DIET QUALITY AND NON-COMMUNICABLE DISEASE RISK ASSESSMENT IN ADULT POPULATION OF URBAN VADODARA

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B.SC. HOME SCIENCE

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A dissertation in partial fulfilment of the requirement for the degree of Master of Science

Family and Community Sciences
Foods and Nutrition (Dietetics)

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CERTIFICATE

This is to certify that the research work present in this thesis has been carried out independently by Miss Drishti Gupta, under the guidance of Dr. Swati Dhruv in pursuit of degree of Master of Science (Family and Community Sciences) with major in Foods and Nutrition (Dietetics) and this is her original work.

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Drishti Gupta

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LIST OF ABBREVIATIONS

NCD - Non-Communicable Diseases
WC - Waist Circumference
HC - Hip Circumference
WHR - Waist to Hip Ratio
WSR - Waist to Stature Ratio
BMI - Body Mass Index
Ow - Overweight
Ob - Obese
Uw - Underweight
SBP - Systolic Blood Pressure
DBP - Diastolic Blood Pressure
CHD - Coronary Heart Disease
CVD - Cardiovascular Disease
HEI - Healthy Eating Index
AHEI - Alternate Healthy Eating Index
DQQ - Diet Quality Questionnaire
FFQ - Food Frequency Questionnaire
MDD - Minimum Dietary Diversity
DQI - Diet Quality Indices
EAR - Estimated Average Requirement
RDA - Recommended Dietary Allowance
IPAQ - International Physical Activity Questionnaire
GDQS - Global Diet Quality Score
NAR - Nutrient Adequacy Ratio
MAR - Mean Adequacy Ratio
LMIC - Low- and middle-income countries
NR-NCD - Nutrition related Non-Communicable diseases

ABSTRACT

ABSTRACT

Transition in global diet and lifestyle, has been quite prominent due to industrialization, urbanization, scientific, and economic development. This has accelerated over the past decades and led to shift in disease risk and burden from infectious diseases to non-communicable diseases (NCDs). NCDs are now a leading global cause of death and are responsible for 74% of deaths worldwide. With the improved standards of living have accompanied increased food availability and diversity of choices, but poor diet and nutrition inadequacy remains one of the key risk factors of NCDs. The challenge is no longer on consuming sufficient calories to avoid malnutrition, but how to eat adequately for optimal health and disease prevention. This transition has affected and increased the significance of the diet quality concept. Several diet quality indices have hence been developed, one that has been launched for universal use is the Global Diet Quality Score (GDQS). Most pre-existing indices adhere to national dietary guidelines, hence, there is a lack of primary data correlating the diet quality indices, with the poor diet related outcomes and nutrient adequacy in the population. Thus, the current study was carried out with the objective to assess Diet Quality and Non-Communicable Disease risk assessment in adult population (20-50 years) of Urban Vadodara and correlate the Diet Quality metrics with nutrient adequacy for the Indian population.

The present cross-sectional study was carried out on 400 subjects in the age group of 20-50 years residing in 4 administrative zones of Urban Vadodara. Data was collected with respect to background information, Socio-Economic status, Family and medical history, Anthropometry and Biophysical parameters, Physical Activity level, Diet Quality assessment via GDQS tool and 24-hour dietary recall, using standardised tools and then subjected to appropriate statistical analysis.

The background information of the subjects revealed an almost equal number of females (N=207) and males (N=193) with a mean age of 37 ± 10 years. The educational status revealed that 56.8% of the subjects were graduates, and 0.3% were illiterate. The socio-economic status indicated that majority (72.25%) of the subjects belonged to Upper Middle SES. The medical history revealed high prevalence of Hypertension(67.5%) and Diabetes (40.3%) among family members. The results indicated an overall high prevalence of NCD risk factors amongst the subjects, including self-reported and family history of chronic diseases (76.5%), High BMI (50% Obese) and abdominal obesity (69.5% high WC), prehypertension (49%) and hypertension (31.25%), physical inactivity (57.3% minimally active) and inadequate macro and micro nutrient intake through diet.

The mean GDQS of the study population was 22.10 ± 3.42, which belonged to moderate risk category. Mean GDQS+ was 10.75±2.83 and mean GDQS- was 11.35±1.83. Contribution to overall GDQS was more from negative score, indicating more consumption of unhealthy food groups than healthy food groups.

The nutrient adequacy ratios for carbohydrate, protein, and total fat (computed from 24 hr dietary recall) were close to 1 for both females and males, indicating adequate intake. Mean NARs for calcium, zinc, thiamine, riboflavin, niacin, and vitamin A were lower than 1, suggesting inadequate intake. Nutrient adequacy lacked in the subjects, and on correlating with GDQS and GDQS+, significant positive correlations were found with MAR% (Mean Adequacy Ratio) as well as individual NARs (Nutrient Adequacy Ratio). GDQS was thus found to be directly associated with nutrient adequacy and inversely with poor dietary outcomes as NR-NCDs and NCD risk factors.

The study results suggest Diet Quality indices like GDQS can be taken as a more convenient, reliable, and indicative measure when assessing non communicable disease risk for our population which are indicative of both ends of poor diet related outcomes- Undernutrition and Overnutrition at once. The GDQS tool, being a semi quantitative tool has a lower respondent burden than 24-hour dietary recall and other conventional dietary assessment tools, can be used to compute diet quality in population-based data, as it was found to be directly associated with Nutrient adequacy, this can result in more resources being spent on interventions and actions aimed at improving population's nutrition related NCD outcomes in future studies.

INTRODUCTION

INTRODUCTION

In recent years, there has been a significant shift in dietary patterns globally, leading to an increase in the risk of non-communicable diseases (NCDs). A study by Afshin et al. (2019) found that poor diet is the leading cause of mortality worldwide, accounting for 11 million deaths and 255 million disability-adjusted life years in 2017. The shift towards a westernized diet, characterized by high intake of processed foods, sugar, and saturated fats, and low intake of fruits, vegetables, and whole grains, has been identified as a major contributor to this trend (Balti et al., 2019).

The increased consumption of processed foods is particularly concerning as they tend to be high in salt, sugar, and unhealthy fats while low in fibre, vitamins, and minerals (Davies et al., 2020). This dietary shift has led to a global increase in the prevalence of overweight and obesity, which are major risk factors for type 2 diabetes, cardiovascular disease, and some forms of cancer (Popkin et al., 2020). Additionally, the high intake of sugar and refined carbohydrates has been linked to a higher risk of dental caries and other metabolic disorders (Lustig, 2016).

The sedentary lifestyles that many people lead today also contribute to the rise in NCDs. Inactivity is a leading risk factor for chronic diseases such as diabetes, obesity, and cardiovascular disease (Bouchard et al., 2012). Physical inactivity is often linked to modern lifestyles, where people spend long hours sitting at work, watching television, or using electronic devices. The COVID-19 pandemic has also exacerbated this issue, as lockdowns and social distancing measures have limited physical activity opportunities and led to more sedentary behaviour (Kohl et al., 2020).

To address this issue, there is a growing focus on promoting healthy eating patterns and lifestyle changes. Public health campaigns aim to encourage people to consume a variety of nutrient-dense foods, including fruits, vegetables, whole grains, and lean proteins (Sarmugam et al., 2020). Additionally, the promotion of physical activity is essential in reducing the risk of NCDs. The World Health Organization recommends at least 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity per week for adults (WHO, 2020)

Poor diet quality has been identified as a major risk factor for NCDs (Mendez & Popkin, 2016; World Cancer Research Fund International [WCRF], 2018). Urbanization and globalization have led to changes in dietary patterns and lifestyles, resulting in a higher prevalence of NCDs in urban populations (Popkin, 2019). Therefore, it is essential to assess diet quality and its association with NCD risk in urban populations.

NON-COMMUNICABLE DISEASES

Non-communicable diseases (NCDs) are a group of chronic diseases that are not caused by infectious agents and are often referred to as lifestyle diseases. The four main types of NCDs are cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes. These diseases account for most deaths worldwide and are a major public health concern. NCD are a result of risk factors which can be categorised into two groups, that is modifiable and non-modifiable.

The modifiable risk factors for non-communicable diseases (NCDs) can be enlisted as follows: (CDC, 2021)

1. Poor diet: Consuming a diet high in processed foods, sugar, salt, and saturated fats can increase the risk of NCDs such as heart disease, diabetes, and cancer.
2. Physical inactivity: Lack of regular physical activity can increase the risk of NCDs such as heart disease, stroke, and diabetes.
3. Tobacco use: Smoking and using other tobacco products can increase the risk of NCDs such as lung cancer, heart disease, and stroke.
4. Excessive alcohol consumption: Drinking too much alcohol can increase the risk of NCDs such as liver disease, cancer, and heart disease.
5. Obesity: Being overweight or obese can increase the risk of NCDs such as heart disease, stroke, diabetes, and certain types of cancer.

Global Prevalence

Non-communicable diseases (NCDs) such as diabetes, cardiovascular disease, and cancer are the leading causes of mortality worldwide, accounting for approximately 74% of all deaths (World Health Organization (WHO, 2022).

National Prevalence

According to the NCD Progress monitor 2022, India accounts for 66% Percentage of deaths from NCDs, that is, 6,047,000 Total number of NCD deaths annually. It also accounted that with the current projections there is a 22% Probability of premature mortality from NCDs(NONCOMMUNICABLE DISEASES PROGRESS MONITOR 2022, n.d.).

There are several reasons for the high prevalence of NCDs globally and in India. One of the main factors is the increasing aging population. As people age, they become more susceptible to NCDs such as cardiovascular disease, cancer, and diabetes. The proportion of the world's

population aged 60 years and older is projected to increase from 12% in 2020 to 22% in 2050, with the greatest increase in low- and middle-income countries (WHO, 2021).

Another significant factor contributing to the rising prevalence of NCDs is lifestyle changes. Rapid urbanization in many parts of the world has led to changes in dietary habits and physical activity levels, which are major risk factors for NCDs. In India, the shift from traditional diets to diets high in calories, saturated fat, and sugar has contributed to the high prevalence of NCDs (Misra & Khurana, 2008). Physical inactivity is also a significant risk factor for NCDs, with a sedentary lifestyle becoming more common in both urban and rural areas in India (WHO, 2018).

Tobacco uses and alcohol consumption are two additional major risk factors for NCDs. Tobacco use is responsible for a significant proportion of preventable deaths due to NCDs, including lung cancer, heart disease, and stroke. Despite efforts to reduce tobacco use, there are still over 1 billion smokers worldwide, with most of them living in low- and middle-income countries (WHO, 2021). Similarly, excessive alcohol consumption is a significant risk factor for NCDs such as liver disease, cancer, and cardiovascular disease. In India, alcohol consumption is a major public health concern, with an estimated 3.3 million deaths attributable to alcohol in 2016 (WHO, 2018).

In conclusion, NCDs are a significant global public health issue, with a high prevalence in both developed and developing countries. The increasing aging population, lifestyle changes, and risk factors such as tobacco use and alcohol consumption contribute to the rising prevalence of NCDs. In India, the burden of NCDs is particularly high, and urgent interventions are required to address this issue. Prevention and management of NCDs require a multifaceted approach, including promoting healthy lifestyles, reducing tobacco and alcohol consumption, and improving access to quality healthcare.

Regional Prevalence

The prevalence of non-communicable diseases (NCDs) in Gujarat was reported in the National Family Health Survey (NFHS-5) conducted in 2019-20 (Ministry of Health and Family Welfare, Government of India, 2020). The survey found that the prevalence of diabetes was 9.7% among women and 9.9% among men, hypertension was 19.1% among women and 22.3% among men, and overweight or obesity was 27.2% among women and 31.8% among men.

The growing prevalence can be traced to the growing urbanisation, economic development, market globalisation and industrialisation (Naicker et al., 2015). This has also led to transition in global diet, various studies and literature attests to the fact that diets and specific nutrient deficiencies and excesses influence the development of NCDs and that appropriate dietary

changes may reduce the risk of NCDs. To understand the definite dietary patterns in the population and to assess the adequacy of a diet there are various dietary assessment tools.

DIETARY ASSESMENT TOOLS

Diet assessment plays a critical role in the assessment and prevention of non-communicable diseases (NCDs). (WHO, 2020) Here are some ways in which diet assessment can be helpful:

1. Identify dietary patterns: Diet assessment can help identify the dietary patterns of an individual or a population, including the types of foods and beverages consumed, the frequency and portion sizes of intake, and the nutrient composition of the diet. This information can be used to evaluate the quality of the diet and identify areas for improvement.

2. Evaluate nutrient intake: Diet assessment can also help evaluate nutrient intake and identify nutrient deficiencies or excesses, which can contribute to the development of NCDs such as heart disease, cancer, and osteoporosis.

3. Assess food environment: Diet assessment can help assess the availability and accessibility of healthy food options in the environment, such as in schools, workplaces, and neighbourhoods. This information can be used to develop strategies to increase the availability of healthy foods and reduce the consumption of unhealthy foods and beverages.

4. Develop interventions: Diet assessment can inform the development of effective interventions to prevent and manage NCDs. For example, interventions can be designed to promote healthy dietary habits, increase awareness of the health benefits of healthy eating, and provide access to healthy foods and beverages.

Dietary assessment tools are utilized to evaluate an individual's dietary intake and are vital in assessing non-communicable diseases (NCDs) such as obesity, diabetes, and cardiovascular diseases. There are several traditional dietary assessment tools, including 24-hour dietary recall, food frequency questionnaire (FFQ), and dietary records.

