelić et al., 2024; Sharma et al., 2024*)*. Physical inactivity further exacerbates NCD risk by promoting weight gain, reducing insulin sensitivity, and impairing cardiovascular health. Regular physical activity, on the other hand, improves metabolic function, reduces hypertension, and lowers the risk of obesity-related complications (Rahelić et al., 2024; Onishchenko et al., 2024; Xu et al., 2024).

Tobacco use is a leading preventable cause of mortality, significantly increasing the risk of lung cancer, chronic obstructive pulmonary disease (COPD), and cardiovascular diseases. Smoking cessation programs, higher taxation on tobacco products, and stricter regulations on advertising have proven effective in reducing tobacco consumption (Rahelić et al., 2024; Andargie et al., 2024; Sharma et al., 2024). Similarly, excessive alcohol consumption is linked to liver disease, hypertension, and certain cancers. Policy interventions such as alcohol taxation and restrictions on advertising have been recommended to curb alcohol-related health risks (Rahelić et al., 2024; Andargie et al., 2024).

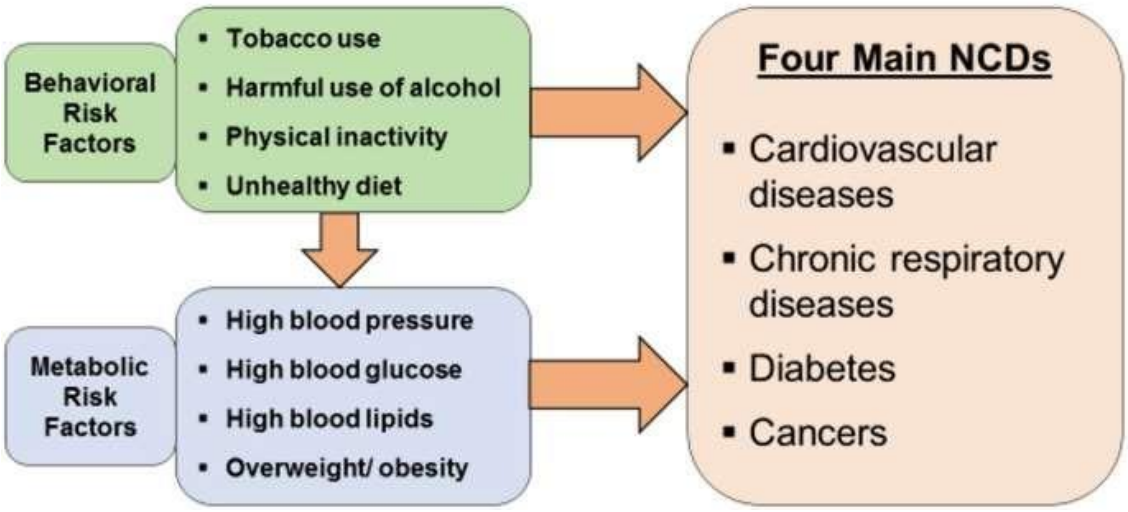
Metabolic Risk Factors and Their Contribution to NCDs

Metabolic risk factors, often exacerbated by behavioral influences, play a significant role in the development of NCDs. Hypertension, a major contributor to cardiovascular diseases and strokes, results from both genetic predisposition and lifestyle choices such as high sodium intake, obesity, and lack of physical activity (Asadi-Aliabadi et al., 2024; Xu et al., 2024*)*. Uncontrolled hypertension can cause endothelial dysfunction, arterial stiffness, and increased cardiac workload, leading to heart failure and other complications (Asadi-Aliabadi et al., 2024; Xu et al., 2024).

Hyperlipidemia, marked by elevated cholesterol and triglyceride levels, is a well-established risk factor for cardiovascular diseases. It often coexists with obesity and insulin resistance, forming a cluster of conditions known as metabolic *syndrome* (Al-Anshary et al., 2024; Asadi-Aliabadi et al., 2024). Obesity, particularly central obesity, is associated with chronic inflammation, dyslipidemia, and insulin resistance, all of which contribute to the development of type 2 diabetes and cardiovascular diseases (Chetry & Collins, 2024; Xu et al., 2024).

Insulin resistance, a hallmark of type 2 diabetes, disrupts glucose metabolism, leading to hyperglycemia and increasing the risk of microvascular and macrovascular complications (Al-Anshary et al., 2024; Asadi-Aliabadi et al., 2024). This condition is closely linked to obesity and sedentary lifestyles, reinforcing the importance of physical activity and dietary modifications in diabetes prevention (Asadi-Aliabadi et al., 2024).

Fig 1.1 Behavioural and Metabolic Risk Factor



:Source: WHO, 2022 – Tackling Noncommunicable Diseases

Global Prevalence of NCD Risk Factor

Behavioral factors serve as triggers for metabolic disturbances and are shaped by societal, cultural, and environmental conditions, which may include urban development, socioeconomic inequalities, and insufficient healthcare systems. The ongoing rise in the occurrence of

metabolic risk factors, often reinforced by behavioral influences, has been linked to an increase in the incidence of non-communicable diseases (NCDs), particularly among individuals aged

30 to 70 years (Tewabe et al, 2021). The 2017 Global Burden of Disease Study reported that metabolic risk factors accounted for a significant share (26%) of total disability-adjusted life-years (DALYs). Specifically, high blood pressure, elevated fasting plasma glucose, increased body mass index (BMI), and high cholesterol levels contribute to 9%, 7%, 6%, and 4% of global DALYs, respectively. Additionally, estimates from 2019 indicated that 463 million individuals (9%) have diabetes, with projections suggesting that this figure will rise to 700 million (11%) by 2045 (Tewabe et al, 2021).

Regional Variations in NCD Risk Factors

The prevalence of behavioral and metabolic risk factors varies across regions. In urban areas, sedentary lifestyles and unhealthy dietary habits contribute to higher rates of obesity and hypertension. In contrast, rural regions often report higher tobacco and alcohol use. For instance, in India, urban populations exhibit greater levels of obesity and hypertension, whereas rural populations have higher rates of tobacco consumption (Chetry & Collins, 2024; Sharma et al., 2024).

One of the main risk factors for non-communicable diseases (NCDs) is overweight or obesity, and the burden of this condition is unacceptably increasing as a global pandemic (Djalalinia et al., 2020). According to YC et al. (2019), the likelihood of being overweight or obese was higher in both developed and developing nations than in those with lower incomes. In 2022, the World Health Organization (WHO) reported that 890 million (16%) of the world's people aged 18 and over were obese, and 2.5 billion (43%) were overweight (World Health Organization, 2024a). Since 1990, the load has more than doubled (World Health Organization, 2024a). It is commonly known that obesity is associated with poor health consequences. Overweight and obesity cause around 2.8 million deaths globally each year, and 35.8 million (2.3 million).

One of the main causes of metabolic dysfunction and a major risk factor for non-communicable diseases (NCDs) such cardiovascular disease, type 2 diabetes, hypertension, and metabolic syndrome is abdominal obesity, especially visceral adiposity. Visceral fat is more metabolically active than subcutaneous fat, generating adipokines, free fatty acids, and pro-inflammatory cytokines that lead to endothelial dysfunction, insulin resistance, and systemic inflammation (Després, 2006). By raising circulating triglycerides and low-density lipoprotein (LDL) cholesterol while lowering high-density lipoprotein (HDL) cholesterol, visceral fat accumulation changes lipid metabolism, promoting atherogenesis and raising the risk of

coronary artery disease (Després, 2006). Furthermore, too much visceral fat causes the overproduction of inflammatory markers like C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α), which worsen insulin resistance and endothelial dysfunction and accelerate the development of cardiovascular diseases (Després, 2006; Lumeng & Saltiel, 2011).

One significant way abdominal obesity contributes to metabolic disorders is through its impact on insulin sensitivity. Visceral fat accumulations release an abundance of free fatty acids (FFAs) into the portal circulation, which disrupts insulin signaling in both the liver and skeletal muscles. This disruption results in the liver producing too much glucose and a reduction in glucose uptake by peripheral tissues, key characteristics of type 2 diabetes (Kahn et al., 2006). Additionally, high levels of FFAs interfere with the function of pancreatic β-cells, leading to decreased insulin secretion and increased hyperglycemia, which further exacerbates metabolic decline (Kahn et al., 2006; Ginsberg, 2000). Furthermore, abdominal obesity is linked to an overactive renin-angiotensin-aldosterone system (RAAS), which contributes to hypertension by enhancing sodium retention, blood volume, and vascular resistance, all of which raise blood pressure and lead to left ventricular hypertrophy (Engeli et al., 2003).

Since visceral fat is a key component of metabolic dysregulation, central obesity is best evaluated by waist circumference (WC) and waist-to-hip ratio (WHR), as opposed to general obesity, which is determined by body mass index (BMI). Abdominal obesity is characterized by a WC of ≥90 cm in men and ≥80 cm in women. According to studies, visceral obesity raises the risk of atherosclerosis and coronary artery disease by causing insulin resistance, systemic inflammation, and endothelial dysfunction (Mensila et al., 2024).

According to the ICMR-INDIAB national cross-sectional research, 40.3% of Indian adults suffer from abdominal obesity, indicating a significant burden on the populace (Anjana et al., 2023). This study evaluated abdominal obesity using waist circumference measurements, which is in line with global guidelines. According to additional analysis of data from the National Family Health Survey-5 (2019–2021), 12% of men and 40% of women nationwide suffer from abdominal obesity (Chaudhary & Sharma, 2023). Interestingly, between 50% and 60% of women between the ages of 30 and 49 are afflicted (Chaudhary & Sharma, 2023).

A combination of anthropometric measurements and imaging methods are used to evaluate abdominal obesity. For assessing visceral fat, magnetic resonance imaging (MRI) and computed tomography (CT) are the gold standards because they can accurately distinguish

between visceral and subcutaneous adipose tissue. However, their high price and restricted availability prevent them from being widely used (Li et al., 2024). The simplicity and affordability of anthropometric measurements, like sagittal abdominal diameter (SAD), waist circumference (WC), and waist-to-hip ratio (WHR), make them popular (Mouchti et al., 2023).

An option that has a strong correlation with visceral adiposity is SAD, which is evaluated when supine (Nishmita & Shankar, 2022). Dual-energy X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA) are more recent techniques that measure fat composition, albeit they may be affected by hydration and other variables (Mouchti et al., 2023). Compared to WC alone, studies indicate that SAD and anterior-posterior abdominal diameter (APAD) may be more accurate indicators of visceral fat (Shikuma et al., 2025). While waist circumference (WC) remains a widely used and cost-effective measure, WC offers a more accurate measure of fat distribution, especially in diseases like metabolic syndrome and polycystic ovarian syndrome (PCOS). According to Singh et al. (2022), their research revealed that WC had a higher association (r=0.75) with BMI than waist-to-hip ratio (r=0.40), confirming its use as an easy and efficient screening method.

Hypertriglyceridemic Waist Phenotype

One such tool for evaluating abdominal obesity is the Hypertriglyceridemic Waist Phenotype (HTWP), a metabolic marker that identifies people at higher risk of insulin resistance, visceral adipose tissue (VAT) accumulation, and cardiometabolic disorders by combining elevated waist circumference (WC) and elevated triglyceride (TG) levels (Tian et al., 2020). The standard definition of HTWP is a waist circumference of 90 cm or more for males and 85 cm or more for women, and triglyceride levels of 150 mg/dL or above (Mendoza-Vázquez et al., 2023). Although Computed Tomography and Magnetic Resonance Imaging are still the gold standards for evaluating VAT, their high cost, labor-intensive processes, and restricted accessibility make them unsuitable for general clinical usage (Yu et al., 2020). Furthermore, CT exposes participants to radiation, which restricts its use in long-term research.

With a sensitivity of 81.08% and specificity of 90.91% in predicting visceral fat accumulation, HTWP, on the other hand, has shown a strong association with VAT accumulation and is a useful, non-invasive, and affordable substitute (Tian et al., 2020). Although beneficial, traditional anthropometric measurements like sagittal abdominal diameter (SAD), waist circumference (WC), and waist-to-hip ratio (WHR) are limited in their capacity to accurately predict cardiometabolic risk because they cannot distinguish between visceral and

subcutaneous fat (Mouchti et al., 2023). Studies have repeatedly shown that HTWP is a better predictor of metabolic syndrome and is more strongly linked to VAT-related metabolic dysfunction than WC alone (Tian et al., 2020). This was further supported by a study by Bao et al. (2023), which found a strong correlation between HTWP and left ventricular hypertrophy (LVH), a condition linked to excessive VAT. This suggests that HTWP may be a more accurate predictor of cardiovascular complications than traditional anthropometric measurements.

Research has confirmed that Hypertriglyceridemic Waist Phenotype (HTWP) is a strong predictor of metabolic syndrome (MetS), cardiovascular disease (CVD), and type 2 diabetes (T2DM). The EPIC-Norfolk Study in the UK linked HTWP to a higher risk of coronary artery disease (CAD), independent of other risk factors. In China, HTWP was associated with a 4.1-fold higher risk of fatty liver, increased insulin resistance, and fatty pancreas (Arsenault, B. J., et al. (2010). Studies in South Africa, Thailand, Canada, and China have identified HTWP as the strongest predictor of hypertension and T2DM in women. In Canada, HTWP was linked to earlier onset of CAD in glucose-intolerant individuals. In Morocco and East Asia, HTWP has been confirmed as a strong association with MetS, dyslipidemia, and hypertension. A U.S. cohort study reported a 2.5-fold increase in cardiovascular events among HTWP individuals. The Canadian study established HTWP as a key MetS marker, increasing CVD risk by 3.6-fold. These studies confirm HTWP as a superior, cost-effective tool for early cardiometabolic risk detection, outperforming BMI and weight control alone (Lemieux et al. (2007)

In an urban Indian research with 2,117 participants, the incidence of HTWP and isolated hypertriglyceridemia (iHTG) was evaluated. It was shown that 17.8% of individuals had HTWP, with a greater frequency among women. According to Snehalatha et al. (2011), HTWP was more prevalent in those with glucose intolerance and was closely associated with atherogenic dyslipidemia, which is defined by higher LDL/HDL ratios. This suggests that HTWP may be used as an inexpensive screening tool for diabetes and dyslipidemia.

Rationale of the study :

Non-communicable diseases (NCDs) have emerged as the primary cause of death and disability globally, with India witnessing a significant increase in their occurrence due to urban growth, inactive lifestyles, and changes in diet. Among different metabolic risk indicators, the Hypertriglyceridemic Waist Phenotype (HTWP)—characterized by a combination of

abdominal obesity and raised triglyceride levels—has been identified as a strong indicator of insulin resistance, metabolic syndrome, cardiovascular disease (CVD), and type 2 diabetes mellitus (T2DM). Although studies conducted in Western populations have consistently associated HTWP with higher cardiometabolic risk, research regarding its prevalence and effects in Indian populations is limited. Considering that Indians are more prone to central obesity and abnormal lipid profiles, it is essential to investigate HTWP within this demographic to evaluate its influence on the development of metabolic disorders specific to them.

HTWP has demonstrated to be a more accurate and cost-efficient measure of cardiometabolic risk than traditional anthropometric assessments. Nonetheless, there is a lack of region-specific data examining its prevalence and relationship with NCD risk among Indian adults, especially in urban settings where lifestyle factors significantly influence metabolic disruptions.

Recent research indicates that HTWP is not only associated with metabolic syndrome but also with organ-specific issues such as liver fat accumulation, fat buildup in the pancreas, and vascular impairment. Individuals displaying this phenotype typically exhibit elevated levels of inflammatory markers, endothelial dysfunction, and arterial rigidity, which serve as early signs of atherosclerosis and cardiovascular diseases. The connection between HTWP and non-alcoholic fatty liver disease (NAFLD) has been examined in some populations; however, there is still insufficient data from India. Additionally, the combination of hypertriglyceridemia and central obesity has been linked to a heightened risk of microvascular complications, especially among those with pre-diabetes or undiagnosed diabetes, emphasizing the need to explore its significance in the Indian context.

Moreover, it will assess whether HTWP contributes to an increased incidence of hypertension and cardiovascular risks independently of BMI, which addresses a significant gap in the current understanding of metabolic health research in India. By analyzing the prevalence of HTWP among adults aged 30–60 years in urban Vadodara and exploring its relationship with key NCD risk factors such as hypertension, dyslipidemia, diabetes, and cardiovascular issues, this study aims to offer data-driven insights into the metabolic health state of this urban population.

CHAPTER 2:

REVIEW OF LITERATURE

Non-communicable diseases (NCDs) are becoming a more significant and potentially catastrophic worldwide health concern. Due to factors including aging, increased urbanization, decreased physical activity, poor diets, and exposure to environmental carcinogens, the epidemiological transition—characterized by altered patterns in the causes of morbidity and mortality—has shifted from communicable diseases toward noncommunicable diseases (NCDs). According to the recent global burden of disease studies, NCDs are now responsible for nearly 75% of deaths worldwide, with a particularly concerning increase in low and middle-income countries. The latest projections indicate that by 2025, NCDs will account for approximately 80% of the global disease burden (Global Burden of Diseases, 2023).

Global Prevalence of Non-Communicable Diseases

Non-communicable diseases (NCDs) cover a broad spectrum of medical conditions such as Cardiovascular Diseases, Chronic Respiratory Diseases, Diabetes, and cancer. As per WHO (2023), Non-Communicable Diseases (NCDs) are responsible for 74% of all the deaths worldwide. More than three-quarters (86%) of NCDs are the leading cause of premature deaths in low and middle-income countries. The major NCDs responsible for all these deaths included cardiovascular diseases (CVD) responsible for 17.9 million deaths annually (44% of all NCD deaths), Cancers responsible for 9.3 million deaths annually (22% of all NCD deaths), Chronic Respiratory Diseases responsible for million deaths annually (9% of all the NCD deaths), Diabetes responsible for 1.6 million deaths annually (4% of all the NCD deaths).

This global health challenge is particularly evident in the cardiovascular disease burden, which has shown alarming trends in recent years. A 2024 comprehensive analysis published in The Lancet Regional Health demonstrates that while communicable diseases have declined, NCDs have risen dramatically, creating a complex "double burden" of disease in many regions.

National Prevalence of Non-Communicable Diseases

Like many other nations, India is experiencing a significant epidemiological shift characterized by a dramatic shift in the prevalence of NCDs. According to recent epidemiological reviews, this transition is fueled by several factors including rapid urbanization, shifts in dietary habits, sedentary lifestyles, and aging of the population. As per WHO Non-Communicable Disease Progress Monitor 2022, 66% of total deaths in India are related to NCDs.

Another ICMR-INDIAB cross-sectional, population-based survey of adults 20 years and older offers valuable insights into the prevalence of Diabetes, Hypertension, and Dyslipidemia. The

study reveals the overall weighted prevalence of Diabetes as 11.4%, hypertension at 35.5%, whereas 81.2% of individuals exhibit dyslipidemia. This study suggested that all the metabolic NCDs except prediabetes were more frequent in Urban than rural areas (Dr Mohan et al, 2023).

According to the systematic review and meta-analysis by Daniel et al. (2021), the overall prevalence of chronic obstructive pulmonary disease (COPD) among adults in India is estimated at 7.4% (95% confidence interval: 5.0%–9.8%). According to the study by Jena et al. (2024), the cancer prevalence rate in India has shown a significant increase from 1990 to 2021. The age-standardized prevalence rate (ASPR) rose from 1,162.2 per 100,000 population in 1990 to 1,785.0 per 100,000 in 2021.

State-Level Prevalence for Non-Communicable Diseases:

As per the ICMR-INDIAB study, the overall prevalence of NCDs like diabetes in Gujarat ranges from 7.5%-9.5% whereas the prevalence of hypertension ranges from 25-29.9%, and dyslipidemia accounts for more than 25%. As per this study, the prevalence in the urban population of Gujarat state is greater than in the rural areas (Dr. Mohan et al,2023).

Risk Factors for Non-Communicable Diseases:

Non-communicable diseases (NCDs), such as cardiovascular diseases, diabetes, cancer, and chronic respiratory diseases, are primarily driven by a combination of metabolic and behavioral risk factors. Metabolic risk factors refer to physiological or biological conditions like elevated blood pressure, high blood glucose, abnormal lipid profiles, and obesity, which increase the likelihood of NCD development (Budreviciute et al., 2021). Behavioral risk factors, on the other hand, encompass modifiable lifestyle practices such as tobacco use, unhealthy diet, physical inactivity, and excessive alcohol consumption. These risks often interact synergistically; creating a feedback loop that accelerates the onset of NCDs (Budreviciute et al., 2021). Metabolic factors like obesity and hypertension directly contribute to pathophysiological changes, including insulin resistance and arterial damage, that underlie chronic diseases (Budreviciute et al., 2021). Behavioral factors act as precursors by triggering these metabolic disturbances and are influenced by societal, cultural, and environmental contexts, which can include urbanization, socioeconomic disparities, and inadequate healthcare systems. The continual increase in the prevalence of metabolic risk factors, often reinforced by behavioral factors, has been associated with a direct increase in the prevalence of NCDs, especially among adults between the ages of 30 and 70 years (Tewabe et al, 2021).

According to the 2017 Global Burden of Disease Study, metabolic risk factors contributed to a substantial proportion (26%) of the total disability-adjusted life-years (DALYs). High BP, high fasting plasma glucose, high body mass index (BMI), and high cholesterol are responsible for 9%, 7%, 6%, and 4% of global DALYs, respectively. Besides, the 2019 estimates on DM prevalence revealed that 463 million people (9%) have diabetes and this number is projected to rise to 700 million (11%) by 2045 (Tewabe et al, 2021).

Obesity is widely recognized as a significant metabolic risk factor for the development of non-communicable diseases (NCDs), contributing substantially to global morbidity and mortality. Defined by an excessive accumulation of adipose tissue, obesity disrupts metabolic homeostasis and is closely associated with systemic inflammation, insulin resistance, and altered lipid metabolism, creating a pathway to numerous chronic diseases (WHO, 2021). One of the most evident outcomes of obesity is an increased risk of cardiovascular diseases, including hypertension, atherosclerosis, and coronary artery disease, driven by endothelial dysfunction and heightened oxidative stress (Smith et al., 2020). Obesity also plays a central role in the pathogenesis of type 2 diabetes mellitus (T2DM) through its adverse effects on insulin sensitivity and pancreatic β-cell function (Smith et al., 2020). Furthermore, chronic low-grade inflammation linked to obesity elevates susceptibility to malignancies, including colorectal, breast, and endometrial cancers (WHO, 2021).

Beyond metabolic dysfunctions, obesity exacerbates respiratory conditions such as obstructive sleep apnea and asthma, primarily through its impact on pulmonary mechanics and systemic inflammation (Brown et al., 2019). Obesity also promotes the progression of chronic kidney disease (CKD) by exacerbating hypertension, hyperglycemia, and increased glomerular filtration pressure (Brown et al., 2019). Importantly, obesity synergizes with other metabolic conditions, amplifying their severity and overall burden (Smith et al., 2020).

Among the forms of obesity, abdominal obesity emerges as a more severe and metabolically active subtype, characterized by an excessive accumulation of visceral fat. Central obesity is defined by the World Health Organization defined central obesity as a waist circumference (WC) greater than 94 cm and 80 cm for males and females, respectively. The International Diabetes Federation proposed different cut-off points for different ethnic groups (e.g. 94 cm for males and 80 cm for females for Europeans, 90 cm for males and 80 cm for females for Asians)This form is particularly detrimental due to its secretion of pro-inflammatory adipokines fostering a chronic inflammatory state (Dhawan & Sharma, Year). Visceral fat’s

metabolic activity disrupts insulin signaling, promoting hyperglycemia and significantly increasing the risk of T2DM (Smith et al., 2020). Furthermore, the release of free fatty acids into the portal circulation exacerbates hepatic steatosis and dyslipidemia, enhancing the likelihood of cardiovascular diseases (Brown et al., 2019). Abdominal obesity also serves as a primary driver of hypertension, (Dhawan & Sharma, Year). The pro-inflammatory and pro-oxidative milieu of abdominal obesity intensifies endothelial dysfunction and atherogenesis, leading to an elevated risk of coronary artery disease and stroke (Smith et al., 2020). Additionally, it contributes to non-metabolic conditions, such as polycystic ovary syndrome (PCOS) and certain cancers, highlighting its systemic implications (Brown et al., 2019).

Global Prevalence of Obesity and Abdominal Obesity

Recent estimates from the World Health Organization (WHO) underline the severity of this issue. In 2022, approximately 2.5 billion adults (43% of the global population aged 18 years and older) were classified as overweight, with 890 million (16%) of these individuals living with obesity (World Health Organization, 2024a). Furthermore, 35.8 million global disability-adjusted life years (DALYs), accounting for 2.3% of the total global burden, are linked to these conditions (World Health Organization, 2024b). The global prevalence of abdominal obesity is 41.5%, based on a systematic review of over 13.2 million individuals (Wong et al., 2020).

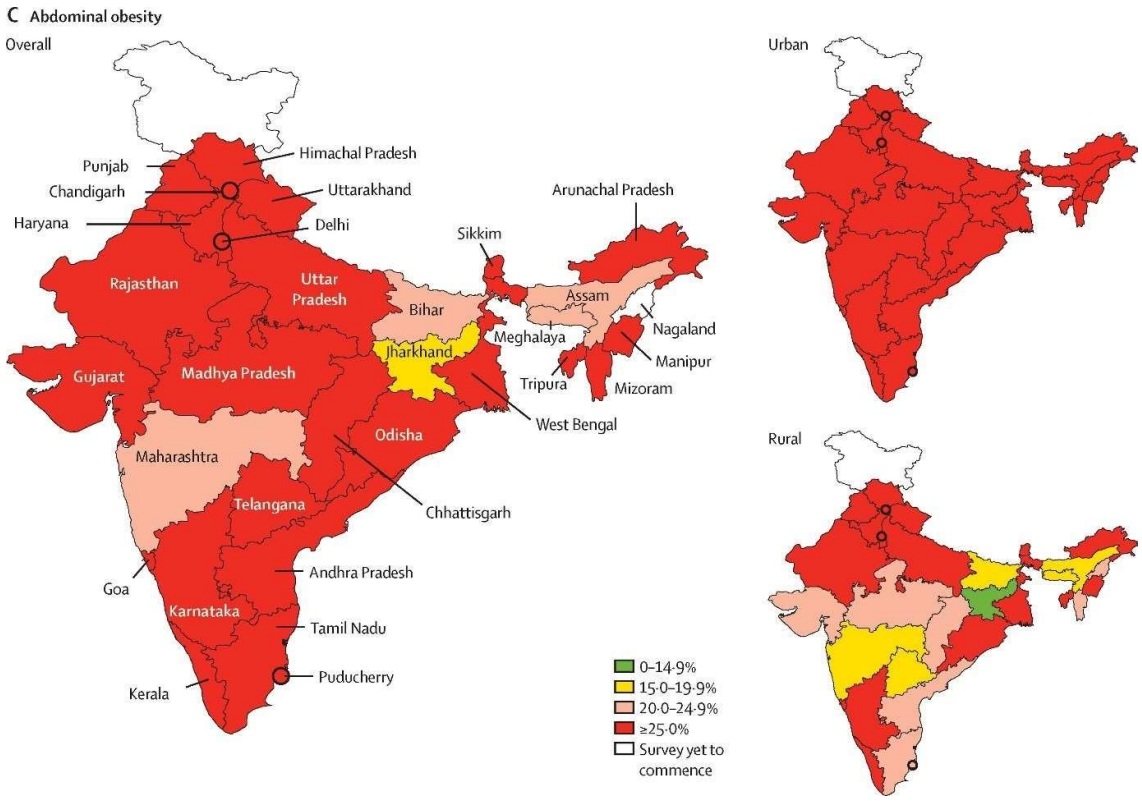
National Prevalence of Obesity and Abdominal Obesity

The overall prevalence of overweight and obesity in the Indian population, as assessed by BMI, is 23% in women and 22.1% in men. Abdominal obesity, measured through waist circumference, demonstrates a higher prevalence, with 40% of women and 12% of men affected. Urban areas exhibit significantly greater rates of abdominal obesity, with prevalence at 49.5% in women and 15.7% in men, compared to rural areas where the prevalence is 35% in women and 10% in men.

Age-wise analysis shows a progressive increase in abdominal obesity. Among women, prevalence rises from 12.7% in the 15–19 age group to 32.2% in the 20–29 age group, 49.3% in the 30–39 age group, and 56.7% in the 40–49 age group. Similarly, among men, prevalence increases from 2.5% in the 15–19 age group to 7.4% in the 20–29 age group, 16% in the 30–39 age group, and 19.7% in the 40–49 age group. These statistics highlight a growing burden of obesity, particularly among women and middle-aged adults. Urban-rural disparities further reflect the impact of lifestyle and socioeconomic factors on obesity prevalence. This

underscores the need for age and region-specific public health interventions to combat obesity-related health risks in India (Chaudhary & Sharma, 2021).

Figure 2.1 Prevalence of Abdominal obesity



Source: The Lancet Global Health, India State-Level Disease Burden Initiative, 2019

Prevalence of Obesity and Abdominal obesity in Gujarat

According to NFHS-5 (2019–21), 20% of men and 23% of women in Gujarat between the ages of 15 and 49 are overweight or obese. According to the waist-to-hip ratio (WHR), 44% of women and 41% of men in this age group suffer from abdominal obesity; rates are greater in urban areas (47% for women and 43% for men) than in rural regions (41% for women and 39% for men). In the 15–19 age group, 35% of women and 24% of men suffer from abdominal obesity; by the 40–49 age group, that number rises to 52% and 56%, respectively.

There are various tools to assess obesity and abdominal obesity, each with distinct advantages and limitations. Body Mass Index (BMI) is the most commonly used measure for general

obesity, offering a simple calculation based on weight and height, but it does not account for fat distribution or distinguish between fat and muscle mass.

For abdominal obesity, waist circumference (WC) is a straightforward and widely adopted method, with population-specific thresholds (e.g., >90 cm for men and >80 cm for women in Asian populations). Waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) provide additional insights by factoring in proportionality, with WHtR showing particular promise for its ease of use and strong correlation with cardiometabolic risks.

Advanced imaging techniques like dual-energy X-ray absorptiometry (DXA) and magnetic resonance imaging (MRI) offer precise measurements of visceral fat but are less feasible for routine use due to cost and complexity. Emerging anthropometric indices, such as the body adiposity index (BAI) and the conicity index, are being explored for their ability to capture body fat distribution more effectively. Despite these advancements, WC remains the most practical and efficient tool for assessing abdominal obesity in clinical and public health settings, given its simplicity and strong association with health risks (Fang et al., 2018).

However, each of these tools has limitations in accurately identifying individuals at the highest risk. BMI, though widely used, does not distinguish between lean and fat mass, nor does i

t account for fat distribution (Després, 2012). Similarly, waist circumference, while indicative of abdominal obesity, cannot differentiate between subcutaneous and visceral fat, the latter

being more strongly associated with metabolic abnormalities (Després et al., 2008). To overcome these limitations, the hypertriglyceridemic-waist phenotype (HTWP) has emerged as a superior screening tool by combining increased waist circumference with elevated triglyceride levels (Arsenault et al., 2010).

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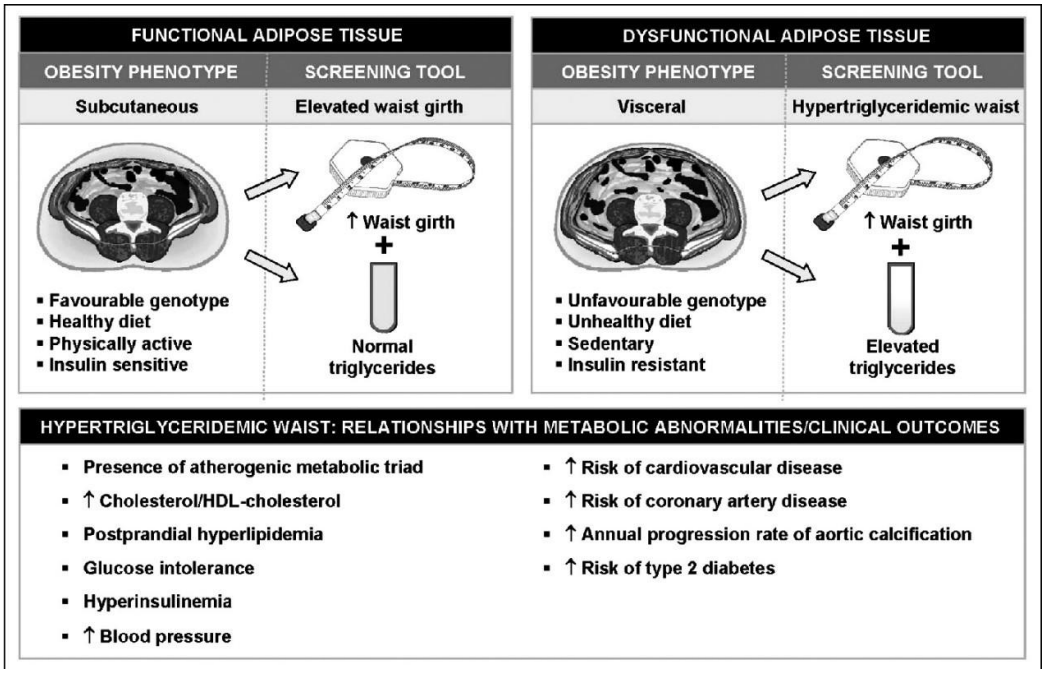
Figure 2.1: Comparative View of Functional vs. Dysfunctional Adipose Tissue and Their Associations with Metabolic Risks.



Source: Lemieux et al., Canadian Journal of Cardiology, 2007

What is the Hypertriglyceridemic Waist Phenotype?

The Hypertriglyceridemic Waist Phenotype (HTWG) is represented by the simultaneous presence of an increased waist circumference (> 90cm in men and > 80 cm in women) with elevated fasting triglyceride concentration (2.0mmol/L).

This phenotype serves as an indirect but effective marker of intra-abdominal adiposity and dysfunctional fat metabolism. Imaging studies using computed tomography (CT) and magnetic resonance imaging (MRI) have demonstrated that excess visceral fat, rather than total body fat, is more predictive of insulin resistance and cardiovascular risk (Arsenault et al., 2010). Although these imaging techniques provide the most precise assessment of fat distribution, their high cost and limited accessibility make them impractical for large-scale screenings. In contrast, HTWP is a simple, inexpensive, and clinically viable alternative that integrates both

anthropometric and metabolic risk factors, thereby offering a more accurate prediction of cardiometabolic diseases (Lemieux et al., 2000).

The hypertriglyceridemic-waist phenotype serves as a cost-effective method to address the limitations of traditional tools like BMI and WC, focusing on identifying visceral fat's metabolic dysfunction. As depicted in Figure 2.1, functional subcutaneous adipose tissue exhibits insulin sensitivity and metabolically favorable traits, while dysfunctional visceral adipose tissue is linked to insulin resistance, dyslipidemia, and chronic inflammation. This distinction underscores the critical role of visceral adiposity in driving cardiometabolic risks, which HTWP aims to effectively screen

Global Level Studies

The EPIC-Norfolk Prospective Population Study, conducted among 25,000 middle-aged adults (aged 45–79 years) from the United Kingdom, examined the hypertriglyceridemic-waist phenotype (HTWP) as a predictor of coronary artery disease (CAD). The study found that individuals with both increased waist circumference and elevated triglycerides had a significantly higher risk of CAD, independent of other cardiovascular risk factors (Arsenault et al., 2010). HTWP was strongly associated with intra-abdominal visceral fat, which contributes to insulin resistance, dyslipidemia, and inflammation—key drivers of cardiovascular disease. The study reinforced that not all obese individuals are metabolically unhealthy, highlighting the importance of distinguishing between subcutaneous and visceral fat for accurate risk assessment. Given its simplicity and cost-effectiveness, HTWP is a practical tool for identifying individuals at higher risk for CAD and type 2 diabetes, making it valuable for large-scale health screenings.

Another study conducted on Chinese adults explored the association between the hypertriglyceridemic waist phenotype (HTWP) and the risk of fatty liver and glycometabolic disorders in overweight and obese individuals. This cross-sectional study included 1,221 participants (mean age 37 years, 37.3% male, 62.7% female), categorized into four phenotypic groups based on triglyceride levels and waist circumference. Results indicated that individuals with HTWP had a 4.1-fold higher risk of fatty liver, a twofold increase in insulin resistance, and a 2.8-fold elevation in HbA1c compared to those with normal triglyceride and waist measurements. These associations were particularly significant in females, overweight individuals, and those with normal blood pressure. The study highlights HTWP as a cost-effective, non-invasive screening tool for identifying individuals at high risk of metabolic

disorders, emphasizing its potential clinical application for early intervention (Zhou et al., 2022). Another study conducted on Chinese adults examined the relationship between the Hypertriglyceridemic waist phenotype (HTWP) and fatty pancreas (FP), a condition linked to obesity, metabolic syndrome, and diabetes. The study included 1,241 participants (mean age 45.7 years, 46.8% male) and categorized them into four phenotypic groups based on waist circumference and triglyceride levels. Findings showed a strong correlation between HTWP and FP, with individuals in the HTWP group having significantly higher prevalence rates of FP (54.7% vs. 21.0% in non-HTWP individuals (Yu et al., 2020).

In a study conducted on 1,349 subjects aged 15–65 years from Durban, KwaZulu-Natal, the hypertriglyceridemic waist (HTGW) phenotype was identified in 35.4% of participants, with a higher prevalence in women (36.1%) and 8.2% among smokers. The study found a significant association between the HTGW phenotype and metabolic derangements, as well as an increased risk of cardiovascular disease. Notably, individuals with the HTGW phenotype had markedly higher odds (OR: 19.7, 95% CI: 13.9–27.9) of developing metabolic syndrome (MetS), emphasizing its role as a reliable marker for early detection of metabolic and cardiovascular risk. (Prakaschandra & Naidoo,2022).