The 24-hour dietary recall involves asking individuals to recall all foods and beverages consumed within the previous 24 hours. FFQs, on the other hand, involve asking individuals about their frequency and quantity of food intake over a specified period, typically the past year. Lastly, dietary records involve keeping track of all food and drink consumed over a specific period, usually a few days to a week.

Each of these tools has its advantages and disadvantages. For instance, the 24-hour dietary recall is easy to administer and less time-consuming, but it may not accurately capture an individual's usual dietary intake due to recall bias. FFQs are useful in evaluating dietary patterns over a more extended period and are less prone to recall bias. However, they may not capture changes in dietary intake over time. Dietary records provide detailed information on food and drink consumed, but they are time-consuming and may be affected by underreporting. (Thompson & Subar, 2017)

New indices have emerged to improve dietary assessment, including the Healthy Eating Index (HEI), which assesses diet quality and adherence to the Dietary Guidelines for Americans, and the Mediterranean Diet Score, which measures adherence to the Mediterranean diet pattern. These indices consider the overall diet and not just individual nutrients, providing a more comprehensive assessment of dietary intake. (Kim et al., 2020; Schwingshackl & Hoffmann, 2017)

Industrialization, urbanization, scientific, and economic development have accelerated over the past decades and this in turn has led to improved standards of living. This advancement accompanied increased food availability and diversity of choices and thus the challenge is no longer on consuming sufficient calories to avoid malnutrition, but how to eat adequately for optimal health and disease prevention.

This transition has affected the significance of the diet quality concept. Beyond providing for fundamental dietary requirements, proper nutrition is necessary for heal thy physical development, mental function, and maintenance of body systems.(Alkerwi, 2014)

DIET QUALITY

Although the phrase "diet quality" is widely used and has gained popularity in research, the term is broadly used but still there is no universally accepted definition of diet quality.

Some indices are based on current nutrition knowledge and some are derived from food consumption data and these are increasingly being used to link diet and health outcomes and also to assess the adherence to nation specific dietary guidelines. They usually have a predefined cut off pattern or a set scoring system by which they help to categorise populations as healthy and unhealthy. For formulation of diet quality indices, the purpose needs to be identified, and then accordingly the dietary method to be used and the dietary variables to be used are decided.

Measures of diet quality help to assess dietary risk factors for non-communicable diseases in nutritional epidemiology. The value of specific nutrients or food groups has been highlighted

in most studies on disease prevention. In a day people eat a combination of food items and not individual foods in isolation and thus diet quality is a great way to assess population. Although several diet quality indices have been developed, there is no universal diet quality index in use. Most indices adhere to national dietary guidelines. Scores in the diet quality indices have been correlated with cancer, coronary heart disease and other cardio-vascular diseases. Data from longitudinal studies provide better insights. The limitations of such studies are the short time duration to show a cause effect relation between diet quality and health outcomes.(Mediratta & Mathur, 2019)

Poor quality diets are associated with adverse health outcomes related to both undernutrition and overnutrition and are a leading cause of disease globally (Global Burden of Disease [GBD] 2016). Yet, until recently, we have lacked a standard, relatively simple, and validated method for routinely measuring diet quality1 in population-based surveys across contexts (Miller et al. 2020), and therefore have lacked a means by which to assess and track this critical dimension of health and well-being.

A number of diet quality indices have been developed using national dietary guidelines as well as the WHO guidelines for prevention of noncommunicable diseases. There are various diet quality indices like HEI, AHEI, DQI, etc. but very few are validated for universal use, two new such validated tools which use diet quality scores as the means of analysis are DDQ (Diet Diversity Questionnaire) and GDQS (Global Diet Quality Score).

Global Diet Quality Score

In 2018, Intake – Center for Dietary Assessment started a 2-year research initiative to support a consortium of researchers at the Harvard T.H. Chan School of Public Health Department of Nutrition and the National Public Health Institute (INSP), Mexico, to develop and validate metrics of diet quality that would be appropriate for collection through routine population-based surveys and that would be fit for purpose for inclusion in global monitoring frameworks. The task involved developing several prospective food group-based metrics that consider the amount of consumption while using the score system.

Over the course of the 2-year research initiative, secondary food frequency questionnaire (FFQ) and quantitative 24-hour dietary recall datasets from various parts of the world were analysed to look at the relationship between each candidate metric and a variety of diet quality outcomes related to nutrient adequacy and noncommunicable disease (NCD) risk. From these analyses, an overall metric of diet quality — the Global Diet Quality Score (GDQS) — was identified. The GDQS was designed to be appropriate for use among non-pregnant, non-lactating women

of reproductive age in low- and middle-income countries (LMICs) but has also been shown through secondary data analysis to be valid for use in high-income countries, thereby providing a simple, standardized metric appropriate for population-based measurement of diet quality globally.(*The Global Diet Quality Score: Data Collection Options and Tabulation Guidelines*, 2021)

In a world filled with uncertainty, a silver lining for NCDs is that we know both how to prevent them and how to manage them. This study presents the assessment of various risk factors associated with them, and focusing on diet quality scores as the major parameter of assessment of the NCD risk in population and aims at reporting the possible correlation between the detailed nutrient adequacy and diet quality scores for a population-based data.

RATIONALE OF THE STUDY

- Poor quality diets are associated with adverse health outcomes related to both undernutrition and overnutrition and are a leading cause of disease globally (Global Burden of Disease [GBD] 2016). Yet, until recently, we have lacked a standard, relatively simple, and validated method for routinely measuring diet quality in population-based surveys across contexts (Miller et al. 2020), and therefore have lacked a means by which to assess and track this critical dimension of health and well-being.
- The burden of diet related NCDs is significant in all regions of the world, and the indicators can more fully reflect diet quality relevant to policies and programs. Metrics that can be calculated simply, using low-burden survey tools, paves the way for monitoring diet quality globally and in countries.
- The existing studies' findings highlight major gaps in assessing Diet Quality amongst the most productive adult age group 20-50 years and addressing global diet quality scores to determine NCD Risk.
- The GDQS as a data collection tool has been administered with pre-existing food frequency data to determine scores but the GDQS as data collection tool itself has not been directly used in the Indian setting yet.

Validation and usage of low burden global dietary assessment tools and assessment and correlation of diet quality for identifying the burden of NCDs in the population is the need of the hour.

Hence, the present study is carried out with the broad objective of Diet Quality and Non-Communicable Disease risk assessment in adult population of Urban Vadodara.

Specific Objectives of the study being assessing anthropometric and biophysical parameters and physical activity patterns in the productive age group 20 to 50 years and correlating the GDQS (Global Diet Quality Scores) with nutrient adequacy from 24 hour recall data on a sub sample of the population.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Non-Communicable disease pose a significant threat to public health globally, causing a high number of fatalities and impairments. While they were previously more prevalent in developed nations, they are now a prominent burden in developing countries, which is due to factors such as urbanization and sedentary lifestyles. It is currently essential to prioritize the prevention and control of NCDs by implementing strategies that are focused on surveillance, health promotion, primary prevention, healthcare management, and treatment. Addressing common risk factors can lead to better outcomes while minimizing expenses.(Wagner & Brath, 2012)

A study was conducted in which epidemiological data were collected from the Global Burden of Disease 2015 study to create health burden projections and analyse rate of change from 2005 to 2015 to project health burden rates for each country and age and sex group through 2040. The results showed that low- and lower-middle-income nations are expected to see dramatic increases in the burden of premature death and disability from noncommunicable diseases by 2040 and most of the increase in noncommunicable diseases will be experienced in populations ages thirty-five and older. It was also concluded that the time for donors and lower-income country governments to increase their investment in preventing and treating noncommunicable diseases is now.(Bollyky et al., 2017)

Poor lifestyle choices, such as smoking, an unhealthy diet, lack of physical activity, excessive salt intake, and harmful alcohol use, result in biological risk factors, including obesity, high blood pressure, high blood cholesterol, and impaired glucose metabolism. These biological factors are the underlying causes of non-communicable diseases (NCDs). Often, multiple risk factors coexist in the same individual or population, increasing the likelihood of developing NCDs.(Pelzom et al., 2017)

Worldwide, the contribution of different risk factors to disease burden has changed substantially, with a shift away from risks for communicable diseases in children towards those for non-communicable diseases in adults. These changes are related to the ageing population, decreased mortality among children younger than 5 years, changes in cause-of-death composition, and changes in risk factor exposures.

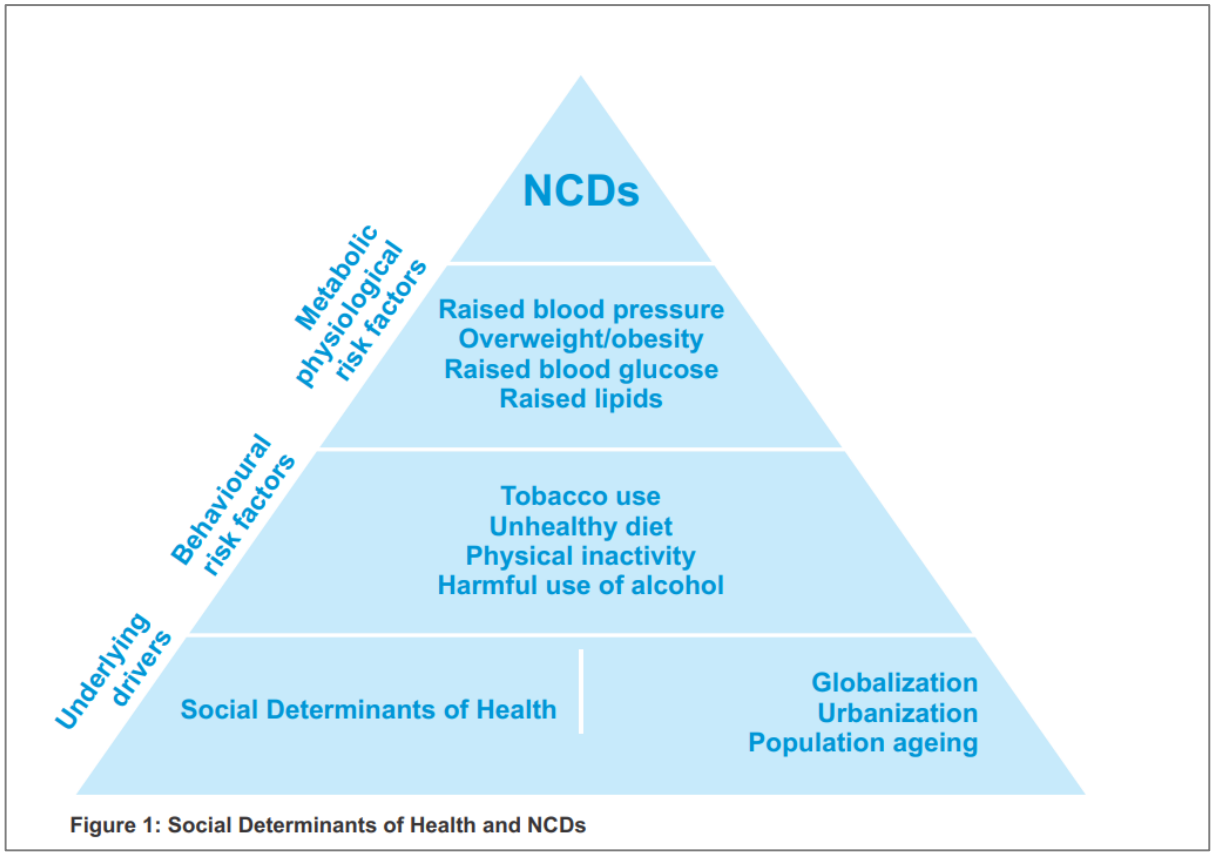


Figure 2.1Social determinants of Health and NCDs
(*Source: India NCD Action Plan 2017-2022)*

Figure 2.1 shows various underlying drivers of Globalisation and urbanisation , has given rise to behavioural risk factors in population, which in turn have led to Metabolic and physiological risk factors, contributing to the development of NCD in an individual.

Global Scenario

17 million people worldwide die from an NCD before they turn 70 each year; 86 percent of these untimely deaths take place in low- and middle-income nations. 77 percent of NCD-related fatalities occur in low- and middle-income nations. The majority of NCD deaths, or 17.9 million people per year, are caused by cardiovascular illnesses, which are followed by cancers (9.3 million), chronic respiratory diseases (4.1 million), and diabetes (2.0 million including kidney disease deaths caused by diabetes). More than 80% of all deaths from NCDs that occur prematurely are caused by these four disease types. Use of tobacco products, inactivity, harmful alcohol use, unhealthy diets, and physical inactivity all raise the chance of dying from an NCD. Key elements of the approach to NCDs include palliative care, NCD detection, screening, and therapy. (WHO, 2022)

Cardio vascular diseases, cancer, chronic respiratory diseases, and diabetes—these four make the largest contribution to morbidity and mortality due to noncommunicable diseases, and on four shared behavioural risk factors of tobacco use, unhealthy diet, physical inactivity and harmful use of alcohol. The WHO Global Action Plan 2013-2020 recognised that the conditions in which people live and work and their lifestyles influence their health, lifestyle and further quality of life. (World Health Organization)

National Scenario

The Global NCD progress Monitor, 2022, indicates India and its burden of non-communicable diseases (NCDs). As of 2021, the total population of India was estimated to be 1.366 billion people. In the same year, there were 6.047 million deaths from NCDs, which accounts for 66% of all deaths in the country. Additionally, the probability of premature mortality from NCDs is 22%, indicating a significant burden of NCDs on the population's health. (*NONCOMMUNICABLE DISEASES PROGRESS MONITOR 2022,* n.d.)