A study found that abdominal obesity (AO), hypertriglyceridemia (eTG), and the hypertriglyceridemic waist (eTGWC) phenotype are associated with an increased risk of hypertension (HT) and type 2 diabetes mellitus (T2DM). Conducted on the Thai population, it revealed that in men, AO was the best marker for HT, while eTG was the best marker for T2DM. In women, eTGWC was the best marker for both HT and T2DM. The findings suggest that waist circumference and fasting triglycerides can serve as inexpensive screening tools to identify individuals at high risk for HT and T2DM, aiding in early intervention and management (Tangvarasittichai et al., 2015).

A study conducted on a population of 1,190 men and women from Canada investigated the relationship between the hypertriglyceridemic waist (HTWP) phenotype and earlier manifestations of coronary artery disease (CAD) in patients with glucose intolerance and type 2 diabetes mellitus. The researchers found that individuals exhibiting the HTWP phenotype, characterized by a waist circumference greater than 90 cm in men and greater than 85 cm in women, coupled with triglyceride levels exceeding 2.0 mmol/L, exhibited symptoms of CAD approximately five years earlier than those without this phenotype ((St-Pierre et al., 2007). This study highlights the potential of the HTWP phenotype as an efficient and cost-effective

marker for identifying individuals at higher risk of CAD. A cross-sectional study conducted on a Chinese middle-aged and older population (aged 40-79 years) investigated the association between the hypertriglyceridemic waist (HTWP) phenotype and hypertension. The study included 9,015 participants and found that individuals with the HTWP phenotype, characterized by a waist circumference greater than 90 cm in men and greater than 85 cm in women, along with elevated triglyceride levels, had a 79.8% higher prevalence of hypertension compared to those without this phenotype. Additionally, this study underscores the importance of monitoring waist circumference and triglyceride levels as critical factors in the early identification and prevention of hypertension among middle-aged and older adults (Xuan et al., 2022).

The hypertriglyceridemic waist (TG+WC+) phenotype's epidemiological features in the Moroccan Amazigh community in the Souss region are examined in the study by Najeh et al. (2024), along with its correlation with cardiovascular risk factors and metabolic syndrome (MetS). The study examined 827 persons and discovered that 27.7% of them had the TG+WC+ phenotype, with a higher prevalence in women (74.2%) and people between the ages of 41 and 60 (53.3%). This phenotype was strongly associated with cardiovascular risk and MetS, with considerably higher rates of general obesity (37.12%), hypoHDLaemia (69.9%), and dyslipidemia (87.3%).

Studies conducted in East Asia, particularly in Japan and South Korea, have shown that HTWP prevalence varies significantly with ethnicity and lifestyle factors, yet consistently correlates with metabolic syndrome and its components. Research in South Korea demonstrated that men and women with HTWP had significantly higher rates of high blood pressure, elevated fasting glucose, and dyslipidemia, marking HTWP as a strong predictor of metabolic syndrome in Asian populations (Park et al., 2012). Another study in Japan echoed these findings, noting that HTWP was associated with increased risks of both type 2 diabetes and hypertension, with the phenotype proving to be a more sensitive marker than BMI alone for metabolic health risks (Kim et al., 2014).In the United States, research has also underscored the predictive value of HTWP for cardiovascular events. In a cohort study conducted by Arsenault et al. (2010) in a population sample of over 5,000 adults, HTWP was associated with a significantly elevated risk of major cardiovascular events, including myocardial infarction and stroke. Participants with HTWP showed a 2.5-fold increase in cardiovascular events over a 10-year follow-up period. This study highlighted HTWP as a useful tool for identifying high-risk individuals

within clinical settings, particularly among those who may not be classified as high-risk based on BMI alone.

The foundational research on HTWP was conducted in Canada, where Lemieux et al. (2007) highlighted the phenotype's significance in identifying individuals at elevated risk for cardiovascular diseases (CVDs). In this study, HTWP was found to be an effective screening marker for metabolic syndrome, independent of body mass index (BMI), with strong correlations to visceral adiposity and insulin resistance. Men presenting with HTWP had an 80% higher likelihood of possessing the "atherogenic metabolic triad" (high triglycerides, low HDL cholesterol, and high LDL cholesterol), conditions that significantly elevate cardiovascular disease risk. This study also found that men with HTWP had a 3.6-fold higher risk of coronary artery disease compared to those without the phenotype.

The study by Oliveira et al. (2014) examines the association between the hypertriglyceridemic waist (HTW) phenotype and metabolic disorders, particularly visceral fat accumulation, in a sample of 191 adults of both sexes. Participants were grouped based on waist circumference (WC) and triglyceride (TG) levels into those with the HTW phenotype (elevated WC and TG) and those without it. The study found that 82% of individuals with the HTW phenotype exhibited three or more cardiovascular risk factors. Among men, 73.7% had hypercholesterolemia, 94.9% had elevated non-HDL cholesterol, and 78.9% had excessive visceral adipose tissue (VAT). Similarly, among women, 65% had elevated systolic blood pressure, 80% had hypercholesterolemia, and 90% had elevated non-HDL cholesterol. These findings demonstrate that the HTW phenotype is strongly associated with metabolic alterations and excess visceral fat, making it a valuable and cost-effective marker for cardiovascular risk assessment. The study by Li et al. (2023) investigates the association between the hypertriglyceridemic waist (HTGW) phenotype and diabetic vascular complications in Chinese individuals with type 2 diabetes mellitus (T2DM) , the study included 3,221 participants, assessing their vascular complications through estimated glomerular filtration rate (GFR), urinary albumin creatinine ratio (UACR), ankle-brachial index (ABI), and brachial-ankle pulse wave velocity (baPWV). Findings revealed that individuals with the HTGW phenotype had a significantly higher risk of developing chronic kidney disease (CKD)-related complications, with odds ratios (OR) of 2.21 for decreased GFR and 2.18 for elevated UACR. Additionally, vascular abnormalities such as decreased ABI (OR = 2.24) and elevated baPWV (OR = 1.63) were more prevalent in the HTGW

S.No	Author(s) and year	Study Title	Population Studied	Results
1.	Ike S. Okosun and John M. Boltri 2008	Abdominal Obesity, Hypertriglyceridemia, hypertriglyceridemic waist phenotype and risk of type 2 diabetes in American Adults	Subjects (N=1914) From NHANESs (2003-2004)	In men, HTGP increased diabetes risk by 2.85 times, while in women, the risk was 2.58 times. The study also showed that Black women with HTGW had a 5.62 times increased risk of diabetes compared to White women.
2.	Yi-Ming Tian, Ning ma, Xiao-Jiao Jia and Qiang Lu 2019	The "Hyper-triglyceridemic Waist Phenotype" is a reliable marker for prediction of accumulation of abdominal fat in Chinese adults	Subjects (N= 195) Chinese Adult population(18-65 years)	Chinese Adults with the HTWG phenotype has the high Abdominal Visceral Fat area and insulin resistance and were associated with higher blood pressure than individuals with normal HTGW.
3.	Begoña de Cuevillas et,al, **2021**	The hypertriglyceridemic-waist phenotype as a valuable and integrative mirror of metabolic syndrome traits	Subjects (N = 314) (18-75 years) SpainPopulation	The study found that women had lower rates of prediabetes, high blood glucose, and MetS compared to men. HTWP was strongly associated with increased risk of high blood glucose, dyslipidemia, hypertension, and MetS. The WCTyG index was the best predictor for diagnosing MetS, with **a higher diagnostic accuracy than other indices. Sex-specific analysis showed higher HTWP in women were linked to increased hypertension and dyslipidemia risks. Optimal cut-off points for these indices were proposed for**

S.No	Author(s) and year	Study Title	Population Studied	Results
				diagnosing MetS and related conditions.
4.	Rosaley Prakashchandra & Datshana P.Naidoo 2022	The Association between the hypertriglyceridemia waist phenotype, cardiovascular risk factor and metabolic syndrome in South African Asian Indians	Subjects (N= 1349) (15-65 years) from Durban , Kwazula-Natal	The HTGW phenotype was recorded in 35.4% of participants, predominantly women (36.1%) and 8.2% smokers. Metabolic derangements and cardiovascular risk factor increased significantly in those with HTGW phenotype. The odds for participants with the HTGW phenotype developing the MetS was 19.7 (95% CI 13.9; 27.9).
5.	Susan Sam et al, 2009	Hypertriglyceridemic Waist Phenotype Predicts Increased Visceral Fat in Subjects With Type 2 Diabetes	N=375 (from CHICAGO COHORT) Type2 diabetic subjects	The presence of hypertriglyceridemic waist phenotype in subjects with type 2 diabetes identifies a subset with greater degree of visceral adiposity. This subset also has greater degree of subclinical atherosclerosis that may be related to the proatherogenic lipoprotein changes.
6.	Michael J LaMonte et al, 2003	The hypertriglyceridemic waist phenotype among women	44 African–American (AA), 45 native American (NA), and 46 Caucasian (CA) women	participants were middle-aged, overweight, and had relatively low CHD risk factors . AA women were older, had larger BMIs, higher systolic blood pressure, insulin, HDL-C and CRP concentrations, and lower fitness compared with NA and CA women. Estrogenic

S.No	Author(s) and year	Study Title	Population Studied	Results
				medication use was highest among AA and CA women. Among all women, Spearman correlations revealed waist girth was associated with insulin
7.	Lemiuex et al, 2000	Hypertriglyceridemic Waist : A Marker of the Atherogenic Metabolic Triad (Hyperinsulinemia; Hyperapolipoprotein B; Small, Dense LDL) in Men?	(For Study 1) N= 185 men (from Quebac city) (For Study 2) N = 287 men	Results of the metabolic study (study 1) conducted on 185 healthy men indicate that a large proportion (>80%) of men with waist circumference values ≥90 cm and with elevated TG levels (≥2.0 mmol/L) were characterized by the atherogenic metabolic triad. Validation of the model in an angiographic study (study 2) on a sample of 287 men with and without coronary artery disease (CAD) revealed that only men with both elevated waist and TG levels were at increased risk of CAD (odds ratio of 3.6, $P<0.03$) compared with men with low waist and TG levels.
8.	Mathur AM**,**et al, 2016	Cardiometabolic Risk in South Asian Inhabitants of California: Hypertriglyceridemic Waist vs Hypertriglyceridemic Body Mass Index	N=2998 individuals (1156 women and 1842 men**),** California	An HTG-waist was present in 670 individuals, of whom 648 (97%) had an HTG-BMI. The cardiometabolic profile was significantly more adverse in those in whom an HTG-waist was present vs absent**;** and the same was true when individuals with an

S.No	Author(s) and year	Study Title	Population Studied	Results
				HTG-BMI were compared with those without
9.	Mohsen Janghorbani et al, 2016	Utility of hypertriglyceridemic waist phenotype for predicting incident type 2 diabetes: The Isfahan Diabetes Prevention Study	N = 1865 Non diabetic Iranian population (30-70 years of age)	There was a correlation between the occurrence of type 2 diabetes and the HTW phenotype at baseline. Type 2 diabetes was more likely to develop in those with HTW (OR 2.36, 95% confidence interval 1.61–3.44), normal WC high TG (OR 1.87, 95% confidence interval 1.29–2.70), and enlarged WC but normal TG (OR 2.84, 95% confidence interval 1.96–4.13) than in those with normal WC and normal TG.
10.	Cunha de Oliveira C, 2014	Hypertriglyceridemic waist phenotype: association with metabolic disorders and visceral fat in adults.	N= 191 (aged >20 years) Salvador , Brazil	Individuals with HTW phenotype, 82% had three or more cardiovascular risk factors. The association between cardiovascular risk factors with HTW phenotype revealed that among men 73.7% had hypercholesterolemia, 94.9% elevated non-HDLc . Among women, 65% had elevated Systolic Blood Pressure, 80% hypercholesterolemia and 90% elevated non-HDLc ($p < 0.02$).

NATIONAL

S.No	Author(s) and year	Study Title	Population Studied	Results
5.	Chamukuttan Snehalatha Arun Nanditha, Ananth Samith Shetty, Amabdy Ramchandra 2011	Hypertriglyceridaemia either in isolation or in combination with abdominal obesity is strongly associated with atherogenic dyslipidaemia in Asian Indians	Subjects(N= 2117) (> 20 years) Chennai	The study presents findings on the prevalence of isolated hypertriglyceridaemia (iHTG) and the hypertriglyceridemic waist phenotype (HTWP). The results indicate that iHTG was present in 13.4% of the subjects, while HTWP was found in 17.8%. The findings suggest that the prevalence of HTWP was significantly higher and was predominant among women. Prevalence of HTWP progressively increased with glucose intolerance.

CHAPTER 3

METHODS AND MATERIALS

The growing prevalence of non-communicable diseases (NCDs) has emerged as a critical public health concern, particularly in rapidly urbanizing regions. Factors such as sedentary lifestyles, dietary transitions, and metabolic abnormalities have significantly contributed to the increasing burden of conditions like cardiovascular diseases, type 2 diabetes, and metabolic syndrome (WHO, 2023). Rapid urbanization and the globalization of food markets have led to an increased intake of energy-dense foods high in saturated fats, refined sugars, and animal products, replacing traditional diets rich in complex carbohydrates and plant-based proteins. This shift, combined with sedentary lifestyles and reduced physical activity, has fueled rising obesity rates and metabolic disorders (WHO, 2023).

Among several metabolic risk markers, the hypertriglyceridemic waist phenotype (HTWP) has received attention due to its connection with negative health consequences. characterized by an elevated waist circumference and elevated triglyceride levels. HTWP is considered a reliable predictor of cardiometabolic disorders and an early indicator of underlying metabolic dysfunction (Arsenault et al., 2010). Urban environments, with their unique socio-economic and lifestyle dynamics, present a distinct landscape where metabolic risk factors tend to cluster, exacerbating the risk of chronic illnesses (Lemieux et al., 2000). Identifying individuals with HTWP within such settings is crucial for the early detection and prevention of NCDs. The interplay between metabolic risk markers and behavioral determinants underscores the need for comprehensive assessment frameworks that integrate epidemiological insights with targeted screening approaches (Budreviciute et al., 2021).

OBJECTIVES OF THE STUDY :

BROAD OBJECTIVE

To assess the risk of Non Communicable Diseases (NCDs) among Hypertriglyceridemic Waist Phenotype (HTWP) adults aged 30-60 years in Urban Vadodara.

SPECIFIC OBJECTIVES OF THE STUDY

I. To screen the participants for HTWP by using standardized anthropometric indices and biochemical parameters.
II. To assess the sociodemographic status, lifestyle factors of the subjects by using structured questionnaires.

STUDY DESIGN:

A cross-sectional study design was used to assess the risk of Non Communicable Diseases(NCDs) among Hypertriglyceridemic Waist Phenotype (HTWP) adults aged 30-60 years in Urban Vadodara.

SAMPLE ESTIMATION:

For cross sectional study, formula for sample size calculation is, $N = 4pq/L^2$

p – Prevalence of Central adiposity is 40%

q – (100-p)

L – allowable error of prevalence as 5%

Using the formula,

$N= 4pq/L^2$

N= 4 (40)(100-40) / 25

To account for potential non-response or attrition, we add 10% of the calculated sample size:

384 + 38.4 = 422.4

Thus, the total sample size for the study will be 422 participants. The final sample size for the study has been determined to **be 450 participants**, rounded up from an initial calculation. This adjustment ensures the study remains sufficiently powered to accurately detect the prevalence of HTWP in the population, while maintaining a 5% margin of allowable.

STUDY CRITERIA

INCLUSION CRITERIA :

- Adults (30– 60 years)
- Willingness to participate in the study

EXCLUSION CRITERIA :

- Pregnant and lactating mothers
- Individuals with any known case of Non Communicable Disease.

- Postsurgical patients(those who have undergone surgery in past 1 or 2 months)

ETHICAL COMMITTEE APPROVAL

Consent for the ethical committee was acquired prior to conducting the study (IECHR/FCSc/M.Sc./10/2024/42). The subjects were informed in detail about the study and written consent was also acquired from the subjects.

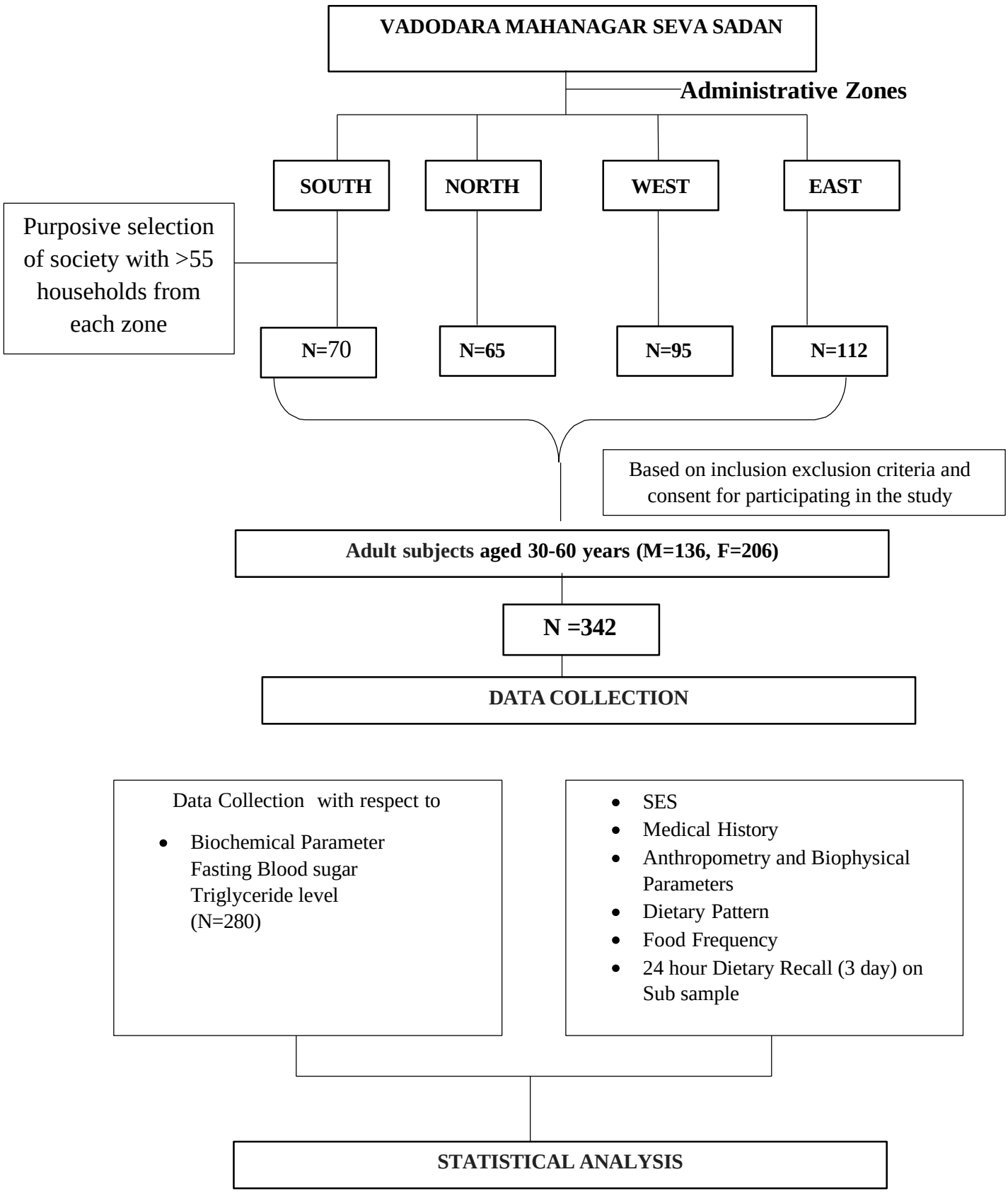
STUDY PLAN

The study was a cross-sectional designed to assess the risk of non-communicable diseases (NCDs) among adults aged 30–60 years presenting with Hypertriglyceridemic Waist Phenotype (HTWP) in urban Vadodara. Vadodara city was divided into four administrative zones, aligned with its municipal structure under Vadodara Mahanagar Seva Sadhan, to ensure comprehensive coverage across urban areas. From each zone, one residential society was purposively selected, serving as the initial sampling unit. Adjacent societies in a concentric manner were selected in order to enroll the subjects.

A total of 342 participants were recruited based on inclusion and exclusion criteria, comprising adults aged 30–60 years. Data collection encompassed various aspects, including medical history, anthropometric and biophysical parameters, biochemical markers, socio-economic status (SES), and dietary patterns. Pretested questionnaires were utilized to gather SES and dietary information, including food frequency analysis and a three-day 24-hour dietary recall for a subsample.

Participants who provided informed consent underwent fasting blood sample collection. Biochemical analyses included fasting blood sugar measured using ADA criteria and triglyceride levels assessed according to HTWP-specific guidelines. The collected data were subjected to rigorous statistical analyses to evaluate HTWP prevalence and its association with NCD risk factors.

STUDY DESIGN



METHODS FOR DATA COLLECTION

Background Information: Participants' socioeconomic profiles were assessed using a pre-tested structured questionnaire. The collected data included age, religion, marital status, family structure (nuclear, joint, or extended), number of family members, and monthly family income. The education and occupation of the family head were also reported. The Revised Kuppuswamy Classification (2024) was used to categorize socioeconomic level.

TABLE: 3.1 THE SCORING SYSTEM FOR EDUCATION

EDUCATION	SCORE
Profession or Honors	7
Graduate	6
Intermediate or diploma	5
High schools certificate	4
Middle schools certificate	3
Primary schools certificate	2
Illiterate	1

(Source: Modified Kuppuswamy Socioeconomic Status Scale (2024)

TABLE: 3.2 KUPPUSWAMY SOCIO-ECONOMIC CLASS

Sr. No.	Score	Socio-Economic Class
1	26-29	Upper class (I)
2	16-25	Upper middle class (II)
3	11-15	Lower middle class (III)
4	5-10	Upper lower class (IV)
5	<5	Lower (V)

(Source: Modified Kuppuswamy Socioeconomic Status Scale (2024)

TABLE: 3.3 THE SCORING SYSTEM FOR OCCUPATION

OCCUPATION	SCORE
Legislators, Senior Officials and Managers	10
Professionals	9
Technicians and Associate Professionals	8
Clerks	7
Skilled Workers and Shop and Market Sales Workers	6
Skilled Agricultural and Fishery Workers	5
Craft and Related Trade Workers	4
Plant and Machine Operators and Assemblers	3
Elementary Occupation	2
Unemployed	1

(Source: Modified Kuppuswamy Socioeconomic Status Scale (2024)

ANTHROPOMETRIC MEASUREMENTS

In this study, the following anthropometric measurements were collected using standard techniques:

Weight

Weight was measured using standard bathroom weighing scale. For calibrating the weighing balance, weight of five subjects for 3 consecutive days was recorded while zero down the weighing balance. This was done to check the repeatability of the weighing scale. Weight measurementswas done for all the subjects using a calibrated nbathroom weighing scale. The subjects were asked to stand erect on the scale without touching anything, with no heavy clothing and footwear and looking straight with hands on side. The weight was recorded in kilograms.

Height

The height of the participants was measured using a stadiometer. Participants were instructed to remove their footwear,and any head accessories before measurement. They were asked to stood upright with their back against the vertical surface of the stadiometer, feet together, and heels touching the base. The stadiometer's headpiece was gently lowered to rest on the crown of the head, and the height was recorded. Measurements were taken to the nearest 0.1 cm. In cases where repeated readings were necessary, the average of two consistent measurements was recorded.

Body Mass Index:

BMI was calculated using the following formula below :

BMI = Weight (kg)/Height * Height (m^2)

Classification of BMI was done according to Asia Pacific criteria, 2004

Presumptive Diagnosis	**BMI**
Underweight	< 18.5
Normal	18.5 - 22.9
Overweight	23 – 24.9
Obese	>_25

Waist circumference was measured following the WHO protocol at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, ensuring accuracy in assessing central adiposity. Participants were instructed to breathe normally and gently exhale during the measurement to avoid muscle contraction or holding their breath. A non-stretchable fiberglass tape was used for precision and consistency. This standardized method ensured reliable and valid measurements**.**

Hip Circumference :

The hip circumference measurement was taken around the widest portion of the buttocks using a non-stretchable fiberglass tape.

Waist Hip Ratio (WHR)

WHR = Waist Circumference/ Hip Circumference

BIOPHYSICAL MEASUREMENT:

Blood Pressure was measured using a Sphygmomanometer by standard technique. The cut-offs given by JNC VIII classification were used for assessing hypertension amongst the subjects.

MEDICAL AND FAMILY HISTORY

Medical and family history of the subjects was collected in order to know the presence of any associated co-morbidities or complications like diabetes, hypertension, chronic heart disease, cancer or any other condition.

DIETARY PATTERN:

The assessment of Dietary Pattern of the subjects was performed using a structured questionnaire regarding the following aspects :

Food Habits : The information regarding eating habits, skipping meals, frequency of eating out was assessed.

Semi Quantitative Food Frequency Questionaire :The frequency of consumption of high fat , salt, sugar foods and consumption of fruits, vegetables, milk and milk products, non- vegetarian foods, nuts and oilseeds, sugar, oil intake of the subjects were obtained using a pre-tested structed questionnaire.

24-hour Dietary Recall: The 24-hour dietary recall was used to collect food consumption data for three days (two weekdays and one weekend). Standard cups and spoons ensured accuracy in portion sizes, minimizing bias across days. The data was manually calculated and analyzed to provide insights into participants' dietary intake and nutritional adequacy.

ADDICTION PATTERN :

Information regarding the addiction pattern of alcohol, tobacco, smoking, tea and coffee etc (both past and the present) of the subjects were studied and tgis information was elicited through interview method using a pre tested questionnaire.

ACTIVITY PATTERN :

Information regarding the activity pattern of the subject was acquired using International Physical Activity Questionnaire (IPAQ). The IPAQ is a 27 item measure of physical activity for use with individual adult aged 15 to 69 years old. It is designed to measure the duration and frequency of physical activity across various domains over the last 7 days. These domains include:

- Job-related physical activity
- Transporation-related physical activity
- Housework, house maintenance, and caring for family
- Recreation, sports, and leisure-time physical activity
- Time spent sitting

BIOCHEMICAL ANALYSIS

After an overnight fasting of 12 hours, fasting venous blood samples were drawn from the subjects by a trained technician using disposable syringes and needles and blood was dispensed into vaccutainers. The blood was drawn for the estimation of fasting blood sugar and triglycerides.

METHODS FOR BIOCHEMICAL ANALYSIS

1. Estimation of Fasting Blood Sugar

It is estimated using the GOD/POD method using an enzymatic kit.

Principle: Glucose is oxidized by glucose oxidase forming gluconic acid and hydrogen peroxide. The hydrogen peroxide formed is broken down by peroxidase to water and

oxygen. The later oxidizes phenol, which combines with 4-aminophenazone to give red coloured complex. The intensity of the red coloured complex is proportional to concentration of glucose in the specimen, which is measured at 515 nm (500-530 nm).
Laboratory normal reference range: 82-115 mg/dl

2. Triglycerides (TG)

Through a sequence of enzymatic catalysis steps by ligase, glycerol kinase (GK) and glycerol phosphate oxidase and peroxidase enzymes, triglycerides are cataylsed to yield hydrogen peroxide, which oxidizes 4-Aminoantipyrine to yield a colored dye of quinoneimine. The absorbency increase is directly proportional to the concentration of triglycerides**.**
Laboratory normal reference range: less than 200mg/dl

Statistical Analysis

The collected data were entered into Epicollect software for systematic organization and management. Statistical analyses were performed using Jamovi software, with descriptive statistics including mean and standard deviation calculated for continuous variables. Frequency and proportions were computed for categorical variables wherever applicable. Inferential analyses, including Student's t-test and ANOVA, were applied to determine statistical significance between groups.

TABLE: 3.5 TOOLS & TECHNIQUES FOR DATA COLLECTION

Parameters	**Method / Tool**
General Information	Semi structured Questionnaire
Physical activity	International Physical Activity Questionnaire (IPAQ)
Biochemical Parameter	
Fasting Blood Glucose	Enzymatic Kit
Triglycerides	Enzymatic Kit
Biophysical parameters	
Blood pressure	Sphygmomanometer
Anthropometric Indices	
Height weight, Waist Circumference, Hip Circumference	Standard Methods
Dietary habits	
Dietary pattern	Structured Questionnaire
Food Frequency	Quantitative Food Frequency Questionnaire
Dietary Recall	24 hour Dietary Recall (3 days)

CHAPTER 4

RESULTS AND DISCUSSION

The study focused on a free-living population in urban Vadodara, aged between 30 to 60 years. A total of 342 participants were included, representing a diverse range of demographic and socioeconomic backgrounds. The distribution of participants across different socioeconomic strata is summarized in Table 4.1, which includes factors such as education level, occupation, family income, and other determinants of socioeconomic status.

The study population primarily consisted of adults aged 30-39 years (46.5%), followed by those aged 40-49 years (32.7%) and 50-60 years (20.8%). The educational status revealed that 58.1% of family heads were graduates. Nearly half (50.7%) were professionals, while 39.3% were skilled workers or shop owners, and a small percentage (3.8%) were unemployed.

The largest segment of participants (39.9%) fell into the middle-income group. According to the modified Kuppuswamy scale, 58.2% belonged to the upper lower class, and a significant majority (86.8%) came from nuclear families.

MEDICAL HISTORY AND ADDICTION PATTERN :

A notable portion of participants (45.0%) reported no significant family history of chronic illnesses, while the rest had a familial history of various non-communicable diseases (NCDs). The most common conditions among family members included hypertension (31.0%) and diabetes (17.8%), followed by hypothyroidism (2.6%), coronary heart disease (CHD) (1.5%), asthma (1.8%), and cancer (0.3%). The high prevalence of hypertension and diabetes indicates a strong genetic predisposition to metabolic disorders.

Lifestyle factors such as smoking, alcohol consumption, and tobacco use significantly contribute to the risk of NCDs. Among participants, 87.7% reported no substance use; however, 9.4% engaged in tobacco chewing, while 1.8% were smokers and 1.2% consumed alcohol.

TABLE 4.1 BACKGROUND INFORMATION OF THE SUBJECTS (N, %)

Variables	N= 342	%
Age		
30-39	159	46.5
40-49	112	32.7
50-60	71	20.8
Religion		
Hindu	330	96.8
Christian	4	1.2
Jain	7	2.1
Marital StatuS		
Married	323	94.7
Unmarried	14	4.1
Divorce	2	0.6
Widow/widower	2	0.6
Qualification of the Head of family		
Profession or honours	57	16.7
Graduate	198	58.1
Intermediate or diploma	12	3.5
High School certificate	43	12.6
Middle School certificate	30	8.8
Primary School certificate	1	0.3
Illiterate	0	0
Occupation of the Head of family		
Legislators, senior officials, managers	13	3.8
Professionals	173	50.7
Technicians and associate professional	2	0.6
Clerks	1	0.3
Skilled workers and shop and market sales workers	134	39.3
Skilled agricultural and fishery worker	5	0
Craft and related trade workers	0	0
Plant and machine operators	0	
Elementary occupation	5	1.5
Unemployed	13	3.8

Family Income		
2,13,814 and above	4	1.2
1,06,850 – 2,13,814	8	2.3
80,110-1,06,850	42	12.3
53,360 – 80,109	136	39.9
31,978 – 53,360	132	38.7
10,703 – 31,77	19	5.6
<10,703	0	0
Socioeconomic class		
Upper (I)		
Upper Middle (II)	21	6.1
Lower Middle (III)	120	35.1
Upper Lower (IV)	199	58.2
Lower (V)	2	0.6
Type of Family		
Nuclear	296	86.8
Extended	30	8.8
Joint	15	4.4

TABLE 4.2 : MEDICAL HISTORY AND ADDICTION PATTERN OF SUBJECTS

Medical History		
Family History		
Diabetes	61	17.8
Hypertension	106	31.0
Hypo/Hypothyroidism	9	2.6
CHD	5	1.5
Cancer	1	0.3
Asthma	6	1.8
None	154	45.0
Addiction		
Alcohol	4	1.2
Tobacco chewing	32	9.4
Smoker	6	1.8
None	300	87.7

Anthropometric and Biophysical Profile of Study Participant

The anthropometric and biophysical characteristics of the study population revealed significant differences between males and females, highlighting trends in body composition and cardiovascular health. The mean age of participants is 41.4 ± 9.13 years, with males slightly older at 42.5 ± 9.33 years compared to females at 40.7 ± 8.95 years,. The male subjects exhibited greater height (170 ± 5.89 cm vs. 155 ± 6.86 cm) and higher body weight (74.0 ± 11.2 kg vs. 63.8 ± 12.6 kg) than females. Despite these differences, the mean BMI (26.0 ± 4.12 kg/m²) falls within the overweight category for both sexes, with females showing a slightly higher BMI (26.2 ± 4.58 kg/m²) than males (25.7 ± 3.31 kg/m²), suggesting potential sex-based differences in fat distribution.

Waist circumference (WC) and waist-to-hip ratio (WHR), both indicators of central obesity, reveal notable gender differences. Males have a higher WC (92.9 ± 7.71 cm) compared to females (83.5 ± 10.4 cm), despite similar hip circumferences (101 cm in both sexes). This results in a significantly greater WHR in males (0.92 ± 0.06) compared to females (0.82 ± 0.09), indicating a higher tendency for central obesity among men. Central obesity is a well-established risk factor for metabolic syndrome and cardiovascular diseases, suggesting that males may face an elevated cardiometabolic risk compared to females.

Blood pressure levels further underscore these sex-specific trends. There was no significant difference found in systolic blood pressure (126 ± 5.98 mmHg vs. 123 ± 7.25 mmHg) and diastolic blood pressure (85.1 ± 4.87 mmHg vs. 83.4 ± 5.57 mmHg) in males and females. The overall mean blood pressure levels were found to be (SBP: 124 ± 6.90 mmHg, DBP: 84.5 ± 5.36 mmHg).

Prevalence of overweight and obesity among the subjects

The findings indicate a high prevalence of overweight and obesity (76.9%) in the study population, with significant gender-based differences. The prevalence of Underweight (<18.5 kg/m²) was found to be (1.5%) occurring in only 1.5% of participants. In contrast, 21.6% of participants had a normal BMI, with a higher proportion of females (14.6%) than males (7.0%).

The prevalence of overweight (BMI: 23–24.9 kg/m²) was greater in males (11.4%) than in females (8.2%),. Conversely, obesity (BMI > 25 kg/m²) was significantly more common in females (36.0%) compared to males (21.3%), reflecting a pattern consistent with global

Table 4.3: Anthropometric Profile of the subjects

Variables	Male (n=136)	Female (n=202)	Total (n=342)
Age (Y)	42.5 ± 9.33	40.7± 8.95	41.4 ±9.13
Height (cm)	170 ± 5.89	155 ± 6.86	165 ± 9.37
Weight (kg)	74.0 ± 11.2	63.8 ± 12.6	67.8 ± 13.1
BMI (Kg/m^2)	25.7 ± 3.31	26.2 ± 4.58	26.0 ± 4.12
WC (cm)	92.9 ± 7.71	83.5 ± 10.4	87.2 ± 10.5
HC (cm)	101 ± 6.87	101 ± 10.1	101 ± 8.95
WHR	0.92 ± 0.06	0.82 ± 0.09	0.86 ± 0.09
SBP (mmHg)	126 ± 5.98	123 ± 7.25	124 ± 6.90
DBP (mmHg)	85.1 ± 4.87	83.4 ± 5.57	84.5 ± 5.36

Table 4.4: Prevalence of overweight and obesity among the subjects (N, %)

BMI classification	Cut offs	Male (n=136)	Female (n=206)	Total (n=342)
Underweight	<18.5	0	5 (1.5%)	5 (1.5%)
Normal	18.5 – 22.9	24 (7.0%)	50 (14.6%)	74 (21.6%)
Overweight	23 – 24.9	39 (11.4%)	28.8 (8.2%)	67 (19.6%)
Obese	>25	73 (21.3%)	123 (36.0 %)	196 (57.3%)

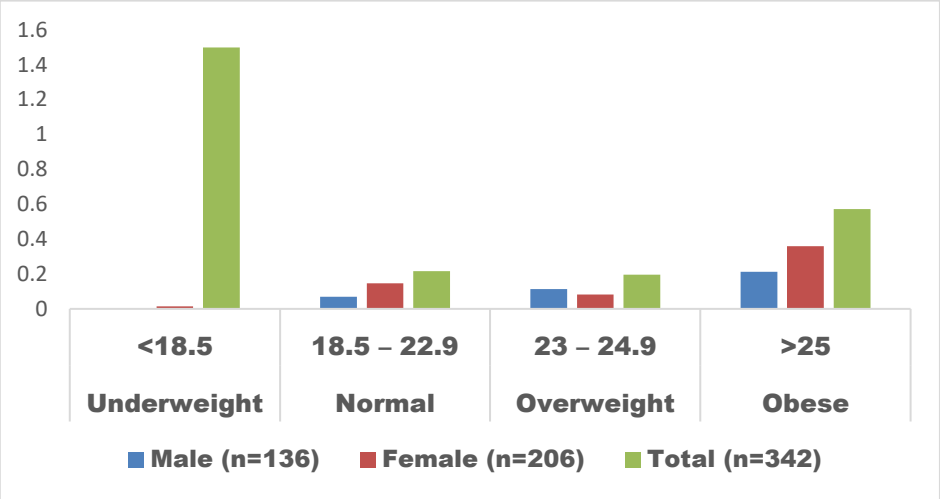


Figure 4.1 Prevalence of overweight and obesity among participants

Prevalence of abdominal obesity among the subjects

The analysis of abdominal obesity, measured by waist circumference (WC) and waist-to-hip ratio (WHR), reveals a significant prevalence of central adiposity, with notable gender differences. Using WC cut-off values (>90 cm for males and >85 cm for females), 67.6% of males (n=92) and 42.7% of females (n=88) were identified as having abdominal obesity. This indicates a higher prevalence of central obesity among males, suggesting a greater tendency for visceral fat accumulation, which is closely linked to increased cardiometabolic risk.