The term "epidemiological transition" refers to the complex changes in patterns of health, illness and death that occur as a result of demographic, economic, and societal changes. Developing nations such as India are trailing behind those that have completed the epidemiological transition and NCDs are thus leading to an increase in premature mortality among adults, particularly in metropolitan areas.(Shetty, 2002)

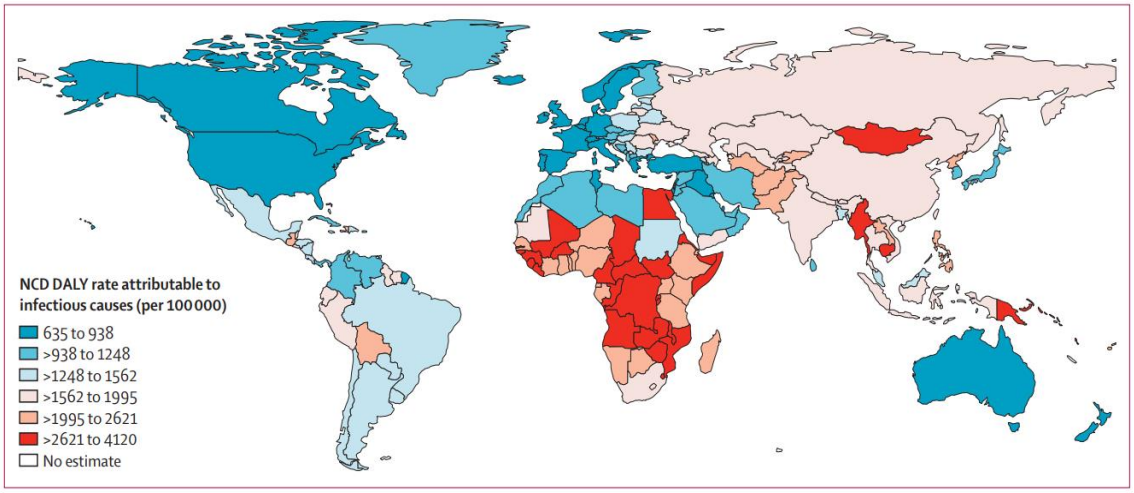


Figure 1: **Age-standardised rates of DALYs from NCDs attributable to infectious causes**
The appendix (pp 4–6) identifies pairs of infectious pathogens and NCD outcomes quantified in the figure. Rates were age-standardised with the Global Burden of Disease Study 2017 standard population. Maps of age-standardised percentages and crude percentages and rates including this figure for comparison are given in the appendix (pp 42–43). Results are stratified in sextiles. DALY=disability-adjusted life-year. NCD=non-communicable disease.

Figure 2.2 Age standardized rates of DALYs from NCDs attributable to infectious causes
Source: Global Burden of diseases report, 2017

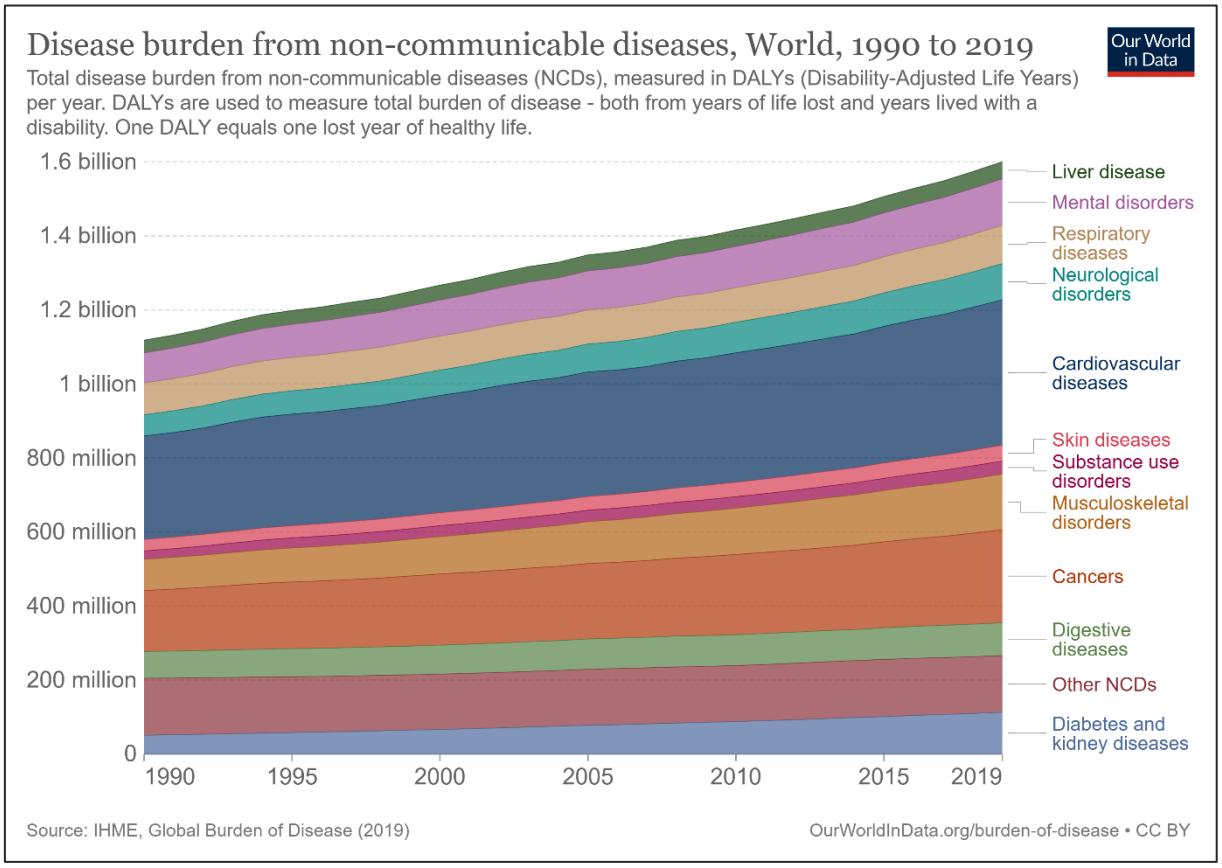


Figure 2.3 Disease burden from Non-Communicable diseases (1990 to 2019)
Source: Global Burden of Diseases (2019)

Figures 2.2 and 2.3, depict the rising prevalence of NCDs over the years, and the burden it causes globally.

A study as a part of national non-communicable diseases (NCD) risk factor surveillance was conducted in different geographical locations (North, South, East, West/Central) in India on a sample of 15,239 from urban, 15,760 from peri-urban/slum and 13,524 from rural areas. The major focus of the study was on Diabetes and its prevalence, the results reported the lowest prevalence of self-reported diabetes was recorded in rural (3.1%) followed by peri-urban/slum (3.2%) and the highest in urban areas. Urban residents with abdominal obesity and sedentary activity had the highest prevalence of self-reported diabetes (11.3%) while rural residents without abdominal obesity performing vigorous activity had the lowest prevalence (0.7%).

India has become the diabetes capital with 69.1 million diabetes cases, which has put India in the second position right after China. A steps survey in Punjab, India was conducted, the study provided reliable and latest epidemiological information regarding the high burden of diabetes mellitus among the adult population in North Indian population. Around 15% of the general adult population were diabetes or pre-diabetes, calling for an urgent attention. This study also highlights a significant burden of undiagnosed cases of DM in the community, most of them are poorly controlled(Tripathy et al., 2017).

In India, mortality due to cancer has grown to 9 million, covering 9% of all deaths. It has become a serious public health concern. The reason behind such a large number of deaths in the population is the detonation, poor and limited diagnostic facilities, and very expensive treatments (Rajpal, 2018).

Regional Scenario

In a study conducted by Kumar et al. (2015) in 26 villages in the Anand district of Gujarat, India, the population was 89755 from 18,269 households, with an average family size of 4.91. About 70.2% of the population comprised adults over 20 years of age. The prevalence of NCD in the population was 5.3%, with females having a little higher prevalence (5.4%) than males (5.2%). Medication was used by 80.7% of hypertensives and 94.9% of diabetics. The proportion of hypertensive females receiving treatment (82.5%) was significantly higher than that of males (78.3%).

Iyer et al. (2011) conducted a study to map the prevalence of noncommunicable diseases in the communities living in freedom in Vadodara and Godhra. A sample of 351 people was obtained

using a multistage sampling technique (cluster and systematic random sampling). Anthropometric information, medical history, lifestyle information, and food habits were all obtained using a conventional approach. Overweight and obesity were similarly common in both cities (overweight: 24 percent vs. 25 percent , obesity: 48 percent vs. 42 percent).
Compared to Vadodara, Godhra had a higher prevalence of diabetes and hypertension (19% and 36%, respectively) (diabetes: 12 percent , hypertension: 24 percent). High BMI, waist circumference, hypertension, physical inactivity, alcohol use, smoking, tobacco use, poor fruit and vegetable intake, and a low consumption of green leafy vegetables were all found to be predictors of developing diabetes in the family. Overall, a rise in prevalence of NCDs was observed from the previous studies (Kumar, 2011).

Figure 2.5 depicts the Modifiable and Non modifiable risk factors
According to WHO, following are the modifiable and metabolic risk factors associated with NCDs.

Modifiable behavioral risk factors

Modifiable behaviors such as tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol, all increase the risk of NCDs.
Tobacco accounts for over 8 million deaths every year (including from the effects of exposure to second-hand smoke).
1.8 million annual deaths have been attributed to excess salt/sodium intake.
More than half of the 3 million annual deaths attributable to alcohol use are from NCDs, including cancer.
830 000 deaths annually can be attributed to insufficient physical activity.

Metabolic risk factors

Metabolic risk factors contribute to four key metabolic changes that increase the risk of NCDs:
raised blood pressure;
overweight/obesity;
hyperglycemia (high blood glucose levels); and
hyperlipidemia (high levels of fat in the blood).

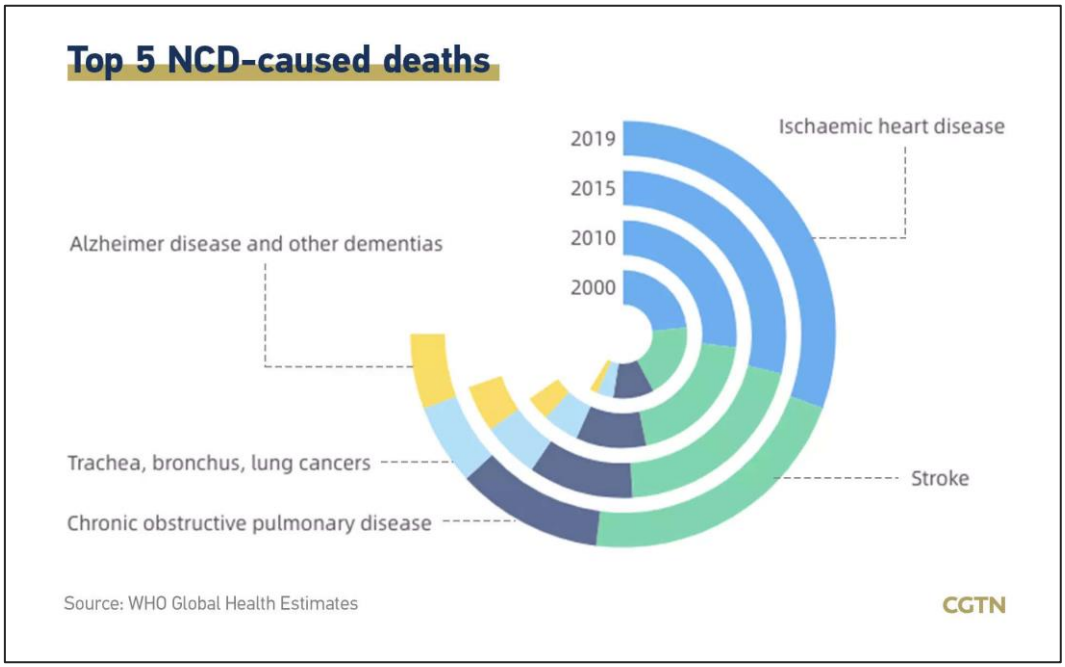


Figure2.4 Top 5 NCD Caused deaths
Source: WHO Global Health Estimates

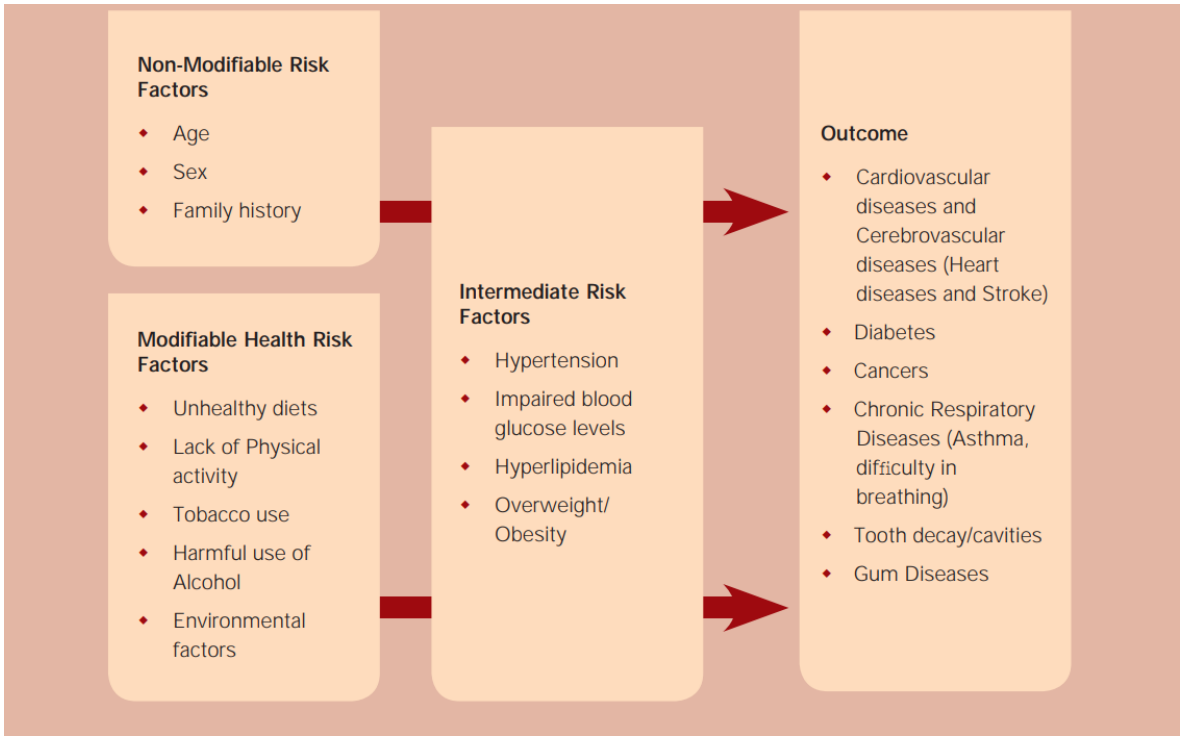


Figure 2.5Modifiable and Non-Modifiable risk factors associated with NCDs
Source: WHO steps approach for NCD surveillance, WHO, 2003

Dietary impact on NCD

The global diet is currently experiencing a worrying shift, with a greater consumption of refined and processed staple foods, an increase in fat and meat intake, and a rise in the consumption of processed dairy products and meals eaten outside of the home. This dietary transition has been influenced by a variety of factors including urbanization, economic development, market globalization, and industrialization, leading to a shift from traditional diets to more Westernized ones. This change in dietary patterns has been linked to a rise in non-communicable diseases (NCDs) worldwide. (Naicker et al., 2015)

The article aimed to develop and validate low-burden indicators to track adherence to global dietary recommendations. The study used nationally representative dietary intake datasets from Brazil and the United States and tested associations between food-group scores and quantitative consumption aligned with 11 global dietary recommendations. The researchers developed three food-group based scores, an overall Global Dietary Recommendations (GDR) score, GDR-Healthy, and GDR-Limit. They also developed nine dichotomous food-group based indicators to reflect adherence to global recommendations for specific dietary components. The study found that food-group consumption data can be used to indicate adherence to global dietary recommendations at a population level and can be used to track progress toward meeting WHO guidance on healthy diets. The study found a moderate to strong association between the GDR score and HDI-2020. Eight out of nine dichotomous indicators predicted adherence to global dietary recommendations, except total fat.(Herforth et al., n.d.)

A study was conducted for Australian adults reported that higher diet quality and a healthier Dietary pattern were primarily associated with favorable anthropometric markers of cardiometabolic health (BMI, WC) and independent of numerous potential demographic. The findings highlighted that the consistency of a diet quality and Dietary pattern methodology was appropriate to estimate associations with anthropometric markers of cardiometabolic health. Diet quality indices score dietary intakes against recommendations, whereas dietary patterns consider the pattern and combination of dietary intakes. Thus the study aimed to study the relationship between diet quality, dietary patterns and markers of cardiometabolic health(Livingstone & McNaughton, 2018).

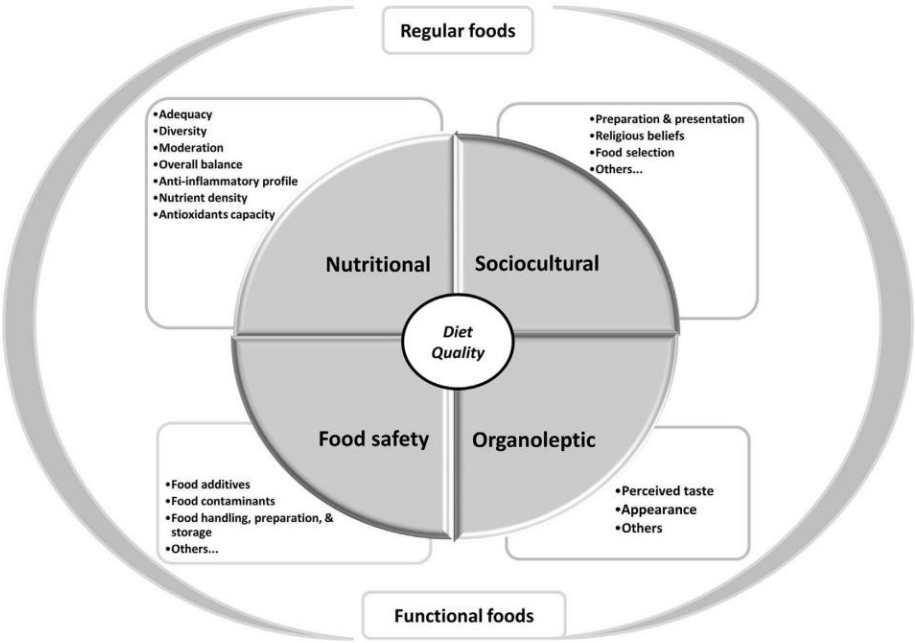


Fig. 2. Diet quality: A multidimensional concept spurring for a new global definition."Regular foods" mean conventional, ordinary foods, whereas "functional foods" can be defined as foods that provide a health benefit beyond basic nutrition. A functional food can contain an added ingredient that makes the traditional food functional (e.g., probiotic bacteria added to traditional yogurt).

Figure 2.6: Diet Quality Concept
Source: A. Alkerwi / Nutrition 30 (2014) 613–618(Alkerwi, 2014)

Diet Quality and various Diet Quality Indices (DQIs)

Poor diet quality is a leading and preventable cause of adverse health globally, which includes both maternal and child health (MCH) & NCDs.

The UN SDGs outline global consensus on social, economic, environmental, and health targets to be met by 2030, with most goals concerned with nutrition including one goal to end malnutrition. Yet rates of progress toward achieving the SDGs have been slow, and accelerated momentum is needed. To develop sound strategies and monitor progress toward these goals, the assessment of global dietary quality is essential. Various assessment tools have been used commonly, including 24 hr dietary recalls, food frequency questionnaires, food dairies/ records, etc. but it has been observed that they are quite time consuming and has a high respondent burden, which can lead to less diligent data given by the subjects. These tools are helpful in evaluating nutritional status of the individual along with diet quality as one of the parameters.

Poor quality diets are associated with adverse health outcomes related to both undernutrition and overnutrition and are a leading cause of disease globally (Global Burden of Disease [GBD] 2016). Yet, until recently, we have lacked a standard, relatively simple, and validated method for routinely measuring diet quality1 in population-based surveys across contexts (Miller et al. 2020), and therefore have lacked a means by which to assess and track this critical dimension of health and well-being.

Measures of diet quality help to assess dietary risk factors for non-communicable diseases in nutritional epidemiology. The value of specific nutrients or food groups has been highlighted in most studies on disease prevention.(Mediratta & Mathur, 2019)

Another cross-sectional population-based study in which 2376 individuals were surveyed in 2003, and 1662 individuals in 2008 (Health Survey of São Paulo, ISA-Capital). Participants enrolled were categorised as aged 12 to 19 years old (adolescents), 20 to 59 years old (adults) and 60 years old or over (older adults) Food intake was assessed using the 24-h dietary recall method while diet quality was determined by the **Brazilian Healthy Eating Index (BHEI-R).** Results showed that the mean BHEI-R increased (54.9 vs. 56.4 points) over the five-year period. However, the age group evaluation showed a deterioration in diet quality of adolescents, influenced by a decrease in scores for dark-green and orange vegetables and legumes, total grains, oils and SoFAAS (solid fat, alcohol and added sugar) components. Thus diet quality remains a concern, especially among adolescents, that had the worst results compared to the other age groups(de Andrade et al., 2016).

A cross-sectional study aimed to investigate the association between depressive and anxiety symptoms and diet quality among university students during the COVID-19 pandemic was done, 440 university students' diet quality was measured using a **10-item mini-dietary assessment index tool**, while depressive and anxiety symptoms were assessed using validated scales. The study found that 61.1% of university students had good diet quality during the COVID-19 pandemic. The study highlights the importance of improving the mental health and well-being of students, particularly during pandemic situations, to enhance their diet quality.(Kundu et al., 2022)

Studies have been conducted to determine a connection between a healthy diet and outcomes. Various Diet Quality Indices have demonstrated a high correlation with mortality from cardiovascular and cancer(Mediratta & Mathur, 2019).

With many diet quality indices being developed, every indice varies in adherence to different national and international guidelines. Table 2.1 depicts an overview of various Diet quality tools being validated internationally in different population groups. Each indice has different scoring pattern and outcomes. Though the wide concept of Diet Quality remains same, yet each indice shows correlation with different outcomes, and depending on the goal of assessment and study, the index is considered.

Table 2.2 shows the various diet quality indices being developed and the chronic disease outcomes it has shown positive association with.

Table 2.3 depicts a comparative overview of the global diet quality indices. GDQS is a semiquantitative tool, that is, it takes into consideration the quantity of consumption of the food group and thus is sensitive to both ends of poor diet related outcomes- undernutrition and overnutrition. The above comparison clearly depicts GDQS Diet quality tool to be more reliable when considering for NCD risk assessment in a population.

TABLE 2.1: Overview of International studies done using Diet Quality Indices

S. No	Index	Objective	Components		Scoring and Interpretation	Dietary method used	Country (Reference)
			Nutrient	Food groups			
1	**Healthy Eating Index (HEI)**	Assess adherence to US Food Guide Pyramid	Overall fat %, energy, saturated fat % energy, cholesterol, sodium	Grains, vegetables, fruit, meat, milk, variety in diet	Ten components each contributes 0–10 points. Components 1–5 basedon conforming to serving recommendations. Score range: 0(worst)–100(best).	One day 24 h recall and 2 days food record	United States
2	**Alternative Healthy Eating Index (AHEI)**	Assess whether AHEI is able to predict risk of disease better than HEI.	Percentage of trans fat, ratio of polyunsaturated fat to saturated fat.	Vegetables, fruit, nuts, ratio of whiteto red meat,cereal (fibre), alcohol	Nine components have 0–10 points each, Score of10 indicates recommendations met and 0 indicates the least Healthy dietary behaviour.	Food frequency questionnaire	United States
3	**Healthy Food Index (HFI)**	Assess adherence of food intake patterns to US food recommendations		Margarine, Butter or lard, vegetables, coarse rye, white bread, fruit	Four components, each receiving 1 point if met daily: Not consuming margarine, butter or lard; Consumption of boiled or raw vegetables; Consumption of coarse rye or white bread; Consumption of fruit at least once Score range 0–4. Score of 4 indicates better diet quality.	Food frequency questionnaire	United State
4	**Healthy Food and Nutrient Index (HFNI)**	Assess adherence to Belgium dietary guidelines	Saturated fat, cholesterol, monounsaturated fat, polyunsaturated fat, protein, fibre, Carbohydrates	Fruit and vegetables	Eight components, each receiving 1 point If consumption is within limit and 0 is awarded if consumption exceeds limit. Score range 0–8, with higher score indicating adherence to recommendations.	1 day food record	Belgium
5	**Diet Quality Index (DQI)**	Assess adherence to WHO dietary recommendations for preventing chronic disease.	Total fat, Saturated fat, cholesterol, protein, calcium, Sodium	Vegetables and fruit, grains	Has 8 components, if diet: meets recommendation = 0, recommendation almost met=1 recommendation not met=2 Score range is 0–16 where 0 indicates excellent diet	24-hour recall and 2 day food record	United States
6	**Diet Quality Index Revised (DQI-R)**	Assess adherence to US dietary guidelines	Total fat, Saturated fat, cholesterol, protein, iron, sodium	Fruit and vegetables, dietary moderation and diversity	Has ten components that receive between 0–10 points. Score range: 0–100. Higher scores better diet quality.	24-hour recall	United States
7	**Diet Quality Score (DQS)**	Assess adherence to Danish Dietary Guidelines	Total fat	Fish, fruit and vegetables	Has four components, each component can get a maximum score of 3 points. very unhealthy =1 point Average intake =2 points very healthy =3 points Points range = 1-12, where a score of 12 is most healthy.	Food frequency questionnaire	Denmark

(Mediratta & Mathur, 2019)