Additionally, when assessed with WHR cut-off values (>0.90 for males and >0.85 for females), 42.7% of males (n=87) and 34.5% of females (n=71) were classified as having abdominal obesity. While the WC-based assessment highlights a higher prevalence among males, the WHR-based analysis emphasizes a significant burden of abdominal obesity in both genders

Table 4.5: Prevalence of abdominal obesity among the subjects (N,%)

Variable	Gender	Cut off	N	%
Waist Circumference	Male	>90 cm	92	67.6
	Female	>85 cm	88	42.7
Waist to Hip Ratio	Male	>0.90 cm	87	42.7
	Female	>0.85 cm	71	34.5

Age-Wise Distribution of Abdominal Obesity Based on Waist Circumference

The distribution of abdominal obesity, as measured by waist circumference (WC), differs across age groups, exhibiting distinct patterns between genders in the study population. Among males, the proportion of individuals with high WC (>90 cm) increases with age. In the 30–39 years age group, 28.7% of males exhibit abdominal obesity, which remains high in the 40–49 years group (22.1%) and 50–60 years group (16.9%). Conversely, the proportion of males with normal WC (<90 cm) decreases with advancing age, from 15.4% in the 30–39 years group to 7.4% in the 50–60 years group. This age-related increase in central obesity among males suggests a progressive accumulation of visceral fat, which is a well-established risk factor for cardiometabolic disorders, including hypertension, insulin resistance, and cardiovascular diseases.

Among females, a similar trend is observed, though with a relatively lower prevalence of high WC (>85 cm) compared to males. In the 30–39 years age group, 21.8% of females exhibit abdominal obesity, decreasing to 14.6% in the 40–49 years group and 6.3% in the 50–60 years group. The proportion of females with normal WC (<85 cm) remains relatively higher across all age groups, with 26.7% in the 30–39 years group, 18.4% in the 40–49 years group, and 12.1% in the 50–60 years group.

Prevalence of Hypertension among subjects

The distribution of blood pressure levels among the study population indicates a high prevalence of pre-hypertension (78.4%), suggesting an elevated risk of progression to hypertension and associated cardiovascular complications. Only 20.2% of participants had normal blood pressure (<120/80 mmHg), reflecting a minority with optimal cardiovascular health. In contrast, 1.5% were classified as hypertensive stage 1 (140–159/90–99 mmHg).

Table 4.6: Prevalence of Abdominal Obesity Based on Waist Circumference Among Across Age Groups :-

Gender	Age group	Normal WC (<90 cm) (N, %)	High WC (>90 cm) (N,%)
Male	30-39	21 (15.4%)	39 (28.7%)
	40-49	13 (9.6%)	30 (22.1%)
	50-60	10 (7.4%)	23 (16.9%)
		Normal WC (<85 cm)	High WC (>85)
Female	30-39	55 (26.7%)	45 (21.8%)
	40-49	38 (18.4%)	30 (14.6%)
	50-60	25 (12.1%)	13 (6.3%)

Correlation Between Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR)

The correlation analysis between Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR) reveals a Negative correlation, with a Pearson's correlation coefficient (r) of -0.097 This indicates that as BMI increases, there is a slight tendency for WHR to increase, but the relationship is not very strong. The correlation is statistically significant, as shown by the p- value of 0.072.

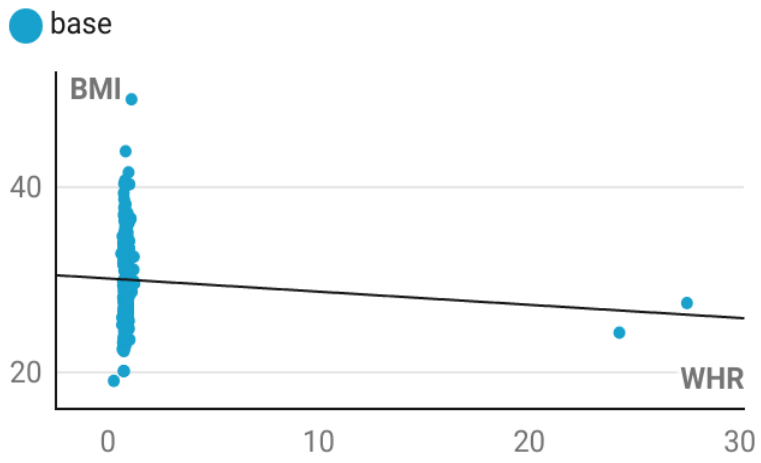


Figure 4.3. Scatter plot illustrating the relationship between Body Mass Index (BMI) and Waist-to-Hip Ratio (WHR) among study participants

CORRELATION BMI VS WC

The correlation between Body Mass Index (BMI) and Waist Circumference (WC), with a Pearson's correlation coefficient (r) of 0.585, indicates a positive relationship. This means that as BMI increases, WC also tends to increase proportionally. The statistical significance ($p < 0.001$).

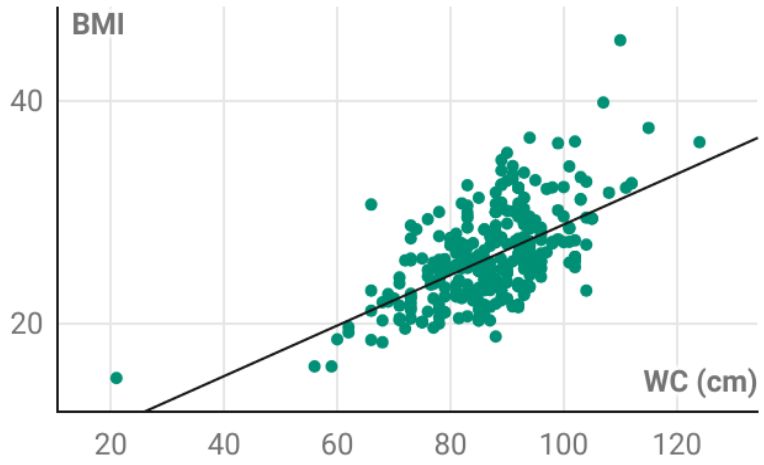


Figure 4.2: Scatter plot showing the relationship between Body Mass Index (BMI) and Waist Circumference (WC).

Table 4.7: Prevalence of Hypertension among subject

	Cut offs		Total (N)	%
	Systolic	Diastolic (N)		
Normal	<120	<80	69	20.2
Pre-hypertensive	120-139	80-89	268	78.4
Hypertensive stage 1	140-159	90-99	5	1.5

Dietary Characteristics of the Subjects

The dietary habits of the study participants reveals a predominantly vegetarian preference, with 82.7% identifying as vegetarian and smaller proportions as non-vegetarian (13.8%) and ovo-vegetarian (3.5%). Meal frequency is largely consistent with 3–4 meals per day reported by 82.4%, while only 15.2% consume fewer than three meals daily, and 2.3% exceed four meals. Meal skipping was observed, with 39.3% of subjects acknowledged skipping meals, though the majority (60.7%) did not. Snacking between meals is less common, with only 28.7% engaging in this behavior.

Eating out habits display a diverse frequency, with 33.1% dining out once per week and 25.2% doing so once per month. Occasional eating out is reported by 19.4%, while daily or frequent consumption (4-5 times a week) remains relatively low at 1.2% and 5.9%, respectivel.

Table 4.8: Dietary Characteristics of the Subjects (N = 342)

Food Preference		
Dietary Habit	**Frequency (N)**	**Percentage** (%)
Vegetarian	282	82.7%
Non-Vegetarian	47	13.8%
Ovo-Vegetarian	12	3.5%

MEAL FREQUENCY		
No. of Meals/Day	**Frequency (N)**	**Percentage (%)**
< 3 meals	52	15.2%
3–4 meals	281	82.4%
> 4 meals	8	2.3%

MEAL SKIPPING		
Skips Meals	**Frequency (N)**	**Percentage (%)**
Yes	134	39.3%
No	207	60.7%

SNACKING BEHAVIOUR		
Snacks Between Meals	**Frequency (N)**	**Percentage (%)**
Yes	98	28.7%
No	243	71.3%

Frequency of Eating Out		
Frequency of Eating Out	**Frequency (N)**	**Percentage (%)**
Daily	4	1.2%
4–5 times a week	20	5.9%
Thrice a week	31	9.1%
Once a week	113	33.1%
Once in 10 days	14	4.1%
Once in 15 days	17	5.0%
Once a month	86	25.2%
Twice a month	0	0.0%
Occasionally	56	19.4%
Never	0	0.0%

Table 4.9 : Mean±Sd of daily Nutrient intake among different age group and gender group

Nutrients	30–39 Years		40–49 Years		50–60 Years	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Energy (kcal)	1442.5 ± 295.7	1433.9 ± 298.8	1530.3 ± 322.1	1450.7 ± 305.2	1398.2 ± 287.5	1326.6 ± 274.4
Protein (g)	40.9 ± 11.8	40.5 ± 11.6	45.2 ± 12.1	43.8 ± 10.9	42.1 ± 11.3	39.4 ± 10.2
Fat (g)	44.7 ± 17.6	44.1 ± 17.4	48.9 ± 18.3	46.5 ± 17.0	41.2 ± 16.1	39.8 ± 15.5
CHO(g)	210.3 ± 38.5	208.9 ±36.7	225.6±41.2	219.1 ± 39.4	198.7 ± 34.9	192.3 ± 32.6
Calcium (mg)	472.6 ± 122.4	498.2 ± 130.1	490.7 ± 136.3	505.9 ± 128.6	461.4 ± 118.9	487.8 ± 125.5
Iron (mg)	10.8 ± 3.1	12.2 ± 3.3	11.6 ± 3.4	12.5 ± 3.1	10.3 ± 2.8	11.7 ± 3.2

The analysis of nutrient intake from the three-day 24-hour dietary recall revealed several critical deviations from the Recommended Dietary Allowances (RDA) 2020 for Indian adults. Protein intake across all age groups and genders was consistently lower than the recommended values. Men consumed an average of 39.6 grams of protein per day, reflecting a 26.7% deficit from the RDA of 54 grams, while women had a slightly smaller but still significant deficit of 15%, consuming approximately 39.1 grams against the recommended 46 grams. When compared to the recommended intake of 25–30 grams of visible fat per day, the average fat intake observed in males (43.5 g) and females (42.5 g) was significantly higher,indicating an excess of 45–74% above the recommended level. dditionally, calcium and iron intake were notably deficient across genders.

Average calcium intake was ~415 mg/day in men and ~406 mg/day in women—representing over a 58% shortfall from the 1000 mg RDA. Iron intake was also substantially low: men consumed about 10.4 mg/day (45.3% deficit from the RDA of 19 mg), and women consumed 9.8 mg/day—reflecting a striking 66.2% gap from the RDA of 29 mg.

FOOD CONSUMPTION FREQUENCY AMONG SUBJECTS

The dietary patterns of the study participants reveal a predominantly traditional food culture marked by distinct consumption behaviors. Grains and pulses serve as dietary staples, with 98.8% of participants reporting daily consumption of grains and 62.3% consuming pulses weekly. Dairy products, particularly milk and paneer, are consumed moderately, with occasional intake reported by 35.8% and 33.1% of participants, respectively. Fried snacks like puffs, samosas, and kachoris are enjoyed by many, reflecting their popularity despite potential health concerns.

Traditional snacks, such as sev mamra and papad poha, are also common, while sugary foods, including ice cream and ready-to-eat sweets, are consumed occasionally at high rates. The beverage choices indicate a strong cultural preference for tea, with 76.5% of participants drinking it daily, while coffee and sugar-sweetened beverages are consumed less frequently. Although breakfast cereals are not commonly eaten, this may indicate a preference for traditional foods over packaged options. Foods high in salt, such as sauces and noodles, are consumed occasionally, highlighting their moderate presence in the diet.

Table 4.10 Frequency Distribution of Food Item Consumption Among Respondents

Food item	Daily	4-5 Times A week	Thrice A Week	Once A Week	Once In 10 Days	Once In 15 days	Once A month	Occasionally	Never
HIGH IN FAT (FRIED SNACKS)									
Puff	0	0	6 (1.8%)	24 (7.1%)	14 (4.1%)	46 (13.5%)	66 (19.4%)	178 (52.4%)	6 (1.8%)
Samosa	0	0	3 (0.9%)	22 (6.5%)	18 (5.3%)	81 (23.8%)	77 (22.6)	133 (39.1%)	6 (1.8%)
Vadapav	0	0	8 (2.4%)	0	29 (8.5%)	48 (14.1%)	80 (23.5%)	157 (46.2%)	18 (5.3%)
Frankie	0	0	1 (0.3%)	0	3 0.9%)	11 (3.2%)	49 (14.4%)	218 (64.1%)	58 (17.1%)
Kachori	0	0	0	0	3 0.9%)	5 (1.5%)	17 (5.0%)	243 (71.5%)	72 (21.2%)
Bhajiya	0	0	2 (0.6%)	0	45 (13.2%)	71 (20.9%)	103 (30.3%)	112 (32.9%)	7 (2.1%)
Bataka Vada	0	0	0	0	2 (0.6%)	3 (0.9%)	20 (5.9%)	212 (62.4%)	103 (30.2%)
HOME-BASED FIRED SNACKS									
Chakri ,Mathri	0	0	0	0	0	15 (4.4%)	2 (0.6%)	197 (57.8%)	127 (37.2%)
Papdi , Ghathiya	7 (2.1%)	5 (1.5%)	24 (7.1%)	30 (8.8%)	3 0.9%)	7 (2.1%)	11 (3.2%)	166 (48.8%)	87 (25.6%)
Namkeen, Chavanu	3 (0.95%)	14 (4.1%)	34 (10.0%	62 (18.2%)	26 (7.6%)	38 (11.2%)	17 (5.0%)	86 (25.3)	60 (17.6%)
Sev mamra /sev	32 (9.45%)	89 (26.2%)	86 (25.3%	57 (16.8%)	9 (2.6%)	5 (1.5%)	3 (0.9%)	44 (12.9)	15 (4.4%)
Papad Poha	2 (0.6%)	0 (0)	13 (3.8%)	7 (2.1%)	4 (1.2%)	12 (3.5%)	15 (5.3%)	176 (51.8%)	108 (31.8%)

Food item	Daily	4-5 Times A week	Thrice A Week	Once A Week	Once In 10 Days	Once In 15 days	Once A month	Occasionally	Never
HIGH IN SUGAR									
Ice-cream	0	0	6 (1.8%)	34 (9.9%)	4 (1.2%)	19 (5.6%)	35 (10.2%)	241 (70.5%)	3 (0.9%)
Cakes / pastry	0	0	1 (0.3)	13 (3.8%)	4 (1.2%)	2 (0.6%)	13 (3.8%)	268 (78.4)	41 (12.0%)
Breakfast cereals	2 (0.6%)	0	0	3 (0.9%)	0	0	0	0	337 (98.5%)
Ready to eat sweets	4 (1.2%)	1 (0.3%)	7 (2.0%)	5 (1.5%)	3 (0.9%)	6 (1.8%)	12 (3.5%)	294 (86.0%)	10 (2.9%)
Cookies/ Khari /toast	10 (2.9%)	9 (2.6%)	16 (4.7%)	12 (3.5%)	2 (0.6%)	6 (1.8%)	13 (3.8%)	187 (54.75)	87 (25.4%)
Sugar-sweetened beverages	0	1 (0.3%)	4 (1.2%	15 (4.4%)	2 (0.6%)	33 (9.7%)	29 (8.5%)	202 (59.2%)	55 (16.1%)
FOOD GROUPS									
Grains	338 (98.8%)	3 (0.9%)	1 (0.3%)	0	0	0	0	0	0
Pulses	4 (1.2%)	7 (2.0%)	213 (62.3%	95 (27.8%)	22 (6.4%)	1 (0.3%)	0	0	0
GLVs									
Roots and Tuber	327 (95.6%)	0	6 (1.8%)	0	0	0	0	0	9 (2.6%)
Fruits	87 (25.4%)	0	29 (8.5%)	110 (32.2%)	25 (7.3%)	18 (5.3%)	22 (6.4%)	48 (14.0%)	3 (0.9%)
Nuts	133 (38.9%)	27 (7.9%)	19 (5.6%)	1 (0.3%)	26 (7.6%)	13 (3.8%)	4 (1.2%)	117 (34.2%)	2 (0.6%)
Oilseeds	49 (14.3%)	4 (1.2%)	1 (0.3%)	5 (1.5%)	0	5 (1.5%)	0	143 (41.8%)	140 (40.9%)
Milk	118 (34.6%)	0	5 (1.5%)	0	122 (35.8%)	0	0	0	96 (28.2%)
Coffee	13 (3.8%)	1 (0.3%)	2 (0.6%)	4 (1.2%)	0	0	6 (1.8%)	108 (31.7%)	0
Tea		1		0	0	0	0	41	

Food item	Daily	4-5 Times A week	Thrice A Week	Once A Week	Once In 10 Days	Once In 15 days	Once A month	Occasionally	Never
	261 (76.5%)	(0.3%)	3 (0.9%)					(12.0%)	35 (10.3%)
Curd	65 (19.1%	13 (3.8%)	60 (17.6%	142 (41.6%)	3 (0.9%)	3 (0.9%)	2 (0.65%)	50 (14.7%)	3 (0.9%)
Paneer	0	1 (0.3%)	5 (1.5%)	31 (9.1%)	8 (2.3%)	55 (16.1%)	108 (31.7%)	113 (33.1%)	20 (5.9%)
Cheese	0	1 (0.3%)	5 (1.5%)	29 (8.5%)	6 (1.8%)	60 (17.6%)	139 (40.8%)	78 (22.9%)	23 (6.7%)
Ghee	276 (81.2%)	0	6 (1.8%)	4 (1.2%)	0	0	2 (0.6%)	51 (15%)	1 (0.3%)
Sugar	336 (98.5)	1 (0.3%)	2 (0.6%)	1 (0.3%)	0	0	0	1 (0.3%)	0
Jaggery	27 (7.9%)	80 (23.5%)	127 (37.45)	34 (10.0%)	1 (0.3%)	1 (0.3%)	1 (0.3%)	64 (18.8%)	5 (1.5%)
Honey	5 (1.5%)	1 (0.3%)	2 (0.6%)	1 (0.3%)	0	1 (0.3%)	5 (1.5%)	204 (59.6%)	123 (36.0%)
HIGH IN SALT									
Instant Soups	0	0	0	2 (0.6%)	0	2 (0.6%)	4 (1.2%)	17 (5.0%)	317 (92.7%)
Instant Sauces	0	16 (4.7%)	1 (0.3%)	11 (3.2%)	3 (0.9%)	20 (5.8%)	47 (13.7%)	196 (57.3%)	48 (14.0%)
Papad	37 (10.8%)	7 (2.0%)	54 (15.8%)	110 (32.2%)	19 (5.6%)	8 (2.3%)	4 (1.2%)	87 (25.4%)	16 (4.7%)
Pickles	33 (9.6%)	4 (1.2%)	51 (14.9%)	45 (13.2%)	14 (4.1%)	8 (2.3%)	8 (2.3%)	145 (42.4%)	34 (9.9%)
Instant Noodles	0	0	3 (0.3%)	7 (2.0%)	2 (0.6%)	21 (6.1%)	28 (8.2%)	111 (32.5%)	172 (50.3%)
Cheese spreads	0	0	0	0	0	0	0	0	0
Ketchup	0	0	1 (0.3%)	24 (7.0%)	4 (1.2%)	40 (11.7%)	91 (26.6%)	153 (44.7 %)	29 (8.5%)
Wafers	0	0	2 (0.6%)	16 (4.7%)	2 (0.6%)	32 (9.4%)	28 (8.2%)	194 (56.7%)	68 (19.9%)

Table 4 Nutrient Intake Among HTWP and NHTWP Subjects (mean±SD)

Nutrient	HTWP (n=27)	NHTWP (n=85)	t-statistic	p-value
Energy (kcal)	1402.7 ± 291.6	1451.3 ± 297.2	-0.75	0.457
Protein (g)	40.9 ± 11.4	42.8 ± 11.6	-0.75	0.456
Fat (g)	42.3 ± 17.3	44.6 ± 17.5	-0.6	0.551
Carbohydrates (g)	200.2 ± 36.9	211.7 ± 37.8	-1.4	0.168
Calcium (mg)	455.3 ± 119.8	489.6 ± 126.3	-1.28	0.207
Iron (mg)	10.8 ± 3.0	12.0 ± 3.1	-1.8	0.079

The data compares average daily nutrient intake between individuals with (HTWP, n=27) and those without (NHTWP, n=85). Across all measured nutrients—energy, protein, fat, carbohydrates,calcium, and iron—the NHTWP group consistently showed slightly higher mean intakes. For example, energy intake averaged 1451.3 kcal in the NHTWP group versus 1402.7 kcal in the HTWP group, and similar patterns were observed for all other nutrients.While the NHTWP group had slightly higher average nutrient intakes compared to the HTWP group,the differences were not statistically significant.

Physical Activity Patterns Among Study Participants

The assessment of physical activity levels among the study participants, conducted using the International Physical Activity Questionnaire (IPAQ), provides a comprehensive understanding of their activity patterns. A majority of participants (50.5%) engage in moderate levels of physical activity, indicating a balanced yet potentially insufficient adherence to recommended guidelines. Conversely, a significant proportion (47.3%) display low levels of physical activity, reflecting a prevalence of sedentary behaviour or inadequate participation in structured exercise. These patterns raise concerns regarding potential long-term health implications, as low physical activity is a recognized risk factor for non-communicable diseases (NCDs) and metabolic disorders. Notably, high levels of physical activity are fpund to be with only 2.1% of participants achieving vigorous activity thresholds

Table 4.11 : Distribution of Physical Activity Levels among Study Participants (N=342)

Physical Activity Level	N	%
Low Activity	133	47.3 %
Moderate Activity	141	50.5%
High Activity	6	2.1 %

Analysis of Hypertriglyceridemic Waist Phenotype and Associated Risks

HTWP Prevalence Among Study Participants

The prevalence of Hypertriglyceridemic Waist Phenotype (HTWP) was evaluated among 280 participants who underwent blood testing as part of this study. HTWP was observed in 27.5% of the participants (n=77), indicating a considerable segment of the population at risk for metabolic health complications linked to elevated triglyceride levels and increased waist circumference. Conversely, 72.5% of the participants (n=203) did not exhibit the phenotype, categorized as Non-Hypertriglyceridemic Waist Phenotype (NHTWP). The table below represents the prevalence of HTWP among the population:

Table 4.12: Prevalence of Hypertriglyceridemic Waist Phenotype Among Study Participants (N=280)

HTWP STATUS	N	%
HTWP	77	27.5
NHTWP	203	72.5

The table 4.12 indicates that Hypertriglyceridemic Waist Phenotype (HTWP) is distributed almost equally across genders, with 13.9% of males and 13.6% of females exhibiting this phenotype**.**

Table 4.13: Gender-wise Distribution of HTWP and NHTWP in the Study Population

Phenotype	Gender	Count	%
HTWP	Male	39	13.9
	Female	38	13.6
NHTWP	Male	69	63.9
	Female	134	77.9

Comparative Analysis of Anthropometric and Metabolic Parameters in HTWP and Non-HTWP Groups

In comparison to those without Hypertriglyceridemic Waist Phenotype (HTWP), the mean age of participants with HTWP was (41.9 ± 8.18 years); however, this difference was not statistically significant (p=0.300). On the other hand, notable differences were noted in a number of important biochemical and anthropometric characteristics. Compared to non-HTWP participants (BMI: 25.2 ± 3.86 kg/m²; WC: 84.4 ± 10.26 cm), HTWP participants had significantly higher BMI (28.1 ± 4.40 kg/m²) and waist circumference (94.8 ± 7.53 cm), with both differences achieving statistical significance (p<0.001).

Triglyceride levels were also significantly higher in the HTWP group (193.5 ± 62.92 mg/dL) than in the non-HTWP group (104.5 ± 45.69 mg/dL, p<0.001), highlighting the phenotype's

distinctive metabolic abnormalities. More metabolic dysregulation was indicated by the considerably higher fasting blood sugar levels (101.7 ± 21.88 mg/dL) in HTWP participants compared to those without the phenotype (93.9 ± 20.35 mg/dL, p=0.005).

Blood pressure study showed that although there was no significant difference in systolic blood pressure (SBP) between the groups (p=0.221), HTWP persons had substantially higher diastolic blood pressure (DBP) (85.3 ± 5.19 mmHg) than non-HTWP participants (83.4 ± 5.18 mmHg, p=0.007). These results demonstrate the unique anthropometric and metabolic characteristics of people with HTWP, which include dysregulated glucose metabolism, higher BMI, abdominal obesity, and hypertriglyceridemia.

Table 4.14: Comparison of Anthropometric and Biochemical Parameters Between HTWP and Non-HTWP Participants

Variable	HTWP ABSENT (n= 203)	HTWP PRESENT (n= 77)	t- value	p-value
Age (years)	40.7 ± 8.87	41.9± 8.18	- 1.04	0.300
BMI (kg/m2)	25.2±3.86	28.1 ± 4.40	- 5.37	<.001
WC (cm)	84.4 ± 10.26	94.8 ± 7.53	- 8.15	<.001
SBP (mmHg)	123.9 ± 6.93	125.1 ± 4.40	-1.23	0.221
DBP (mmHg)	83.4 ± 5.18	85.3 ± 5.19	-2.73	0.007
Triglycerides (mg/dl)	104.5 ± 45.69	193.5 ± 62.92	-13.05	<.001
FBS (mg/dl)	93.9 ± 20.35	101.7 ± 21.88	-2.81	0.005

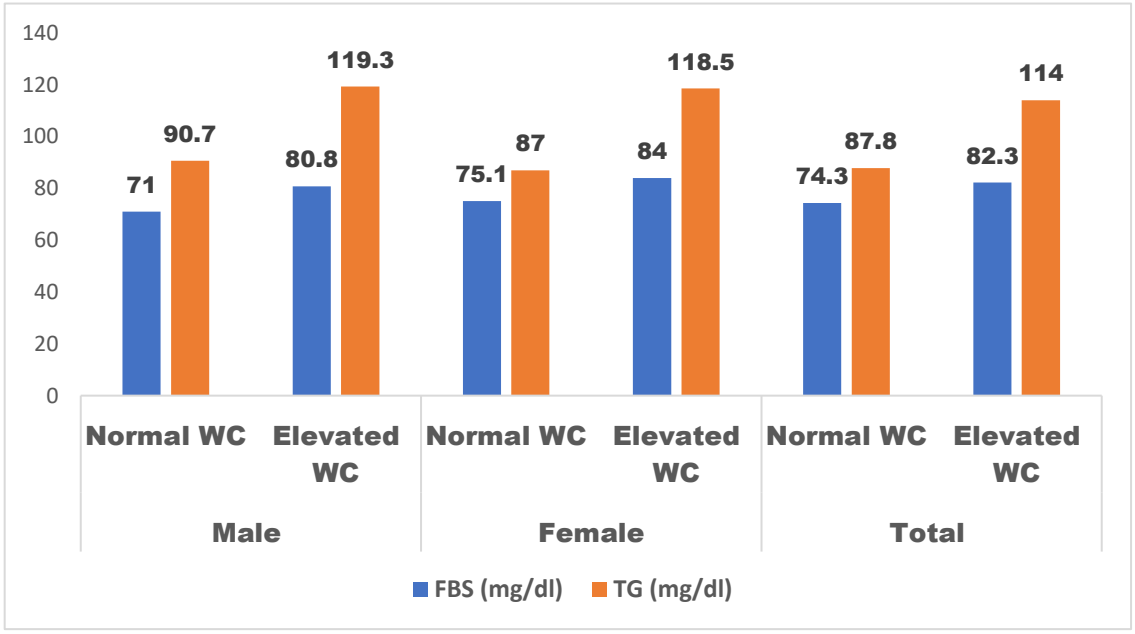
Comparison of FBS and TG Levels by Waist Circumference and Gender

The below table shows that FBS and TG levels varied with waist circumference in both genders. In males, FBS was 71.0mg/dl with normal waist and 80.8mg/dl in those with elevated waist, while in females, it was 75.1 mg/dl and 84.0 mg/dl respectively. Triglcerides showed similar patterns, with males at 90.7mg/dl (normal waist) and 119.3mg/dl (elevated waist), and females with 87.0mg/dl (normal waist) and 118.5 mg/dl (elevated waist) respectively.

TABLE 4.15 Comparison of FBS and TG Levels by Waist Circumference and Gender

Group	Waist Circumference	FBS (mg/dl)	TG (mg/dl)
Male (n=136)	Normal WC	71.0 ± 52.5	90.7 ± 69.6
	Elevated WC	80.8 ± 45.2	119.3 ± 84.4
Female (n=206)	Normal WC	75.1 ± 36.2	87.0 ± 64.8
	Elevated WC	84.0 ± 38.1	118.5 ± 78.2
Total (n =342)	Normal WC	74.3 ± 40.6	87.8 ± 65.6
	Elevated WC	82.3 ± 41.9	114 ± 81.3

Figure 4.2 Comparison of (FBS) and (TG) Levels by Waist Circumference and Gender



Bars represent mean values ± standard deviation (SD) for each subgroup (male, female, and total participants) with normal or elevated waist circumference**.**

Association Between Physical Activity Levels and HTWP Prevalence

HTWP is most common in individuals with low physical activity (21.4%) and significantly lower in those with moderate activity (6.1%). No cases of HTWP were found in the high activity group (0%). This suggests that higher physical activity levels are associated with a lower risk of HTWP.

Table 4.16: Association Between Physical Activity Levels and HTWP Prevalence

Physical Activity Level	**HTWP Present (N, %)**		**HTWP absent (N, %)**	
Low Activity	60	21.4 %	73	26.1 %
Moderate Activity	17	6.1 %	124	44.3 %
High Activity	0	0 %	6	2.1 %

Association of BMI, Hypertension, and FBS with HTWP Status

The table presents the association between HTWP status and key health indicators: age, BMI, hypertension, and fasting blood sugar (FBS). Age group differences were not statistically significant ($p=0.505$). BMI showed a highly significant association ($p<0.001$) with HTWP, confirming obesity as a major contributing factor. Hypertension, although not statistically significant ($p=0.059$), displayed important trends. Only 3.2% of HTWP participants had normal blood pressure, compared to 17.5% in the non-HTWP group. Prehypertension was more prevalent among HTWP individuals, suggesting possible early cardiovascular strain.FBS showed a statistically significant association with HTWP ($p=0.020$), with HTWP participants being more likely to have prediabetes or diabetes. Overall, these findings indicate that HTWP is strongly associated with obesity, elevated blood sugar levels, and potential cardiovascular risk, making it a valuable marker for identifying individuals at risk of metabolic disorders.

TABLE 4. 17 ASSOCIATION OF BMI, HYPERTENSION , AND FBS WITH HTWP STATUS

Variable	HTWP Absent	HTWP Present	P value
Age group			
30-39	100 (35.7%)	32 (11.4%)	0.505
40-49	67 (23.9%)	30 (10.7%)	
50-60	36 (12.9%)	15 (5.4%)	
BMI category			
Underweight	4 (1.4%)	0	<.001
Normal weight	59 (21.1%)	4 (1.4%)	
Overweight	43 (15.4%)	11 (3.9 %)	
Obese	97 (34.6%)	62 (22.1%)	
Hypertension			
Normal Bp	49 (17.5%)	9 (3.2%)	0.059
Prehypertensive	153 (54.6%)	67 (23.9%)	
Hypertensive	1 (0.4%)	1 (0.4%)	
FBS category			
Normal	163 (58.2%)	51 (18.2%)	0.020
Prediabetes	34 (12.4%)	19 (6.8%)	
Diabetes	6 (2.1%)	7 (2.5%)	

There are notable differences in the anthropometric and metabolic features amongst HTWP groups. There was a statistically significant difference between the groups ($p=0.032$), with the mean age of participants in the HTWP group being 42.2 ± 8.40 years, which was slightly higher than that of the other groups. This difference was statistically significant ($p<0.01$), with the participants with HTWP having the highest mean Body Mass Index (BMI) at 28.1 ± 4.43 kg/m², significantly higher than those in the Elevated Waist Normal Triglycerides (EWNT) group (27.3 ± 3.65 kg/m²), Normal Waist Elevated Triglycerides (NWET) group (25.3 ± 3.19 kg/m²), and Normal Waist Normal Triglycerides (NWNT) group (23.3 ± 3.12 kg/m).

The mean waist circumference of HTWP individuals was also considerably higher (94.9 ± 7.48 cm) than that of EWNT participants (92.5 ± 5.13 cm), NWET participants (81.2 ± 5.16 cm), and NWNT participants (77.4 ± 9.03 cm) ($p<0.01$). Significant differences were in blood pressure values between the groups. The HTWP group had the highest mean diastolic blood pressure (DBP) at 85.2 ± 5.22 mmHg, followed by the EWNT group at 84.9 ± 5.37 mmHg. The DBP values of the NWET and NWNT groups were

lower (81.8 ± 5.20 mmHg and 82.3 ± 4.57 mmHg, respectively), and the differences were statistically significant ($p<0.01$).

In a similar vein, HTWP participants' systolic blood pressure (SBP) was substantially higher (125 ± 6.69 mmHg) than NWNT participants' (122 ± 6.65 mmHg) ($p=0.016$). The HTWP group had the highest fasting blood sugar (FBS) levels (102 ± 21.9 mg/dL) and they were considerably higher than those of the EWNT (97.0 ± 19.3 mg/dL), NWET (94.3 ± 14.9 mg/dL), and NWNT (91.0 ± 22.0 mg/dL) groups ($p<0.01$). With a mean value of 195 ± 61.4 mg/dL for HTWP individuals and 206 ± 52.1 mg/dL for NWET participants, triglyceride levels demonstrated the most notable changes compared to EWNT (98.8 ± 26.1 mg/dL) and NWNT (87.8 ± 27.5 mg/dL) people ($p<0.01$).

Table 4.18 : Characteristics of subjects across HTWP groups

Variable	NWNT (n=96)	EWNT (n=87)	NWET (n=20)	HTWP (n=77)	P-value
Age (Y)	39.0±7.85	42.3±9.56	41.3±8.85	42.2±84.0	0.032
BMI (kg/m$^{2)}$	23.3± 3.12	27.3 ± 3.65	25.3±3.19	28.1 ± 4.43	<0.01
WC (cm)	77.4 ± 9.03	92.5 ± 5.13	81.2 ± 5.16	94.9 ± 7.48	<0.01
SBP (mmHg)	122 ± 6.65	126 ± 6.53	122 ± 6.43	125 ± 6.69	0.016
DBP (mmHg)	82.3 ± 4.57	84.9 ± 5.37	81.8 ± 5.20	85.2 ± 5.22	<0.01
FBS (mg/dl)	91.0 ± 22.0	97.0 ± 19.3	94.3 ± 14.9	102 ± 21.9	<0.01
TG (mg/dl)	87.8 ± 27.5	98.8 ± 26.1	206 ± 52.1	195 ± 61.4	<0.01

NWNT – NORMAL WAIST NORMAL TRIGLYCERIDES , **EWNT** – ELEVATED WAIST NORMAL TRIGLYCERIDES, **NWET** -NORMAL WAIST ELEVATED TRIGLYCERIDES, **HTWP** -HYPERTRIGLYCERIDEMIC WAIST PHENOTYPE

Multinomial Logistic Regression Results for Predictors of Hypertriglyceridemic Waist Phenotype (HTWP)

The multinomial logistic regression analysis provides a deeper understanding of how various factors differentiate participants in the Hypertriglyceridemic Waist Phenotype (HTWP) group (Group 4, reference group) from other groups—NWNT, EWNT, and NWET. BMI emerged as a critical predictor, showing a consistent and significant inverse relationship in comparisons with Groups 1 (NWNT) and 3 (NWET).

This suggests that individuals with lower BMI were more likely to fall into these groups rather than the HTWP group, reaffirming the association of higher BMI with HTWP, albeit with nuances specific to this population. Interestingly, physical activity status played an important role, being significantly higher in participants belonging to Groups 1 and 3 compared to HTWP. This highlights the role of sedentary behavior as a potential contributor to HTWP.

Fasting blood sugar (FBS), on the other hand, did not show a significant association across comparisons, indicating its limited influence in differentiating HTWP from the other groups in this study. Overall, these results emphasize the multifactorial nature of HTWP, with BMI, physical activity, and blood pressure emerging as key contributors, while FBS played a lesser role.

Table 4.19: Multinomial Logistic Regression

Predictor	Estimate	Standard Error (SE)	Z-value	p-value
Comparison: Group 1 (NWNT) vs. HTWP (Group 4)				
Intercept	17.12171	2.99892	5.7093	< .001
FBS (mg/dL)	−0.01637	0.01220	−1.3419	0.180
BMI	−0.45560	0.06613	−6.8895	< .001
Systolic BP (mmHg)	0.00815	0.03177	0.2564	0.798
Diastolic BP (mmHg)	−0.08544	0.04401	−1.9412	0.052
Physical Activity Status	1.47362	0.37627	3.9164	< .001
Comparison: Group 2 vs. HTWP (Group 4)				
Intercept	−2.49991	3.00530	−0.8318	0.406
FBS (mg/dL)	−0.00821	0.00735	−1.1173	0.264
BMI	−0.04603	0.04154	−1.1080	0.268
Systolic BP (mmHg)	0.07366	0.03153	2.3362	0.019
Diastolic BP (mmHg)	−0.05868	0.04034	−1.4549	0.146
Physical Activity Status	0.28667	0.31752	0.9029	0.367
Comparison: Group 3 (NWET) vs. HTWP (Group 4)				
Intercept	14.36174	1.92731	7.4517	< .001
FBS (mg/dL)	−0.00593	0.01539	−0.3856	0.700
BMI	−0.22175	0.08113	−2.7332	0.006
Systolic BP (mmHg)	−0.00235	0.04042	−0.0583	0.954
Diastolic BP (mmHg)	−0.12733	0.05918	−2.1516	0.031
Physical Activity Status	1.04635	0.52718	1.9848	0.047

DISCUSSION

In recent years, Hypertriglyceridemic Waist Phenotype (HTWP) has gained recognition as a marker for metabolic and cardiovascular health. As a result of elevated waist circumference and triglyceride levels, it reflects a combination of central obesity and dyslipidemia, which contribute to Non Communicable diseases (NCDs) such as type 2 diabetes and cardiovascular disease. The utility of HTWP lies in its simplicity as a screening tool, offering a practical alternative to complex biochemical and imaging-based assessments. This study assessed the prevalence and associated metabolic risks of HTWP in a population of urban Vadodara adults aged 30–60 years, utilizing WC cut-offs of >90 cm for males and >85 cm for females, along with TG levels exceeding 150 mg/dL.