TABLE 2.2 Associations between Diet Quality and diet related Chronic disease

S. No.	Study and reference	Index	Dietary method	Country	Study population	Main outcome	Key findings	Limitations
1	Schatzkin etal. 2000	**RFS**	62-itemFFQ	USA	42254 women (mean age 61 years).	Mortality due tocancer	High RFS score is associated with reduced mortality risk in women (RR=0.69, 95% CI, p<0.001)	Lack of diversity in sample
2	Fitzgerald etal. 2002	**DQS**	24 h recall	Canada	2108 adults (18–74 years).	Cancer incidence	Highest DQS quintile showed no association with cancer incidence (multivariate adjusted odds ratio 0.81, p=0.41)	Short study duration
3	Osler et al. 2002	**HFI**	26-itemFFQ	Denmark	7316 adults (30–70 years).	Mortality due to Coronary heart disease	High HFI score is associated with reduced mortality dueto coronary heart disease (hazard ratio estimate is 0.94)	Short food frequency questionnaire
4	Trichopoulouet al. 2003	**MDS-II**	150-itemFFQ	Greece	22043 adults (20–86 years).	Mortality due tocancer and coronary heart disease	High MDS-II score is associated with reduced mortality caused by coronary heart disease (0.67; 95% CI 0.47-.94) and cancer (0.76, 95% CI 0.59 to 0.98)	Presence of unevaluated confounding factors
5	Seymour et al. 2003	**DQI**	68-itemFFQ	USA	52724 men and 63109 women (50–79 years), American Cancer SocietyCancer Prevention Study II Nutrition Cohort	Mortality due tocirculatory disease	Positive association with mortality due to circulatory disease in women (1.86; 95%CI)	Short follow-up periodfor mortality outcome
6	McCullough et al. 2000	**HEI-f**	131-itemFFQ	USA	51529 men aged 40–75 years. (Health professionals Follow-Up Study)	Cardiovascular disease incidence	High HEI-f score wasassociated with Reduction in cardiovascular risk by 14% (RR=0.86; 95% CI: 0.72-1.03).	Short study duration, lack of diversity in sample
7	Huijbregts etal. 1997	**HDI**	Diet history	Netherlands	3045 men (50-70 y); 20 years follow up.	Mortality disease risk dueto cardiovascular disease	High HDI score was associated with lower risk of mortality due to cardiovascular disease in Males (RR=0.56; p=0.03)	Lack of Diversity in cohort
8	McCullough et al. 2002	**AHEI**	130-itemFFQ	USA	67271 women and 38615 men. (Health Professionals' Follow-Up Study andNurses' Health Study)	Cardiovascular disease incidence	High AHEI score was associated with significant reduced risk for CVD in men (RR=0.61) and in women (RR=0.72)	Lack of diversity in cohort

(Mediratta & Mathur, 2019)

Table 2.3 Overview of New Global Diet Quality Indices

INDEX	Components	Scoring and Interpretation	Dietary Method used	Advantages
1. DQQ (Dietary Quality Questionnaire) 2022	The food groupings in the DQ-Q were developed in tandem with the indicator validation, resulting in 29 food groups that each contribute statistically and normatively to the DQ-Q indicators, also allowing for possible inferences related to environmental impacts (e.g. GHG emissions)	The DQ-Q is a set of yes/no questions about consumption of 29 food groups in the previous day or night. Respondents are asked whether they consumed any of up to 7 sentinel foods per question, which are the most commonly-consumed food items in each food group in each country setting.	Sentinel food Questionnaire - FDGS AND MDD-W can be calculated.	It takes 5 minutes and can be administered in person or via phone, and is thus feasible(a maximum amount of information with a minimum amount of time and resources can be collected) The food groups of the DQ-Q are universal, while the specific question wording for each food group is adapted for each country, thus attention to cognitive validity in question design.
2. GDQS (Global Diet Quality Score) & 3. PDQS (Prime Diet Quality Score) 2021	Entirely food-based metric- 25 food groups: 16 healthy food groups, 7 unhealthy food groups, and 2 food groups (red meat, high-fat dairy) that are unhealthy when consumed in excessive amounts. 3D cubes are used for estimating the category of quantity of consumption for each GDQS food group.	The overall GDQS is a sum of the points across all 25 GDQS food groups. The GDQS has a possible range of 0 to 49. high risk for poor diet quality outcomes (GDQS<15) Low risk for poor dietary outcomes (GDQS >= 23),	24 hr dietary recall data FFQ (Food Frequency Questionnaire) data PDQS is an upgrade for 30 day analysis of the GDQS.	Quantitative data is also obtained Data collection is currently estimated to require an average of approximately 10 minutes per respondent, with the amount of time required for data collection highly dependent on the complexity of the diet consumed

Global Diet Quality Score

Research led by Sabri Bromage et. al. in 2018, was done to develop an easy-to-use metric for nutrient adequacy and diet-related NCD risk in diverse settings. They developed the Global Diet Quality Score (GDQS), which is a food-based metric that includes a comprehensive list of food groups and a simple means of scoring consumed amounts. The GDQS was compared to other existing metrics and was found to perform comparably or better than MDD-W and AHEI-2010 in capturing nutrient adequacy, anthropometric and biochemical indicators of undernutrition, and NCD-related outcomes. The validation study was done using cross-sectional and cohort data from nonpregnant, nonlactating women of reproductive age in 10 African countries as well as China, India, Mexico, and the United States, secondary analyses was undertaken to develop novel metrics of diet quality and to evaluate associations of metrics with parameters (Deitchler & Bromage, 2021).

One of the study analysed data from 35,146 individuals in China to examine the association between diet quality, as assessed by the GDQS, and the coexistence of metabolic syndrome and nutrient inadequacy, defined as the double burden. The results showed that individuals with a higher GDQS score had a lower likelihood of having metabolic syndrome, nutrient inadequacy, or the double burden. The association was consistent across different household income levels and stronger in younger, female, urban residents, and those with higher education. The study highlighted the importance of improving diet quality to prevent the double burden of malnutrition in China (Ye et al.,2021).

A validation study conducted in India which included data from 3041 nonpregnant women of reproductive age (15–49 years) from 2 previous studies, showed that the GDQS was associated with better nutrient adequacy. Secondary data from the Andhra Pradesh Children and Parents Study (APCAPS) and the Indian Migration Study (IMS) was used to come with the results that the GDQS was associated with higher TC, lower HDL, and higher BMI. It was concluded that GDQS was a useful tool for reflecting overall nutrient adequacy and some lipid measures as well but a need of further studies was mentioned refine the GDQS for populations who consume large amounts of unhealthy foods, like refined grains, along with healthy foods included in the GDQS metrics (Matsuzaki et al.,2021).

Another study was done in Indian setting, where exploration of GDQS as low cost screening method for detecting prediabetes in rural region was done. It was recorded that individuals with prediabetes or diabetes had a higher average GDQS (representing higher diet quality) than their

counterparts without prediabetes or diabetes, thus it was found that although the GDQS on its own did not perform strongly as a classifier, several models including the GDQS as well as models including the GDQS food groups achieved AUCs >0.70.Thus the study recommended for future studies to examine the utility of the GDQS in screening for other noncommunicable diseases (Birk et al.,2021).

Apart from India, another GDQS validation study was conducted in 10 sub-Saharan african countries to evaluate GDQS against other diet quality metrics against capturing diet quality and undernutrition in rural adult population. Results showed positive correlations between the GDQS and an energy-adjusted aggregate measure of dietary protein, fiber, calcium, iron, zinc, vitamin A, folate, and vitamin B-12 adequacy were 0.34 (95% CI: 0.30, 0.38) in men and 0.37 (95% CI: 0.32, 0.41) in women. The GDQS was found to be performing comparably with the MDD-W in capturing nutrient adequacy–related outcomes in rural SSA (Bromage et al.,2021).

Another study was done to evaluate performance of a novel Global Diet Quality Score (GDQS) in capturing diet quality outcomes among Ethiopian adults. The GDQS was scored and a comparative metrics in secondary analyses of FFQ and 24-hour recall (24HR) data from a population-based cross-sectional survey of nonpregnant, nonlactating women of reproductive age and men (15–49 years) was done. Correlations between the GDQS and an energy-adjusted aggregate measure of dietary protein, fiber, calcium, iron, zinc, vitamin A, folate, and vitamin B12 adequacy were 0.32 in men and 0.26 in women. GDQS scores were inversely associated with folate deficiency in men and women, inversely associated with underweight, low midupper arm circumference and anemia in women; and positively associated with hypertension in men(Deitchler & Bromage, 2021).

In another similar study conducted in Mexico, GDQS was evaluated with markers of nutrient adequacy and chronic disease in nonpregnant nonlactating (NPNL) Mexican women of reproductive age and was also compared with the Alternate Healthy Eating Index-2010 (AHEI-2010) and the Minimum Dietary Diversity for Women (MDD-W). Results from 2542 sample size depicted positive correlation of GDQS with positively correlated with the intake of calcium, folate, iron, vitamin A, vitamin B-12, zinc, fiber, protein, and total fat and inverse correlation with the intake of added sugar, TOTAL FAT, SFA, MUFA with both 24 hr and MDD-W data (Castellanos-Gutiérrez et al.,2021).

A study was also conducted to examine the associations of changes in the Global Diet Quality Score (GDQS) and each GDQS food group with concurrent weight and waist circumference change in in the Mexican Teachers' Cohort between 2006 and 2008. FFQ of the previous year and anthropometric measures were self-reported in the study and the results reported that women with the largest increase in the GDQS (>5 points) had less weight and waist circumference gain, similarly women with the largest decrease in the GDQS (<-5 points)had more weight and waist circumference gain. Increased GDQS+ food groups' intake was also associated with less weight gain (Angulo et al.,2021).

A similar study in US women from previously available data in the Nurses' Health Study II (aged 27–44 y in 1991) through repeated questionnaires (1991–2015) showed higher GDQS is associated with less 4-year weight gain. (Fung et al.,2021). The same study was also extended to conclude that higher Global Diet Quality Score was found to be inversely associated with risk of Type 2 Diabetes in US Women.

Most recently, research was conducted to operationalize data collection by modifying the quantity of consumption cutoffs originally developed for the GDQS food groups and to statistically evaluate the performance of the operationalized GDQS relative to the original GDQS against nutrient adequacy and noncommunicable disease (NCD)-related outcomes. GDQS application was developed and a secondary analysis using 5 cross-sectional datasets comparing the GDQS with the original and operationalized cutoffs showed that the operationalized GDQS remained strongly correlated with nutrient adequacy and was equally sensitive to anthropometric and other clinical measures of NCD risk. It was concluded that the performance of GDQS metrics remained same even when operationalised cut offs were applied. (Moursi et al.,2021)

The above literature clearly depicted the validation and possible positive correlations, however as GDQS has been recently developed for the universal use, studies with primary data is still a limitation**.** Thus, this study aims to use GDQS as a primary data collection tool and analyse diet quality scores and correlate with Nutrient adequacy and NCD risk factors in adult Indian population, which is a gap in previously validated studies in the setup.

METHODS AND MATERIALS

METHODS AND MATERIALS

According to the NCD Progress Monitor 2022, 66% deaths annually are from NCDs.
22% probability of premature mortality from NCDs in India.
India has shown limited progress towards achieving GNT for diet related NCDs. According to GNR 2021, an estimated 6.2% adult (aged 18 and above) women and 3.2% adult men in India are living with obesity. Meanwhile, diabetes is estimated to affect 9% of adult women and 10.2% of adult men.

- Poor quality diets are associated with adverse health outcomes related to both undernutrition and overnutrition and are a leading cause of disease globally (Global Burden of Disease [GBD] 2016). Yet, until recently, we have lacked a standard, relatively simple, and validated method for routinely measuring diet quality in population-based surveys across contexts (Miller et al. 2020), and therefore have lacked a means by which to assess and track this critical dimension of health and well-being.
- The burden of diet related NCDs is significant in all regions of the world, and the indicators can more fully reflect diet quality relevant to policies and programs. Metrics that can be calculated simply, using low-burden survey tools, paves the way for monitoring diet quality globally and in countries. There are number of tools used for assessing quality of diet, viz. Healthy Eating Index (HEI), Alternate Healthy Eating Index (AHEI), Diet Quality Index (DQI), etc., the recent tools developed include Diet Quality Questionnaire (DQQ), Prime Diet Quality Score (PDQS) and Global Diet Quality Score (GDQS) being one amongst them.
- The GDQS metrics as a data collection tool has been administered with pre-existing/secondary food frequency or 24-hour recall data to determine scores but the GDQS as data collection tool itself has not been directly used in Indian setting yet.

Comparing the GDQS to other straightforward diet-related measurements, it offers a number of interesting properties. The GDQS is intended to be sensitive to diet-related outcomes associated with both undernutrition and overnutrition, in contrast to the majority of existing diet quality-related metrics. The metric is entirely food-based and therefore does not require the use of a food composition table for analysis. The GDQS includes an expanded set of food groups in comparison to most existing simple food-based metrics and incorporates a measure of quantity of consumption in the metric scoring, to allow for a more sensitive assessment of healthy diets. Hence, the current study was carried out keeping in mind the following objectives**:**

OBJECTIVES OF THE STUDY

BROAD OBJECTIVE OF THE STUDY:

To study the Diet Quality and assessment of Non- Communicable Disease risk in adult population of Urban Vadodara.

SPECIFIC OBJECTIVES OF THE STUDY:

- To assess the quality of diet, anthropometric, biophysical parameters and physical activity patterns of adults residing in urban Vadodara.
- To correlate the GDQS as a diet quality assessment tool in adult Indian population with 24 hr. recall data.

STUDY DESIGN

The study is a Cross sectional study, undertaken to assess the diet quality and NCD Risk in adult population (20-50 years) in Urban Vadodara, Gujarat.
Details of the same are given below:

SAMPLE SIZE CALCULATION:

For cross sectional study, formula for sample size calculation is, $4pq/L^2 = 354$ (approx.)
Where,
p= prevalence = 33%
(Taking the prevalence of poor diet quality in the urban adult population)
ref. NNMB urban survey data
q= (100-p)
L= Allowable error of prevalence (5%)
354 + 10% (potential dropouts)
354+ 36= 390 = 400 (approx.)