The selection of the 30–60 years age range for this study was based on evidence that this group experiences considerable metabolic changes driven by shifts in lifestyle and dietary habits. Chong et al. (2022) pointed out that middle adulthood is a crucial period characterized by alterations in eating habits and a rise in sedentary behaviour, which heightens the risk of obesity and cardiometabolic diseases. Gherasim et al. (2020) further noted the cumulative impact of lifestyle and dietary elements on metabolic health, stressing their significance during middle adulthood. Gupta and Gupta (2017) supported these observations, indicating that lifestyle choices and related dietary changes in adulthood lead to negative health consequences.

Furthermore, national studies have reported an increasing incidence of dyslipidemia and abdominal obesity within this age demographic. Findings indicated that average triglyceride levels rose significantly with age, reaching a peak of 178 mg/dL in males and 156 mg/dL in females between the ages of 40 and 49. Likewise, the occurrence of abdominal obesity, determined by waist circumference, significantly increased, with 56.7% of females and 19.7% of males aged 40–49 years classified as having abdominal obesity. These results highlight the importance of concentrating on this vital age group to understand key metabolic changes and their associated risk factors.

In the study group, 11.4% of males and 8.2% of females were identified as overweight (BMI: 23–24.9 kg/m²), whereas 21.3% of males and 36.0% of females were found to be obese (BMI > 25 kg/m²). These findings align with those from the National Family Health Survey (NFHS-5), which indicated a higher prevalence of obesity among urban females than males.

The NFHS-5 data further emphasized the increasing prevalence of obesity in urban areas, which is closely associated with changes in diet, reduced physical activity, and improvements in socio-economic status. Similarly, the Comprehensive National Nutrition Survey (CNNS) highlighted that urban women are disproportionately affected by obesity, mirroring trends observed in this study. The noted gender differences in obesity prevalence may be due to differences in hormonal regulation, body composition, and sociocultural influences on dietary and activity patterns.

Regarding abdominal obesity, measured by waist circumference (WC), the prevalence was significant, with 67.6% of males (WC >90 cm) and 42.7% of females (WC >85 cm) falling into this category within the study group. This is consistent with results from Rajat Das Gupta et al (2023) which identified abdominal obesity as a major health issue, particularly in urban settings. The study pointed out similar gender differences, revealing that males had higher WC measurements despite lower general obesity rates. This trend is also reflected in the research of Gupta et al. (2023), which pointed out that males are more likely to accumulate visceral fat, increasing their risk for cardiometabolic issues like hypertension and insulin resistance.

When evaluated using waist-to-hip ratio (WHR) criteria (>0.90 for males and >0.85 for females), 42.7% of males and 34.5% of females in the study cohort were classified as having abdominal obesity. These results are in line with data from the ICMR-INDIAB Study (Phase I), which identified WHR as a significant indicator of central obesity and related metabolic health issues. The elevated WHR in males, as observed in this study, reinforces the established gender-specific variations in fat distribution, where males show a greater inclination towards visceral fat accumulation.

This prevalence rate is comparable to that reported in several other studies. For instance, Borges et al. (2021) investigated individuals with arterial hypertension and/or diabetes mellitus and reported that the prevalence of HTWP varied widely (ranging from approximately 21% to 55%) depending on the characteristics of the study population. Similarly, research conducted among healthcare workers by Tárrega Marcos et al. has reported prevalence figures within a similar range (roughly 25–30%), reinforcing the observation that about one in four adults may exhibit the HTWP. Moreover, a genome- and epigenome-wide association study conducted in Mexican American families identified a HTWP prevalence of approximately 26%, which aligns closely with the 27.5% observed in our cohort.

The present study revealed key differences in risk markers between individuals with the hypertriglyceridemic waist phenotype (HTWP) and those without it. Subjects with HTWP had a higher body mass index (28.1 ± 4.40 kg/m²) and larger waist circumference (94.8 ± 7.53 cm) compared to those without HTWP (BMI of 25.2 ± 3.86 kg/m² and waist circumference of 84.4 ± 10.26 cm). Triglyceride levels were also significantly higher in the HTWP group—193.5 ± 62.92 mg/dL versus 104.5 ± 45.69 mg/dL in the non-HTWP group—and fasting blood sugar (FBS) was elevated (101.7 ± 21.88 mg/dL compared to 93.9 ± 20.35 mg/dL). In addition, diastolic blood pressure was slightly higher among the HTWP subjects, while systolic blood pressure did not show a significant difference.

When the results were examined by gender and waist circumference, a similar trend was observed. In males, FBS increased from 71.0 mg/dL in those with a normal waist to 80.8 mg/dL in those with an elevated waist; in females, FBS rose from 75.1 mg/dL to 84.0 mg/dL. Likewise, triglyceride levels increased from 90.7 mg/dL to 119.3 mg/dL in males and from 87.0 mg/dL to 118.5 mg/dL in females with an elevated waist.

These results demonstrate that simple clinical measurements—such as waist circumference, FBS, and triglycerides—can effectively help identify individuals who are at higher risk for type 2 diabetes and cardiovascular problems. Du et al. (2013) focused on the association between markers of visceral adiposity and the risk of diabetes. The study found that, in both men and women, the presence of this phenotype was associated with significantly higher odds of being diagnosed with type 2 diabetes when compared to individuals whose waist and triglyceride levels were below the defined cut points. In practical terms, this means that the combination of a larger waist circumference and elevated triglycerides is a strong predictor of diabetes.

The study group was further analyzed by dividing participants into four distinct groups based on waist circumference and triglyceride levels: NWNT (Normal Waist, Normal Triglycerides), EWNT (Elevated Waist, Normal Triglycerides), NWET (Normal Waist, Elevated Triglycerides), and HTWP (Hypertriglyceridemic Waist Phenotype). This categorisation revealed that the NWNT group demonstrated the most favorable profile, with the lowest mean BMI (23.3 ± 3.12 kg/m²) and waist circumference (77.4 ± 9.03 cm), along with correspondingly lower systolic and diastolic blood pressures, fasting blood sugar, and triglyceride levels.

In contrast, the HTWP group exhibited the most adverse values, including the highest mean BMI (28.1 ± 4.43 kg/m²) and waist circumference (94.9 ± 7.48 cm), as well as significantly

higher fasting blood sugar (102 ± 21.9 mg/dL). The EWNT group, characterized by an elevated waist with normal triglycerides, showed intermediate values—particularly a BMI of 27.3 ± 3.65 kg/m² and a waist circumference of 92.5 ± 5.13 cm—while the NWET group presented with normal waist circumference but notably elevated triglyceride levels (206 ± 52.1 mg/dL) despite having a lower BMI (25.3 ± 3.19 kg/m²) and waist measurement (81.2 ± 5.16 cm). Statistical analyses confirmed that these differences were significant (e.g., $p < 0.01$ for BMI, waist circumference, fasting blood sugar, and triglycerides; $p = 0.016$ for systolic blood pressure; and $p < 0.01$ for diastolic blood pressure), indicating a clear, graded worsening in metabolic risk factors as one moves from NWNT to HTWP.

This four-group classification is comparable to the method used in a study by Arsenault et al. , participants were similarly divided based on waist and triglyceride thresholds. Their analysis revealed that individuals in the group with both an enlarged waist and high triglycerides—the hypertriglyceridemic-waist phenotype—had markedly worse cardiometabolic profiles and a significantly higher risk of coronary artery disease. They found that risk factors such as blood pressure and lipid abnormalities worsened progressively from the group with normal waist and triglyceride levels, to those with only one abnormality, and were highest in the HTWP group.

Futher multinomial logistic regression analysis identified key factors that differentiate the HTWP group from the others. Notably, BMI was found to be a particularly strong predictor; individuals in the NWNT and NWET groups exhibited significantly lower BMIs compared to those in the HTWP group, underscoring the close relationship between elevated BMI and the combined risk of central obesity and dyslipidemia. Additionally, the levels of physical activity were notably higher among participants in the NWNT and NWET groups in comparison to the HTWP group, emphasizing the role of physical inactivity in the onset of HTWP.. Importantly, fasting blood sugar levels did not significantly vary among the groups in our analysis.

These findings align with results from studies that also utilized similar logistic regression methods to investigate the hypertriglyceridemic-waist phenotype. A population-based study conducted by Yang et al. (2022). The study included logistic regression analysis highlighted higher BMI and reduced physical activity as important predictors of the HTWP, echoing our findings that unfavorable anthropometric characteristics and sedentary lifestyles are significant factors contributing to this phenotype. Furthermore, Yang et al. showed that the combined assessment of waist circumference and triglyceride levels effectively identified individuals at increased metabolic risk.

The study underscores the utility of Hypertriglyceridemic Waist Phenotype (HTWP) as an effective marker for identifying metabolic and cardiovascular risks, particularly in urban adults. Elevated waist circumference and triglyceride levels were strongly associated with increased BMI, fasting blood sugar, and diastolic blood pressure, indicating heightened cardiometabolic risk. Stratification of participants revealed a increased risk profile from the NWNT group to the HTWP group, highlighting the phenotype's predictive value. These findings emphasize the importance of early screening and targeted interventions to mitigate the growing burden of Non-Communicable Diseases (NCDs).

SUMMARY AND CONCLUSION

The current cross-sectional research was conducted to assess the prevalence of the Hypertriglyceridemic Waist Phenotype (HTWP) and its correlation with risk factors for non-communicable diseases (NCD) among individuals aged 30–60 years in urban Vadodara. This study was carried out across the four administrative zones of Vadodara city, utilizing purposive sampling to select one society containing more than 55 households from each zone. Data collection involved structured pre-tested questionnaires that captured information on socioeconomic status (SES), lifestyle patterns, dietary habits, levels of physical activity (evaluated via the IPAQ), anthropometric measurements, and biochemical evaluations of fasting blood sugar (FBS) and triglycerides (TG). The research aimed to study significant metabolic markers and lifestyle factors contributing to the increasing incidence of NCDs within this urban demographic.

BROAD OBJECTIVE

To assess the risk of Non Communicable Diseases (NCDs) among Hypertriglyceridemic Waist Phenotype (HTWP) adults aged 30-60 years in Urban Vadodara.

SPECIFIC OBJECTIVES OF THE STUDY

I. To screen the participants for HTWP by using standardized anthropometric indices and biochemical parameters.
II. To assess the sociodemographic status, lifestyle factors of the subjects by using structured questionnaires.

Socioeconomic profile of the subjects :

- Most participants (58.2%) belonged to the upper-lower socioeconomic class, followed by 35.1% in the lower-middle class, with a small proportion (6.1%) in the upper-middle class.
- The majority (86.8%) lived in nuclear families, 8.8% in extended families, and 4.4% in joint families.
- Educationally, 58.1% of family heads were graduates, and 16.7% had professional or honors qualifications.
- Around half (50.7%) of family heads were professionals, while 39.3% were skilled workers or shopkeepers, and 3.8% were unemployed.
- Regarding family income, 39.9% reported monthly earnings between ₹53,360–₹80,109, and 38.7% fell in the ₹31,978–₹53,360 range.

Medical history and Addiction pattern among the subjects

- 45% of participants reported no significant family history of chronic illnesses. Among those with a family history, hypertension was the most common (31%), followed by diabetes (17.8%) and other conditions like hypothyroidism (2.6%) and coronary heart disease (1.5%).

- The majority (87.7%) of participants reported no substance use. Tobacco chewing was the most common form of addiction (9.4%), while smoking (1.8%) and alcohol consumption (1.2%) were comparatively less prevalent.

Anthropometric and Biophysical Profile of Subjects

- The anthro indicators showed that the mean height of males was (170 ± 5.89 cm) and body weight (74.0 ± 11.2 kg) and females, whose mean height and weight were 155 ± 6.86 cm and 63.8 ± 12.6 kg, respectively.
- The mean BMI of the population was 26.0 ± 4.12 kg/m², with females having a slightly higher BMI (26.2 ± 4.58 kg/m²) than males (25.7 ± 3.31 kg/m²).
- Waist circumference was significantly higher in males (92.9 ± 7.71 cm) compared to females (83.5 ± 10.4 cm), reflecting greater central obesity among males.
- Waist-to-hip ratio was also higher in males (0.92 ± 0.06) than females (0.82 ± 0.09), indicating differences in fat distribution.
- Blood pressure levels showed no significant difference in systolic blood pressure (124 ± 6.90 mmHg), though diastolic blood pressure was slightly higher in males (85.1 ± 4.87 mmHg) compared to females (83.4 ± 5.57 mmHg).

- **Overweight and obesity Prevalence**:
- With respect to Asia Pacific classification, Overweight was more common among males (11.4%) compared to females (8.2%), totaling 19.6% of the study population.
- Obesity was significantly higher in females (36.0%) than males (21.3%), affecting 57.3% of participants overall.
- **Abdominal Obesity Prevalence**: Based on waist circumference, abdominal obesity was observed in 67.6% of males (WC >90 cm) and 42.7% of females (WC >85

cm), compared to waist-to-hip ratio, which identified 42.7% of males (WHR >0.90) and 34.5% of females (WHR >0.85).

- Both WC and WHR were used as markers of abdominal obesity, but prevalence rates indicate WC is a more reliable predictor for gender-specific differences in abdominal obesity than WHR.
- **Age-wise Prevalence of Abdominal Obesity**: Among males, abdominal obesity (WC >90 cm) increased with age, from 28.7% in the 30–39 years group to 22.1% in the 40–49 years group and 16.9% in the 50–60 years group. Among females, abdominal obesity (WC >85 cm) was highest in the 30–39 years group (21.8%), followed by 14.6% in the 40–49 years group and 6.3% in the 50–60 years group.

Prevalence of Hypertension among the participants

- Pre-hypertension was highly prevalent, affecting 78.4% of participants, indicating a significant risk of progression to hypertension.
- Only 20.2% of participants maintained normal blood pressure (<120/80 mmHg), reflecting a minority with optimal cardiovascular health.
- Hypertension stage 1 (140–159/90–99 mmHg) was observed in 1.5% of the study population.

Dietary Characteristics of the subjects

- The subjects consumed predominantly vegetarian diet (82.7%), with smaller proportions of non-vegetarians (13.8%) and ovo-vegetarians (3.5%).
- Majority consumed 3–4 meals daily (82.4%), while meal skipping was common (39.3%).
- Snacking between meals was reported by 28.7%, and dining out weekly by 33.1%.
- Most participants (74.8%) relied on three home-cooked meals daily, indicating a preference for traditional food habits.
- Grains were consumed daily by 98.8% of participants, while pulses were consumed weekly by 62.3%.
- Daily consumption of green leafy vegetables was 95.6%, while fruits were consumed daily by 25.4%.
- Occasional intake of fried snacks, sugary foods, and packaged items was reported.

- Tea was the most consumed beverage daily (76.5%), while coffee and sugar-sweetened drinks were occasionally consumed.

Physical Activity Status of the Subjects:

- Only 1.8% of participants reported engaging in vigorous physical activity, while 57.0% performed moderate activity.
- Low activity levels were prevalent among 41.2%, indicating sedentary habits.

Prevalence of HTWP

- HTWP was prevalent in 27.5% of participants, highlighting a considerable segment at risk for metabolic health complications, while the remaining 72.5% were classified as Non-HTWP.

Comparative analysis between HTWP AND NHTWP GROUP

- HTWP participants showed higher BMI (28.1 ± 4.40 kg/m²) and waist circumference (94.8 ± 7.53 cm) compared to non-HTWP participants (BMI: 25.2 ± 3.86 kg/m²; WC: 84.4 ± 10.26 cm).
- Triglyceride levels were elevated in HTWP individuals (193.5 ± 62.92 mg/dL) versus non-HTWP individuals (104.5 ± 45.69 mg/dL).
- HTWP participants had higher fasting blood sugar (101.7 ± 21.88 mg/dL) than those without the phenotype (93.9 ± 20.35 mg/dL).
- Diastolic blood pressure was slightly higher in HTWP individuals (85.3 ± 5.19 mmHg) compared to non-HTWP participants (83.4 ± 5.18 mmHg).
- No significant difference was observed in systolic blood pressure between the two groups

Comparison of FBS and TG Levels by Waist Circumference and Gender

- In males, FBS was found to be 71.0 mg/dl (normal waist) and 80.8 mg/dl (larger waist), while in females, it was found to be 75.1 mg/dl amongst normal waist and 84.0 mg/dl among females having higher waiat circumference.

- Triglycerides followed a similar trend, increasing from 90.7 mg/dl to 119.3 mg/dl in males and from 87.0 mg/dl to 118.5 mg/dl in females as waist size increased.
- Participants with HTWP had the highest BMI (28.1 ± 4.43 kg/m²), significantly higher than NWNT (23.3 ± 3.12 kg/m²), EWNT (27.3 ± 3.65 kg/m²), and NWET (25.3 ± 3.19 kg/m²).
- Waist circumference in HTWP individuals was the largest (94.9 ± 7.48 cm), compared to EWNT (92.5 ± 5.13 cm), NWET (81.2 ± 5.16 cm), and NWNT (77.4 ± 9.03 cm).
- HTWP participants also had elevated diastolic blood pressure (85.2 ± 5.22 mmHg) and systolic blood pressure (125 ± 6.69 mmHg), compared to other groups.
- Fasting blood sugar levels were highest among HTWP individuals (102 ± 21.9 mg/dL), followed by EWNT (97.0 ± 19.3 mg/dL), NWET (94.3 ± 14.9 mg/dL), and NWNT (91.0 ± 22.0 mg/dL).
- Triglycerides levels were notably higher in HTWP participants (195 ± 61.4 mg/dL) and NWET (206 ± 52.1 mg/dL), compared to EWNT (98.8 ± 26.1 mg/dL) and NWNT (87.8 ± 27.5 mg/dL).

Recommendations

- There is a lack of comprehensive studies on Hypertriglyceridemic Waist Phenotype (HTWP) in the Indian context. More region-specific research is needed to understand its prevalence and impact on metabolic health among diverse Indian populations.
- HTWP should be considered as a simple, cost-effective screening tool in routine health check
- -ups, especially in urban settings, to enable early detection and prevention of metabolic risks.

Future Scope

- Longitudinal studies could investigate the progression of HTWP and its impact on long-term health outcomes, such as cardiovascular diseases and diabetes
- Comparative studies across different urban and rural demographics may provide insights into socio-environmental factors affecting HTWP.
- Evaluating the effectiveness of targeted interventions on HTWP risk reduction could guide more refined public health strategies.