SAMPLE SELECTION:

The present study was carried out in the adult population (20-50 years) of Urban Vadodara. Using the VMC map of the city, four administrative zones in Vadodara were identified. From each of these zones, purposive selection of 1-2 societies having individuals greater than 100 was carried out. Enumeration of individuals in each society was carried out. Based upon the

inclusion exclusion criteria and consent for participating in the study, subjects were interviewed from the selected societies until the desired sample size 100 was achieved from each zone.

Data collection

Data was collected with respect to Background information, Socio-Economic status, Medical History, Anthropometry and Biophysical Parameters, Physical Activity pattern, Dietary pattern via GDQS application and 1 day 24-hour diet recall (on a sub sample of 100 participants).

Before starting the study, the permission of the secretary of the society was taken for all the societies.

INCLUSION CRITERIA

- Adults (20 – 50 years)
- Willingness to participate in the study

EXCLUSION CRITERIA

- Pregnant and Lactating women.
- Individuals following some special diets.
- Post-surgical patients (those who have undergone surgery in the past 1-2 months).

ETHICAL COMMITTEE APPROVAL

Consent of the ethical committee was acquired prior to conducting the study (IECHR/FCSc/MSc/2022/36). *(Annexure I)*

STUDY PLAN

The study being a cross sectional study had a single phase to assess the diet quality and non-communicable disease risk in the adult population of Urban Vadodara. The study design is mentioned in Figure 3.1.

In the present study a detailed questionnaire was formulated along with the use of GDQS metrics to assess the diet quality and non-communicable disease risk amongst the adults. The tools and techniques are mentioned in Table 3.1. The major parameters included in the questionnaire for assessment were as follows:-

BACKGROUND INFORMATION

Background information of the subjects were collected using a semi structured questionnaire and consent was taken from the participants.*(Annexure II &III)*

- Name, Age, Religion, Marital Status

- Education, Occupation
- Number of family members, family composition
- Socio Economic status

Socio-economic profile was reported using a pre tested questionnaire following the Aggarwal Scale (2005) for SES scoring.

S.No.	Social Status	Score
1.	Upper High	>76
2.	High	61-75
3.	Upper Middle	46-60
4.	Lower Middle	31-45
5.	Poor	16-30
6.	Very Poor or Below Poverty Line	<15

Aggarwal socioeconomic class classification (Aggarwal 2005 scale)

ANTHROPOMETRIC MEASUREMENTS

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

Weight:

Digital Bathroom Weighing Scale was used to measure body weight of the subject. Weight was measured using an electronic balance with 100g of accuracy. Body weight of the subjects was taken with precautions like minimal clothing, without footwear and with empty pockets. First, the weighing scale was kept on an even surface and after checking the "zero" on the scale the subjects were asked to stand at the centre of the bathroom scale with body weight evenly distributed on both the feet, without touching any other object. The weight was recorded in kilograms, to the nearest 100 grams.

Height:

A non-stretchable fibreglass tape was used to measure height during the study. The subjects were instructed to stand upright, without wearing shoes or heels, with their shoulders, hips, and heels contacting the wall. The arms were casually slung by the side and the head held pleasantly upright. The top of the head was lightly touched with a ruler to softly crush the hair, and the height, measured in centimetres to the nearest 0.1 cm, was then recorded.

Body Mass Index:

BMI was calculated using the following formula below:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height X Height (m}^2\text{)}}$$

Presumptive Diagnosis	**BMI (kg/m^2)**
Obese	≥25
Overweight	23- 24.9
Normal	18.5- 22.9
Underweight	<18.5

Classification of BMI according to Asia Pacific criteria, 2004

BMI	**Obesity grade**
25.0 – 29.9	Class 1
≥30	Class 2

Gradation of Obesity according to Asia Pacific criteria, 2004

Waist Circumference (WC)

As per the WHO protocol, the measurement of waist circumference was taken at the midpoint between the top of the iliac crest and the lower edge of the last palpable rib. When taking measurements, the participant was instructed to breathe normally and to slowly exhale in order to prevent them from tensing their muscles or holding their breath. This measurement was also made using a non-stretchable fibreglass tape.

Gender	**Category**	**WC**
Male	Obese	≥90
Female	Obese	≥80

WC cut off Category defined by International Diabetes Federation (IDF)

Hip Circumference (HC)

For the hip circumference, a non-stretchable tape was only used to measure around the widest portion of the hip/ buttocks.

Waist to Hip Ratio (WHR):

$$WHR = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

Category	Male	Female
Normal	<0.95	<0.8
At Risk	≥0.95	≥0.8

Waist- Hip Ratio Cut off, WHO, 2004

Waist to Stature Ratio (WSR):

$$WSR = \frac{\text{Waist circumference (cm)}}{\text{Height (cm)}}$$

Gender	Category	WSR
Male	Obese	>=0.51
Female	Obese	>=0.53

Category recommended by for Asians (Liu et al., 2011)

BIOPHYSICAL MEASUREMENT:

Blood Pressure was measured using a sphygmomanometer by standard technique.

Blood Pressure Classification	SBP mmHg	DBP mmHg
Normal	<120	and <80
Prehypertensive	120-139	or 80-89
Stage 1 Hypertension	140-159	or 90-99
Stage 2 Hypertension	>=160	or >=100

Classification of blood pressure according to Joint National Committee, JNC8 guidelines, 2014

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. The subject's medication (if any) along with dosage, frequency and duration was also noted Presence of addiction (if any) of Tobacco/ Alcohol/Smoking along with history, duration and frequency was collected as well.

ACTIVITY PATTERN:

Information regarding the activity pattern of the subject was acquired using short last 7 days self-administered version of the International Physical Activity Questionnaire (IPAQ).

The IPAQ short form asks about three specific types of activity undertaken in the three domains (heavy, moderate & walking) and sitting. Walking, moderate-intensity activities, and vigorous-intensity activities are the specific types of activity that are assessed; frequency (measured in days per week) and duration (minutes per day) were gathered individually for each specific type of exercise. The amount of activity was calculated by weighing each type of activity according to its METS (METs are multiples of resting metabolic rate) energy requirements, which resulted in a score in MET minutes.

MET values and Formula for computation of Met-minutes

Walking MET-minutes/week = 3.3 * walking minutes * walking days

Moderate MET-minutes/week = 4.0 * moderate-intensity activity minutes * moderate days

Vigorous MET-minutes/week = 8.0 * vigorous-intensity activity minutes * vigorous-intensity days

A combined total physical activity MET-min/week can be computed as the sum of Walking + Moderate + Vigorous MET-min/week scores.

The categorical scoring is proposed for three levels,

1. Inactive: No activity is reported
2. Minimally Active: Subjects with minimum of at least 600 MET-minutes/week
3. HEPA Active: Subjects with minimum of at least 3000 MET-minutes/week.

DIETARY PATTERN

In order to evaluate the individuals' dietary patterns, the subjects' food consumption over the previous 24 hours was taken into account.

Diet recall via GDQS tool by Intake:

The overall GDQS is a sum of the points across all 25 GDQS food groups The GDQS has a possible range of 0 to 49. Population-based cut-offs of 15 and 23 have been identified for the GDQS, to allow for reporting the percent of the population, based on the information collected for the 24- hour reference period.

- high risk for poor diet quality outcomes (GDQS<15)
- low risk for poor diet quality outcomes (GDQS ≥23)

The GDQS+ and GDQS are valuable because they offer more precise data on the relative contributions of consumption of healthy and unhealthy food groups to overall diet quality in a specific environment. *(Annexure IV)*

There are seven main steps that were involved in collecting data for the GDQS with the GDQS app:

Step 1 – Respondent ID and demographic information

Step 2 – Foods and drinks consumed in the past 24 hours using open recall

Step 3 – Ingredients of mixed dishes (recipes)

Step 4 – Additional information on certain foods to classify them into the GDQS food groups

Step 5 – Deep fried foods

Step 6 – Caloric sweeteners

Step 7 – Quantity consumed at the food group level

To collect quantity of consumption information for the GDQS, the respondent was reminded of the foods that he/she reported consuming for a given GDQS food group and were asked to visualize the total amount of food consumed and compare the amount (volume) to a set of ten 3D cubes, each of which has been predetermined in size to reflect the volume that corresponds to a quantity of consumption cut-off (in grams) that is used for a food group to tabulate the GDQS.

24 hr dietary recall (for sub-sample)

A 24-hour dietary recall (24HR) as a structured interview of the same data as collected in GDQS application, intended to capture detailed information about all foods and beverages in the previous day along with their amount of intake in standardised cup sizes or grams. A single one day 24 hour recall which provided an estimate of mean intake of foods and nutrients by an individual was collected. Fast or feast days were excluded.

Mean Adequacy Ratio with the nutrient intake found in the recall was done to analyse the nutrient adequacy.

The first step to estimate the MAR is to estimate the NAR for all nutrients of interest. The NAR is equal to the ratio of an individual's nutrient intake to the current RDA given by the , ICMR (NIN, 2020) of the nutrient for his or her age, sex, and physical activity status.

If the intake of a nutrient exceeded the RDA, the NAR was capped at 1, depending on whether it is expressed as a percentage or ratio. This prevents nutrients with very high intake (NAR

value > 1) from masking nutrients with very low intake (low NAR value) when they are averaged to calculate the MAR.(INDEXX PROJECT, 2018)

Once the NAR was calculated for each nutrient, the MAR was calculated by averaging all the NAR values together, as demonstrated in the equation below:

MAR = Sum of NAR / Number of Nutrients (multiply by 100 if representing as a percentage)
The MAR was reported on a scale from 0 to 100% (or 1), where 100% (or 1) indicates the requirements for all the nutrients were met.

STATISTICAL ANALYSIS

The data was collected using Epicollect5, entered in excel and then analysed using Microsoft excel (2019) and SPSS (29 version).

- Diet Quality Scores were computed by processing GDQS data downloaded from CSPro 7.7 web Server in SPSS.
- The nutritive value calculation for 24-hour dietary recall was performed using NSR-NutriCal Software(Version 4.0). NSR-NutriCal helps in precise nutrient calculation & also saves time to have more in-depth knowledge of nutrient intake from the ingredients present in IFCT as well as USDA database.
- Frequency distribution and percentages were calculated for all parameters that were exposed numerically.
- Appropriate statistical tests and Correlation were calculated for all the trends observed.

FIGURE 3.1 EXPERIMENTAL DESIGN

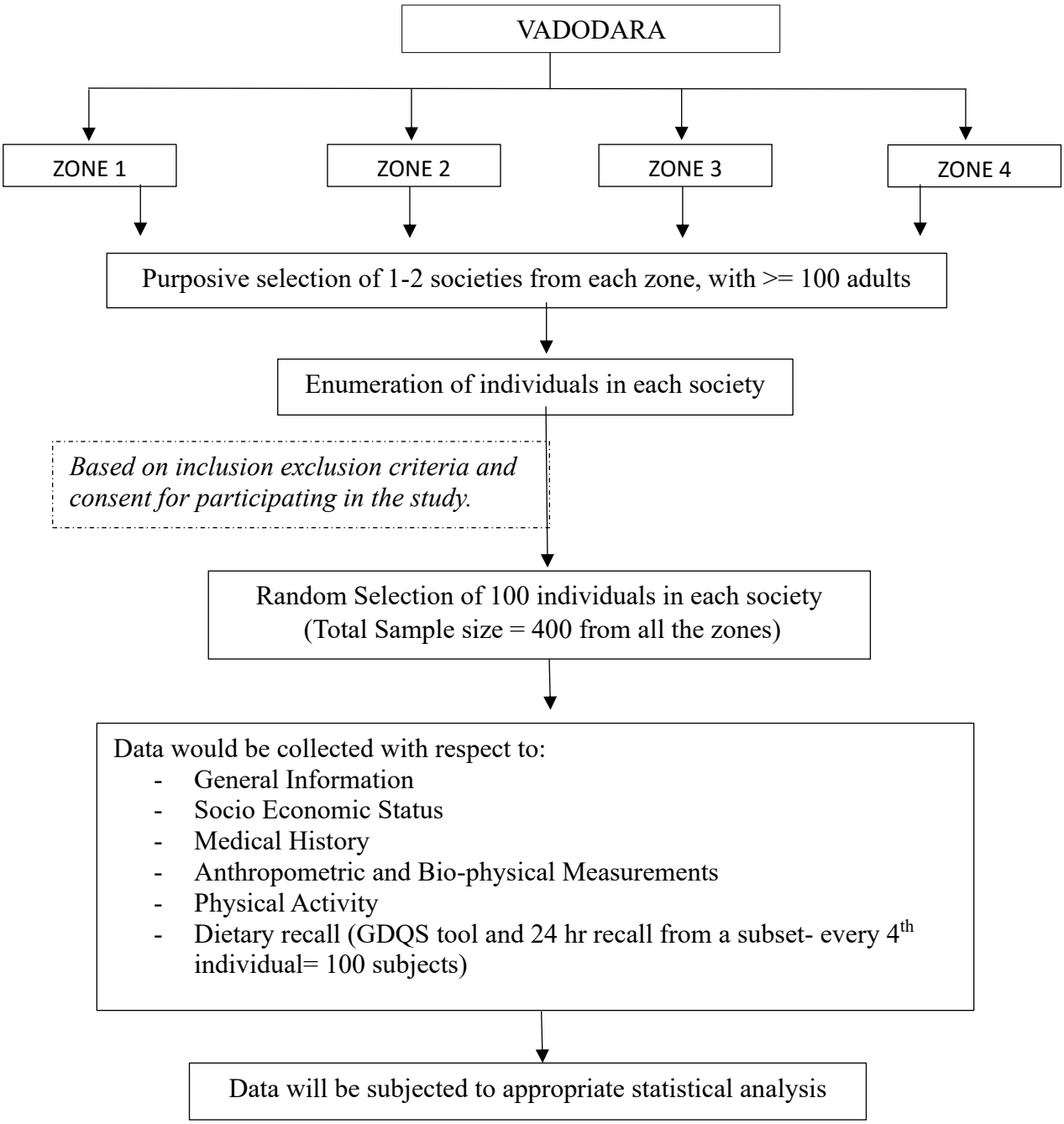


TABLE 3.1 METHODS AND TOOLS USED FOR DATA COLLECTION

Parameters	**Method / Tool**
General Information	Semi structured Questionnaire
Socio Economic Status	Pre-Tested Questionnaire
Medical History	Semi structured Questionnaire
Anthropometric Indices	
Height, weight, Waist Circumference, Hip Circumference	Standard Methods (Non stretchable fiberglass measuring tape & Bathroom weighing scale)
Biophysical parameters	
Blood pressure	Sphygmomanometer
Physical activity	International Physical Activity Questionnaire
Dietary habits	
Diet Quality	GDQS tool developed by Intake
Dietary Recall	1 day 24-hour Dietary Recall

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The impact of diet on the development and aetiology of non-communicable diseases (NCDs) is of utmost importance, and a plethora of ecological and epidemiological studies, clinical trials with specific nutrients and foods, as well as molecular and genetic investigations, have consistently shown a link between unhealthy diets and the occurrence of NCDs. Thus, nutrition plays a crucial role in modifying the risk of NCDs. By examining the quality and patterns of diets in relation to the widespread prevalence of NCDs in specific populations, it is possible to develop ethno-sensitive prudent and effective interventions to promote healthy eating habits.(Naicker et al., 2015)

Over the past few decades, food systems have undergone significant change. It is well known that this has affected environmental sustainability, food security, and dietary intake. By affecting the nutritional value of foods that are accessible, affordable, and acceptable to consumers, changes to the global food system have also had significant effects on NCDs.(WCRF, 2014)

In 2017, it was found that dietary risk factors, mainly high intake of sodium, low intake of whole grains, and low intake of fruits attributed to one-fifth of all deaths in adult population and 15% of disability-adjusted life years (DALYs). The double burden of malnutrition, both undernutrition and overweight/obesity, continues to be a significant problem in many countries, particularly low- and middle-income countries (LMICs). Consequently, the importance of adequately measuring diet quality at the population level thus became apparent and has been met with increasing efforts to develop low-burden diet quality instruments that are feasible in LMICs where resources for data collection are limited. (Deitchler & Bromage, 2021)

Therefore, the present study was carried out to elicit information on the Non-Communicable disease risk prevalence in the population and correlate the Diet Quality profile (using GDQS metrics) with nutrient adequacy from the dietary intake of the subjects.

For the study, the subjects were enrolled from the free – living population of Urban Vadodara. The detailed methodology regarding selection of subjects is given in the methods and material chapter. There were 400 subjects selected from four zones of Vadodara in the age group of 20 to 50 years. The results of this section are discussed under the following headings:

1. Background Information and Socio-economic Status
2. Medical and Family History
3. Anthropometric and Bio-physical Measurements
4. Physical Activity level

5. Dietary Intake analysis from GDQS and 24-hour recall

1. BACKGROUND INFORMATION AND SOCIO-ECONOMIC STATUS

A semi structured questionnaire was used to collect the background information from the subject through one-on-one interviews. It included information on age, gender, religion, educational status, marital status, occupation, and type of family.

The background information of the subjects showed an almost equal proportion of females(N=207) and males(N=193) participated in the study (Table 4.1 (a) and (b). The mean age of the subjects was 37± 10 years. Majority of the study population followed Hindu religion (96.5%) and only 0.5% of the subjects followed Muslim religion. Most of the subjects (56.8%) were graduates and about 0.3% were illiterate. 72% of the subjects enrolled were married. A greater percentage of subjects lived in Extended (47%) and Nuclear (41%) families.

Most of the subjects i.e., 32.8% were involved in service as an occupation. Majority (56.5%) of males were engaged in service, whereas the majority of females (59.9%) were housewives. With respect to total family income, it was observed that 87% of the subjects had family monthly income > 46,095 (income slabs according to the latest Kuppuswami socioeconomic status scale). Majority of the subjects (50.5%) had per capita income between 10,000 to 19,999, and about 36.2% having higher per capita income. 85.3% of the subjects had no significant other source of income, while 7.3% subjects had agriculture as other source of income in family.

SOCIO-ECONOMIC STATUS (SES)

For classification of subjects based on their socio-economic status(SES), Aggarwal Scale (2005) was used(Rajoura et al., n.d.). The subjects were scored across a total of 22 questions on a scale of 0-100 points into six socio-economic categories, namely Upper high (combined score of more than 76), High (61-75), Upper Middle (46-60), Lower Middle (31-45), Poor (16-30) and Very Poor (combined score less than 15).

The socioeconomic status of the subjects is shown in Table 4.1 (c).

In the present study, Majority (72.25%) of the subjects were from Upper Middle social status. Apart from the background information, on analysing the 22 questions, following findings were also observed:

- Head of the family (HOF) for majority of the subjects were graduates (52.5%), with occupation of HOF being service in Private sector or independent business (47.25%)
- The no. of family possessions and vehicles owned were also scored. 66% of the subjects were living in their own house with 3-4 rooms.
- All the subjects possessed at least one vehicle inclusive of Car/Tractor/Scooter/ Bullock Cart/Cycle (not baby cycle), 76.75% owned a four wheeled vehicle.
- 100% of the subjects were having water and electricity supply, along with private tap as water supply, Aquagaurd/RO as drinking water type, Private toilet facility, closed drainage facility and majority (98.5%) had VMSS van as the garbage disposal facility.
- 100% of the subjects were residing in urban locality and had all the children in the house going to school/college.
- Most subjects, i.e., 40.25% had only one earning family member, followed by 2 earning members (34.75%).

2. MEDICAL AND FAMILY HISTORY

FAMILY HISTORY OF DISEASES AMONG THE SUBJECTS

Table 4.2(a) and 4.2 (b) represents the family history of diseases among the subjects.

The information depicted that the family history had highest prevalence of Hypertension (67.5%) and Diabetes Mellitus (40.3%) followed by Stroke (11.8). (Figure 4.1)

It was observed that Diabetes was equally prevalent in mothers and fathers of the subjects (13.25%), Hypertension (23%) and Hypo/Hyperthyroidism (4.75%) were most prevalent in mothers. CHD (3%) and Hyperlipidemia (2.75%) were observed at a greater prevalence rate in fathers of the subjects. While Stroke (7.75%), Asthma(1%) and Cancer(3.75) were observed to be more prevalent in grandparents of the subjects.

MEDICAL HISTORY OF SUBJECTS

The self- reported medical history of the subjects is shown in Table 4.3. It was observed that prevalence of Hypertension was 7% followed by 4.25% of Diabetes. Figure 4.2 shows the self-reported prevalence of diseases in male and female subjects. Prevalence of self-reported addiction of Alcohol (0%) and Smoking (0.0025%, N=1) was found to be negligible in the subjects.

More than 3/4th of the subjects i.e., 76.5% had at least one disease present in the family history or were themselves suffering from one.

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

(Religion, Education, Type of family, Marital Status)

VARIABLE		Female N= 207		Male N= 193		Total N= 400	
		N	N%	N	N%	N	N%
Mean Age in years		36±10		38±11		37 ±10	
Religion	Hindu	198	95.6	188	97.4	386	96.5
	Muslim	2	1.0	0	0	2	0.5
	Jain	7	3.4	5	2.6	12	3.0
Educational Status	Professional qualification with technical degrees or diplomas	28	13.5	29	15.0	57	14.3
	Post Graduation (non-technical incl. Ph.D.)	5	2.4	1	0.5	6	1.5
	Graduation	111	53.6	116	60.1	227	56.8
	10th class pass but < Graduation	58	28.0	43	22.3	101	25.3
	Primary pass but < 10th	4	1.9	4	2.1	8	2.0
	Illiterate	1	0.5	0	0	1	0.3
Marital Status	Divorced	1	0.5	3	1.6	4	1.0
	Married	151	72.9	137	71.0	288	72.0
	Unmarried	51	24.6	52	26.9	103	25.8
	Widowed	4	1.9	1	0.5	5	1.3
Type of Family	Extended	100	48.3	88	45.6	188	47.0
	Joint	23	11.1	23	11.9	46	11.5
	Nuclear	84	40.6	82	42.5	166	41.5

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

(Occupation, Total Family Income, Per Capita Income)

VARIABLE		Female N= 207		Male N= 193		Total N= 400		Chi Square Test
		N	N%	N	N%	N	N%	
Occupation	Business	3	1.4	39	20.2	42	10.5	χ^2= 222.50***
	Service	22	10.6	109	56.5	131	32.8	
	Self employed	19	9.2	8	4.1	27	6.8	
	Student	38	18.4	30	15.5	68	17.0	
	Laborer	0	0	1	0.5	1	0.3	
	Retired	1	0.5	5	2.6	6	1.5	
	Unemployed	0	0	1	0.5	1	0.3	
	Housewife	124	59.9	0	0	124	31.0	
Total Family income(Rs)	>=1,84,376	17	8.2	12	6.2	29	7.3	χ^2= 2.89
	92,191 to 1,84,370	55	26.6	65	33.7	120	30.0	
	68,967 to 92,185	57	27.5	48	24.9	105	26.3	
	46,095 to 68,961	50	24.2	42	21.8	92	23.0	
	27,654 to 46,089	10	4.8	8	4.1	18	4.5	
	9,232 to 27,648	18	8.7	18	9.3	36	9.0	
Per capita income (Rs)	>= 50,000	7	3.4	4	2.1	11	2.8	χ^2= 2.32
	20,000 to 49,999	66	31.9	68	35.2	134	33.5	
	10,000 to 19,999	103	49.8	99	51.3	202	50.5	
	5,000 to 9,999	26	12.6	17	8.8	43	10.8	
	2,500 to 4,999	5	2.4	5	2.6	10	2.5	
Other source of income	Agriculture	15	7.2	14	7.3	29	7.3	χ^2= 0.94
	House/shop rent	16	7.7	11	5.7	27	6.8	
	Pension	2	1.0	1	0.5	3	0.8	
	None	174	84.1	167	86.5	341	85.3	

****Significantly different at p<0.001*

TABLE 4.1 (c) SOCIO ECONOMIC STATUS CLASSIFICATION OF THE SUBJECTS (N, %)

(Cut offs according to Aggarwal Scale of SES)

VARIABLE	Female N= 207		Male N= 193		Total N= 400	
	N	N%	N	N%	N	N%
High	35	16.91	32	16.58	67	16.75
Upper middle	149	71.98	140	72.54	289	72.25
Lower middle	23	11.11	21	10.88	44	11

TABLE 4.2 FAMILY HISTORY OF DISEASES AMONG THE SUBJECTS (N,%)

VARIABLE	Female (N= 207)		Male (N= 193)		Total (N= 400)	
	N	N%	N	N%	N	N%
Diabetes						
Mother	31	14.98	22	11.40	53	13.25
Father	37	17.87	18	9.33	55	13.75
Sibling	7	3.38	2	1.04	9	2.25
Grandparents	23	11.11	21	10.88	44	11.00
Hypertension						
Mother	49	23.67	43	22.28	92	23.00
Father	42	20.29	46	23.83	88	22.00
Sibling	8	3.86	4	2.07	12	3.00
Grandparents	34	16.43	44	22.80	78	19.50
CHD						
Mother	3	1.45	2	1.04	5	1.25
Father	7	3.38	5	2.59	12	3.00
Sibling	1	0.48	0	0	1	0.25
Grandparents	3	1.45	5	2.59	8	2.00
Hyperlipidemia						
Mother	1	0.48	2	1.04	3	0.75
Father	3	1.45	8	4.15	11	2.75
Sibling	3	1.45	0	0	3	0.75
Grandparents	5	2.42	3	1.55	8	2.00
Stroke						
Mother	1	0.48	0	0	1	0.25
Father	7	3.38	8	4.15	15	3.75
Sibling	0	0	0	0	0	0
Grandparents	16	7.73	15	7.77	31	7.75
Hypo/Hyperthyroidism						
Mother	9	4.35	9	4.66	18	4.50
Father	2	0.97	0	0	2	0.50
Sibling	3	1.45	0	0	3	0.75
Grandparents	2	0.97	3	1.55	5	1.25
Asthma						
Mother	0	0	0	0	0	0
Father	1	0.48	2	1.04	3	0.75
Sibling	2	0.97	1	0.52	3	0.75
Grandparents	2	0.97	2	1.04	4	1.00
Cancer						
Mother	3	1.45	3	1.55	6	1.50
Father	3	1.45	7	3.63	10	2.50
Sibling	1	0.48	0	0	1	0.25
Grandparents	4	1.93	11	5.70	15	3.75

FIGURE 4.1 PREVALENCE OF DISEASES IN FAMILY HISTORY OF SUBJECTS (%)