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APPENDICES

SES QUESTIONAIRRE

BACKGROUND INFORMATION:

1. Name:

2. Date of Birth:

3. Age :

4. Gender :

5. Address:

6. Contact no : Email Id:

7. Religion:
   a) Hindu
   b) Muslim
   c) Sikh
   d) Christian
   e) Jain
   f) Others

8. Marital Status
   a) Unmarried
   b) Married
   c) Divorce
   d) Widow/Widower

9. Occupation :
   a) Business
   b) Service
   c) Unemployed
   d) Student
   e) Retired
   f) Labourer
   g) Self employed
   h) Housewife

10. If the mother is working, what are the working hours per day ?

11. Number of family members with age :

12. Type of family:
    a) Nuclear
    b) Joint
    c) Extended

13. Total Income (Rs):

14. Other sources of Income?

15. Economic Status :

    - Per capita income
    -

MEDICAL AND FAMILY HISTORY:

1. Family history :

Type	Self	Mother	Father	Sibling	Grandparents
Diabetes					
Hypertension					
CHD					
Hyperlipidemia					
Stroke					
Hypo/ Hyperthyroidism					
Asthma					
Cancer					
Any other (Specify)					

2. Are you on any medication presently ?
   a) Yes
   b) No

   If yes:

Name of Drug	**Dosage**	**Frequency**	**Duration (yrs)**

3. Addiction Pattern:

	Currently	**Past History**	**Duration**	**Frequency**
Smoking				
Alcohol				
Tobacco Chewing				

ANTHROPOMETRY AND BIOPHYSICAL MEASUREMENTS:

PARAMETERS	VALUE
Weight (kg)	
Height (cm)	
BMI	
Waist Circumference (cm)	
Hip Circumference (cm)	
Waist hip ratio	
Blood pressure	

DIETARY ASSESSMENT

1. Food habit:
   (a) Vegetarian
   (b) Non Vegetarian
   (c) Ovo vegetarian
   (d) Vegan

2. If Non vegetarian , what is the frequency of eating non veg _____ /week/month.

3. If Ovo vegetarian, what is the frequency of consuming egg _____ / week/month.

4. Any food allergy?
   a) Yes
   b) No

5. Do you take any dietary supplement?
   a) Yes
   b) No
   If yes than specify _____

6. How many meals in a day are cooked at home?
   a) All

b) 3 meals
c) 2 meals
d) 1 meal

7. Do you skip any of the meals?
   a) Yes
   b) No
   If yes, which meal do you skip majorly? _____

8. How many cups of tea/coffee do you drink in a day?
   a) 1
   b) 2
   c) 3
   d) >3

9. How much quantity of sugar do you prefer in your tea/coffee?
   a) 1 tsp
   b) 2 tsp
   c) 3 tsp
   d) >3 tsp

10. How many times do you prefer eating out?
    a) Daily
    b) Once a week
    c) Once in 10 days
    d) Twice a month
    e) Once in 1 month

11. What type of food do you prefer to eat outside the house?
    a) Gujarati
    b) Punjabi
    c) Chinese
    d) Mexican
    e) Italian
    f) Fast food

12. How many times in a week lunch is given from home/
    a) 6 days
    b) 5 days
    c) 4 days
    d) 3 days
    e) Less than 3 day

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work

you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

Yes

No **Skip to PART 2: TRANSPORTATION**

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

_____days per week

No vigorous job-related physical activity **Skip to question 4**

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

_____hours per day

_____minutes per day

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____days per week

No moderate job-related physical activity **Skip to question 6**

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____hours per day

_____minutes per day

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____days per week

No job-related walking **Skip to PART 2: TRANSPORTATION**

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____hours per day

_____minutes per day

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work,

stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____days per week

No traveling in a motor vehicle **Skip to question 10**

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____hours per day

_____minutes per day

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____days per week

No bicycling from place to place **Skip to question 12**

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____hours per day

_____minutes per day

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____days per week

No walking from place to place **Skip to PART 3: HOUSEWORK,**

HOUSE MAINTENANCE, AND

CARING FOR FAMILY

13. How much time did you usually spend on one of those days **walking** from place to place?

_____hours per day

_____minutes per day

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and

caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____days per week

No vigorous activity in garden or yard **Skip to question 16**

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____hours per day

_____minutes per day

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____days per week

No moderate activity in garden or yard **Skip to question 18**

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____hours per day

_____minutes per day

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____days per week

No moderate activity inside home **Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY**

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____hours per day

_____minutes per day

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____days per week

No walking in leisure time **Skip to question 22**

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____hours per day

_____minutes per day

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities likeaerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____days per week

No vigorous activity in leisure time **Skip to question 24**

LONG LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised October 2002.

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____hours per day

_____minutes per day

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____days per week

No moderate activity in leisure time **Skip to PART 5: TIME SPENT SITTING**

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

_____hours per day

_____minutes per day

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____hours per day

_____minutes per day

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____hours per day

_____minutes per da

24 HOUR DIETARY RECALL (3 DAY)

Time	Meal	Ingredients	Raw Amt used for Family (gm) [A]	Cooked Vol. for Family (ml) [B]	Vol. consumed by the subject (ml) [C]	Raw amt consumed by the subject (gm) [D] D=A*C/B

Time	**Meal**	**Ingredients**	**Raw Amt used for Family (gm) [A]**	**Cooked Vol. for Family (ml) [B]**	**Vol. consumed by the subject (ml) [C]**	**Raw amt consumed by the subject (gm) [D] D=A*C/B**

SEMI-QUANTITAVE FOOD FREQUENCY

no	Food item	Amount	Daily	4-5 Times A week	Thrice A Week	Once A Week	Once In 10 Days	Once In 15 days	Once A month	Occasionally	Never
	FOODS HIGH IN FAT										
	Puff										
	Samosa										
	Vadapav										
	Frankie										
	Kachori										
	Bhajiya										
	Bataka Vada										
	Home based										
	Chakri										
	Mathri										
	Chips										
	Choda fadi, mathiya										
	Papdi , Ghathiya										
	Namkeen, Chavanu										
	Puri										
	Sev mamra										
	Sev										
	Papad Poha										

no	**Food item**	**Amount**	**Daily**	**4-5 Times A week**	**Thrice A Week**	**Once A Week**	**Once In 10 Days**	**Once In 15 days**	**Once A month**	**Occasio nally**	**Never**
HIGH IN SUGAR											
	Cream roll/Bun										
	Ice-cream										
	Cakes / pastry										
	Breakfast cereals										
	Ready to eat sweets										
	Cookies/ Khari /toast										
	Carbonated Soft drinks										
	Fruit Syrups										
	Fruit Drinks Maaza ,slice										
	Packed Fruit Juices										
	Homemade Sweets										
	Sukhadi										
	Kacchariyu										
	Chikki										
	Others										

no	**Food item**	**Amount**	**Daily**	**4-5 Times A week**	**Thrice A Week**	**Once A Week**	**Once In 10 Days**	**Once In 15 days**	**Once A month**	**Occasionally**	**Never**
	Grains										
	Millets										
	Pulses										
	GLVs										
	Other vegetables										
	Roots and Tuber										
	Fruits										
	Grains										
	Millets										
	Fruits										
	Nuts and oilseeds										
	Milk										
	Coffee										
	Tea										
	Curd										
	Paneer										
	Cheese										
	Ghee										
	Oil										
	Sugar										
	Jaggery										
	Honey										

no	**Food item**	**Amount**	**Daily**	**4-5 Times A week**	**Thrice A Week**	**Once A Week**	**Once In 10 Days**	**Once In 15 days**	**Once A month**	**Occasionally**	**Never**
	Fruits										
HIGH IN SALT											
	Instant Soups										
	Instant Sauces										
	Papad										
	Pickles										
	Instant Noodles										
	Cheese spreads										
	Frozen foods										
	Ketchup										
	Wafers										
NON VEGETARIAN FOOD ITEMS											
	Chicken										
	Mutton										
	Fish										
	Prawns										

CONSENT FORM

STUDY TITLE: Assessment of risk of Non Communicable Diseases(NCDs) among Hypertriglyceridemic Waist Phenotype adults aged 30-60 years of Urban Vadodara.

Investigator: Ms. Bhargavi Brahmkhatri

Research GUIDE: Dr. Swati Dhruv

PURPOSE OF THE STUDY

The Hypertriglyceridemic Waist Phenotype (HTWP), defined by increased waist circumference and elevated triglyceride levels, has emerged as a reliable predictor of metabolic disorders and cardiovascular diseases in Western populations. However, there is a scarcity of data on the prevalence and impact of the HTWP phenotype in the Indian population. To address this gap, the purpose of this study is to assess the risk of NCDs among adults aged 30-60 with the Hypertriglyceridemic Waist phenotype in Urban Vadodara. By evaluating the association between HTWP and NCD risk, this research will provide crucial insights for the early identification of individual at risk of suffering from chronic diseases.

PROTOCOL OF THE STUDY

The study is focused on adults in productive age (30 – 60 years). In the study the information regarding following aspects would be collected:

1. Socio economic status
2. Medical history
3. Anthropometric Measurements
4. Biophysical parameter
5. Biochemical Parameter
6. Quantitative food frequency
7. 24 hour dietary recall (3days – 2 weekdays & 1 weekend)
8. Physical activity level

All the above information will be assessed with the help of standard tools & techniques.

COSTS

This study requires only your time and co-operation and there is no financial compensation for your participation in this research.

POSSIBLE BENEFITS AND RISKS

The study will help identify adults with the Hypertriglyceridemic Waist phenotype who may be at a higher risk of developing Non-Communicable Diseases (NCDs).

CONFIDENTIALITY

In the study your identity will be kept confidential. The results of the study, may be published for scientific purposes but will not reveal your name or include any identifiable references to you.

RIGHT TO WITHDRAW

Your decision to join the study is voluntary. You may quit at any time, for any reason, without notice. We hope you will take part for entire study period because we need all the information to draw correct conclusions.

AVAILABILITY OF RESULTS

A copy of the results will be provided to you for future use. If any abnormalities seen in the biophysical profile you would be advised to contact your doctor. If you have any questions about any part of the study or your rights as volunteer, you can contact the investigators mentioned above.

VOLUNTARY CONSENT

Your co-operation is important for the success of this study. Unless many volunteers like you agree to join; this study will not be possible.

INVESTIGATOR'S STATEMENT

I have explained the research program, the purpose of the study and the possible benefits and risks to the participant. The participant was given an opportunity to discuss these procedures and to ask any additional questions.

_____

Signature of the investigator with date

PARTICIPANT'S STATEMENT

I certify that I have read, or had read out to me, and that I have understood the description of the study. By signing this form I am attesting that I have read and understood the information given above. I give my consent to be included as the subject in the study being carried out by the post graduate student Ms. Bhargavi Brahmkhatri under the guidance of Dr. Swati Dhruv at the Maharaja Sayajirao University of Baroda to provide information required by the investigators.

I understand that the study requires the participant to provide information regarding Socio economic status, Medical history, anthropometric measurements, blood pressure, Food frequency, and physical activity.

I have had a chance to ask questions about the study. I understand that I may ask further questions at any time. I have been explained to my satisfaction the purpose of this study and I am also aware of my right to opt out of the study any time.

_____

Signature of the participant with date

સંમતિ ફોર્મ

અભ્યાસનું શીર્ષક: શહેરી વડોદરાના ૩૦- ૬૦ વર્ષની વયના પુખ્ત વયના લોકોમાં હાઈપરટ્રિગ્લિસેરીડેમિક વેસ્ટ ફેનોટાઈપના નોન કોમ્યુનિકેબલ ડિઝીઝ ના જોખમનું મૂલ્યાંકન.

સંશોધન માર્ષદશષક: ડૉ. સ્વાતિ ધ્રુવ

તપાસકર્તા: કુ. ભાર્ગવી બ્રહ્મખાત્રી

અભ્યાસનો હેતુ

હાઈપરટ્રિગ્લિસેરીડેમિક વેસ્ટ ફેનોટાઇપ (HTWP), જે કમરનો પરિઘ અને એલિવેટેડ ટ્રાઇગ્લિસેરાઇડ સ્તરો દ્વારા વ્યાખ્યાયિત કરવામાં આવ્યો છે, તે પશ્ચિમી વસ્તીમાં મેટાબોલિક ડિસઓર્ડર અને કાર્ડિયોવેસ્ક્યુલર રોગોના વિશ્વસનીય આગાહીકર્તા તરીકે ઉભરી આવ્યો છે. જો કે, ભારતીય વસ્તીમાં હાઈપરટ્રિગ્લિસેરીડેમિક વેસ્ટ ફેનોટાઇપના વ્યાપ અને પ્રભાવ અંગેના ડેટાની અછત છે. આ તફાવતને સંબોધવા માટે, આ અભ્યાસનો હેતુ શહેરી વડોદરામાં હાઈપરટ્રિગ્લિસેરીડેમિક વેસ્ટ ફેનોટાઈપ સાથે ૩૦- ૬૦ વર્ષની વયના પુખ્ત વયના નોન લોકોમાં નોન કોમ્યુનિકેબલ ડિઝીઝ (NCD) જોખમનું મૂલ્યાંકન કરવાનો છે. હાઈપરટ્રિગ્લિસેરીડેમિક વેસ્ટ અને નોન કોમ્યુનિકેબલ ડિઝીઝ (NCD) જોખમ વચ્ચેના જોડાણનું મૂલ્યાંકન કરીને, આ સંશોધન ક્રોનિક રોગોથી પીડાતા જોખમમાં વ્યક્તિની પ્રારંભિક ઓળખ માટે નિર્ણાયક આંતરદૃષ્ટિ પ્રદાન કરશે.

અભ્યાસનો પ્રોટોકોલ

આ અભ્યાસ ઉત્પાદક વય (૩૦- ૬૦ વર્ષ) માં પુખ્ત વયના લોકો પર કેન્દ્રિત છે. અભ્યાસમાં નીચેના પાસાઓ સંબંધિત માહિતી એકત્રિત કરવામાં આવશે:

1. સામાજિક આર્થિક સ્થિતિ

2. તબીબી ઇતિહાસ

3. એન્થ્રોપોમેટ્રિક માપન

4. બાયોફિઝિકલ પેરામીટર

5. બાયોકેમિકલ પેરામીટર

6. માત્રાત્મક ખોરાકની આવર્તન

7. 24 કલાક ડાયેટરી રિકોલ (3 દિવસ - 2 અઠવાડિયાના દિવસો અને 1 સપ્તાહાંત)

8. શારીરિક પ્રવૃત્તિ સ્તર

ઉપરોક્ત તમામ માહિતીનું મૂલ્યાંકન પ્રમાણભૂત સાધનો અને તકનીકોની મદદથી કરવામાં આવશે.

ખર્ચ

આ અભ્યાસ માટે ફક્ત તમારા સમય અને સહકારની જરૂર છે અને આ સંશોધનમાં તમારી ભાગીદારી માટે કોઈ નાણાકીય વળતર નથી.

સંભવિત લાભો અને જોખમો

આ અભ્યાસ હાઈપરટ્રિગ્લિસેરીડેમિક વેસ્ટ ફેનોટાઈપ ધરાવતા પુખ્ત વયના લોકોને ઓળખવામાં મદદ કરશે જેમને નોન કોમ્યુનિકેબલ ડિઝીઝ (NCDs) થવાનું વધુ જોખમ હોઈ શકે છે.

ગોપનીયતા

અભ્યાસમાં તમારી ઓળખ ગુપ્ત રાખવામાં આવશે. અભ્યાસના પરિણામો, વૈજ્ઞાનિક હેતુઓ માટે પ્રકાશિત થઈ શકે છે પરંતુ તેમાં તમારું નામ જાહેર કરશે નહીં અથવા તમારા માટે કોઈ ઓળખી શકાય તેવા સંદર્ભોનો સમાવેશ કરશે નહીં.

અભ્યાસ માથી છોડી જવાનો અધિકાર

અભ્યાસમાં જોડાવાનો તમારો નિર્ણય સ્વૈચ્છિક છે. તમે કોઈપણ સમયે, કોઈપણ કારણસર, સૂચના વિના છોડી શકો છો. અમે આશા રાખીએ છીએ કે તમે સમગ્ર અભ્યાસ સમયગાળા માટે ભાગ લેશો કારણ કે અમને સાચા તારણો કાઢવા માટે બધી માહિતીની જરૂર છે.

પરિણામોની ઉપલબ્ધતા

પરિણામોની એક નકલ તમને ભવિષ્યના ઉપયોગ માટે પ્રદાન કરવામાં આવશે. જો બાયોકેમિકલ પેરામીટર માં કોઈ અસાધારણતા જોવા મળે તો તમને તમારા ડૉક્ટરનો સંપર્ક કરવાની સલાહ આપવામાં આવશે. જો તમને અભ્યાસના કોઈપણ ભાગ વિશે અથવા સ્વયંસેવક તરીકેના તમારા અધિકારો વિશે કોઈ પ્રશ્નો હોય, તો તમે ઉપર જણાવેલ તપાસકર્તાઓનો સંપર્ક કરી શકો છો.

સ્વૈચ્છિક સંમતિ

આ અભ્યાસની સફળતા માટે તમારો સહકાર મહત્વપૂર્ણ છે. જ્યાં સુધી તમારા જેવા ઘણા સ્વયંસેવકો જોડાવા માટે સંમત ન થાય ત્યાં સુધી; આ અભ્યાસ શક્ય બનશે નહીં.

તપાસકર્તાનું નિવેદન

મેં સંશોધન કાર્યક્રમ, અભ્યાસનો હેતુ અને સહભાગીને સંભવિત લાભો અને જોખમો સમજાવ્યા છે. સહભાગીને આ પ્રક્રિયાઓની ચર્ચા કરવાની અને કોઈપણ વધારાના પ્રશ્નો પૂછવાની તક આપવામાં આવી હતી.

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તારીખ સાથે તપાસકર્તાની સહી

સહભાગીનું નિવેદન

હું પ્રમાણિત કરું છું કે મેં વાંચ્યું છે, અથવા મને વાંચ્યું છે, અને હું અભ્યાસનું વર્ણન સમજી ગયો છું. આ ફોર્મ પર સહી કરીને હું પ્રમાણિત કરું છું કે મેં ઉપર આપેલી માહિતી વાંચી અને સમજી લીધી છે. બરોડાની મહારાજા સયાજીરાવ યુનિવર્સિટીમાં ડૉ. સ્વાતિ ધ્રુવના માર્ગદર્શન હેઠળ અનુસ્નાતક વિદ્યાર્થી સુશ્રી ભાર્ગવી બ્રહ્મખાત્રી દ્વારા તપાસકર્તાઓને જરૂરી માહિતી પૂરી પાડવા માટે કરવામાં આવી રહેલા અભ્યાસમાં વિષય તરીકે સામેલ કરવા હું મારી સંમતિ આપું છું.

હું સમજું છું કે અભ્યાસમાં સહભાગીને સામાજિક આર્થિક સ્થિતિ, તબીબી ઇતિહાસ, માનવશાસ્ત્રીય, એન્થ્રોપોમેટ્રિક માપન બ્લડ પ્રેશર, ખોરાકની આવર્તન અને શારીરિક પ્રવૃત્તિ સંબંધિત માહિતી પ્રદાન કરવાની આવશ્યકતા છે.

મને અભ્યાસ વિશે પ્રશ્નો પૂછવાની તક મળી છે. હું સમજું છું કે હું કોઈપણ સમયે વધુ પ્રશ્નો પૂછી શકું છું. મને આ અભ્યાસનો હેતુ મારા સંતોષ માટે સમજાવવામાં આવ્યો છે અને હું કોઈપણ સમયે અભ્યાસ માથી છોડી જવાના અધિકારથી પણ વાકેફ છું.

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તારીખ સાથે સહભાગીની સહી