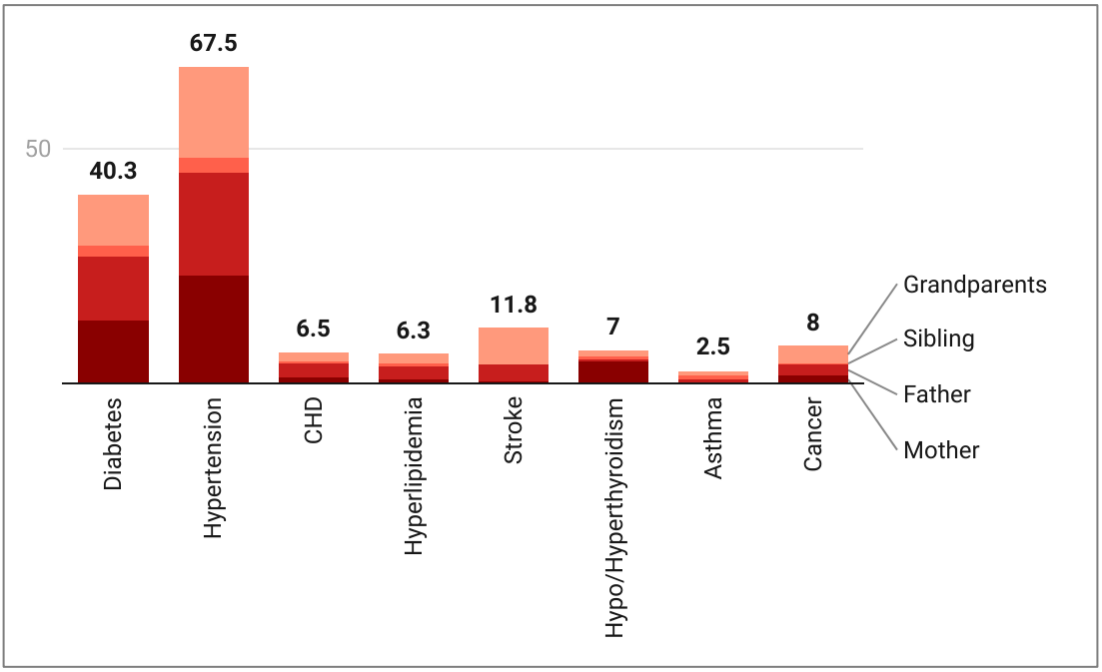
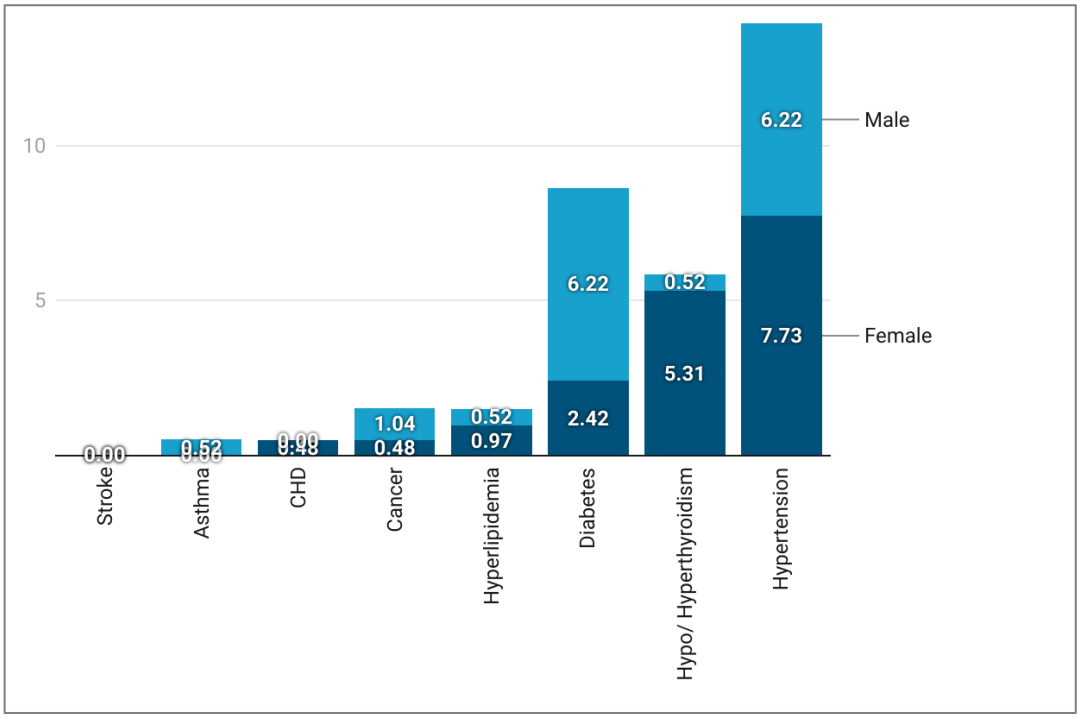


TABLE 4.3 MEDICAL HISTORY OF THE SUBJECTS (SELF- REPORTED) (N,%)

VARIABLE	Female N= 207		Male N= 193		Total N= 400	
	N	N%	N	N%	N	N%
Diabetes	5	2.42	12	6.22	17	4.25
Hypertension	16	7.73	12	6.22	28	7.00
CHD	1	0.48	0	0	1	0.25
Hyperlipidemia	2	0.97	1	0.52	3	0.75
Stroke	0	0	0	0	0	0
Hypo/ Hyperthyroidism	11	5.31	1	0.52	12	3.00
Asthma	0	0	1	0.52	1	0.25
Cancer	1	0.48	2	1.04	3	0.75

FIGURE 4.2 PREVALENCE OF DISEASES AMONG THE SUBJECTS (%) (SELF REPORTED)



3. ANTHROPOMETRIC AND BIO-PHYSICAL MEASUREMENTS

The Anthropometric and Biophysical(Blood Pressure) measurements of the subjects are depicted in Table 4.4. The mean height of the subjects was 163.68 ± 9.20 cm while the average weight was 68.11 ±12.29 kg. The BMI had a mean value of 25.47 ± 4.53, which is on a higher side and can be categorised as Obese. The abdominal obesity parameters were found to be on higher side with mean WC being 89.35 ± 10.04 cm, mean HC being 101.44 ± 9.10 cm, with mean WHR of 0.88 ± 0.07 and mean WSR of 0.55 ± 0.06.

Comparisons between male and female subjects revealed that HC and WSR were significantly higher in females while WC and WHR were higher in males.

PREVALENCE OF UNDERWEIGHT, OVERWEIGHT AND OBESITY AMONG THE SUBJECTS

According to the Asia pacific criteria of BMI Classification, the overall prevalence of Obesity was 50%, followed by 18.75% Overweight and 3.5% subjects were Underweight. The prevalence of Overweight was found to be higher in male subjects (23.83% vs 14.01%) while the prevalence of Obesity (53.62%) and Underweight (4.83%) was higher in female subjects as shown in Table 4.5.

The abdominal Obesity parameters, namely WC, WHR and WSR, more than half of the subjects were in at-risk and obese category respectively. Comparisons between male and female subjects, according to the respective WC and WHR cut offs revealed that more females were abdominally obese (75.85%) and in at-risk category (81.16%) than males. While the majority of males (72.02%) were found to be abdominally obese when WSR cut offs were compared. Higher measurements of these parameters depict increasing risk of cardiovascular diseases among the subjects. Table 4.6 shows the further gradation of Obesity, majority, i.e.,71.50% of the obese subjects fell in the Obesity class 1 category.

Table 4.7 shows that all means of all the anthropometric indices have increased significantly with increasing BMI. Table 4.8 shows the age wise prevalence, across BMI categories. The prevalence of Overweight was almost similar in both the age groups, i.e., 17.9% in 20 to 35 year old subjects, and 19.3% in 36 to 50 year old subjects. However, with respect to obesity, the overall prevalence was much higher in the older age group (59.7%) than the younger age group (35.8%). More subjects from the younger age group (6.8%) were found underweight than the older age group (1.3%).

Table 4.9 shows that all the anthropometric indices, except height are significantly higher in the older age group (36 to 50 years) as compared to younger age group (20 to 35 years).

PREVALENCE OF PREHYPERTENSION AND HYPERTENSION

The mean systolic blood pressure was 123.01 ± 14.94 mmHg while mean diastolic blood pressure was 84.78 ± 10.35 mmHg. Majority of the subjects were classified as Prehypertensive (49%), followed by Stage 1 Hypertension (20.75%) as depicted in Table 4.10. Prevalence of Prehypertension and Stage 1 Hypertension was observed higher in male subjects. Figure 4.3 shows the majority of Obese subjects were Hypertensive (Stage 1 and 2) and pre hypertensive, while majority of subjects with normal BMI also had normal blood pressure. Table 4.11 shows significant Positive Correlation between BMI and both Systolic and Diastolic Blood pressure, which indicates that with increasing BMI, blood pressure parameters tended to increase, increasing the risk of cardiovascular diseases. Figure 4.4 shows the linear relation of BMI with blood pressure.

4. PHYSICAL ACTIVITY LEVEL

An overall self-reported Physical Activity pattern of the subjects was assessed by International Physical Activity (Short) Questionnaire. Based on MET minutes/week, subjects were categorised accordingly under 3 heads- Inactive, Minimally Active and HEPA Active, meaning sedentary, moderate and heavy worker respectively. Table 4.12 shows physical activity of the subjects. The mean MET minutes /week were 1085.1 ± 1046.6, which falls in the category of "Minimally Active". The mean values depicted that overall female subjects were comparatively more active than male subjects. Table 4.13 shows the classification of subjects based on physical activity profile, 57.3% subjects were Minimally Active who burn between 600 to 3000 MET minutes/week, followed by 36.3% Inactive subjects. Out of all the subjects, only 6.5% qualified for the HEPA Active Category.

BMI and the physical activity (MET minutes/week) were found to be negatively correlated. The relation was not significant, but it was observed that with decrease in physical activity, BMI increased. Figure 4.5 depicts majority of normal, obese, and overweight subjects were leading a minimally active or inactive lifestyle. Table 4.1 shows physical activity profile of normal, overweight and obese subjects..

TABLE 4.4 ANTHROPOMETRIC AND BIOPHYSICAL PROFILE (Mean, S.D.)

VARIABLE	Female		Male		Total		T value
	Mean	SD	Mean	SD	Mean	SD	
Weight (kg)	64.02	12.07	72.49	10.96	68.11	12.29	7.32***
Height (cm)	157.62	6.50	170.18	6.97	163.68	9.20	18.63***
BMI	25.84	5.03	25.07	3.90	25.47	4.53	1.68
WC (cm)	87.34	11.50	91.51	7.66	89.35	10.04	4.23***
HC (cm)	102.49	10.56	100.32	7.06	101.44	9.10	2.4*
WHR	0.85	0.06	.91	0.05	0.88	0.07	10.43***
WSR	0.55	0.08	.54	0.05	0.55	0.06	2.56*
SBP (mmHg)	121.23	17.55	124.93	11.25	123.01	14.94	2.495*
DBP (mmHg)	84.78	11.86	84.78	8.46	84.78	10.35	

**Significantly different at p<0.05*
****Significantly different at p<0.001*

TABLE 4.5 PREVALENCE OF UNDER WEIGHT, OVERWEIGHT AND OBESITY AMONG THE SUBJECTS (N,%)

VARIABLE		Female N= 207		Male N= 193		Total N= 400		Chi Square Test
		N	N%	N	N%	N	N%	
BMI Category	Underweight (<18.5)	10	4.83	4	2.07	14	3.50	$\chi2$= 8.446*
	Normal (18.5-22.9)	57	27.54	54	27.98	111	27.75	
	Overweight (23-24.9)	29	14.01	46	23.83	75	18.75	
	Obese (≥25)	111	53.62	89	46.11	200	50	
WC cut off	Normal	50	24.15	72	37.31	122	30.50	$\chi2$= 8.149**
	Obese (Female ≥80 Male ≥90)	157	75.85	121	62.69	278	69.50	
WHR cut off	Normal	39	18.84	149	77.20	188	47	$\chi2$= 136.567***
	At- risk (Female ≥0.8 Male ≥ 0.95)	168	81.16	44	22.80	212	53	
WSR cut off	Normal	77	37.20	54	27.98	131	32.75	$\chi2$= 3.85*
	Obese (Female ≥0.53 Male ≥ 0.51)	130	62.80	139	72.02	269	67.25	

**Significantly different at p<0.05*
***Significantly different at p<0.01*
****Significantly different at p<0.001*

TABLE 4.6 GRADATION OF OBESITY (Asia Pacific cut offs) (N,%)

VARIABLE	Female N= 207		Male N= 193		Total N= 400		Chi Square Test
	N	N%	N	N%	N	N%	
Obesity Class 1 (25.0-29.9)	73	65.77	70	78.65	143	71.50	$\chi2$= 4.025*
Obesity Class 2 (≥ 30)	38	34.23	19	21.35	57	28.50	

**Significantly different at p<0.05*

TABLE 4.7 ANTHROPOMETRIC PROFILE OF NORMAL, UNDERWEIGHT, OVERWEIGHT AND OBESE SUBJECTS (MEAN±SD)

VARIABLE	BMI Category												F- value
	Underweight			Normal			Overweight			Obese			
	Female N= 10	Male N=4	Total N=14	Female N=57	Male N=54	Total N=111	Female N=29	Male N=46	Total N=75	Female N=111	Male N=89	Total N=200	
Weight (kg)	44.09 ± 3.72	50.95 ± 8.3	46.05 ± 5.99	54.03 ± 4.53	63.05 ± 7.14	58.42 ± 7.45	60.12 ± 5.96	71.31 ± 5.24	66.98 ± 7.76	71.97 ± 9.82	79.79 ± 9.2	75.45 ±10.29	115.50*
Height (cm)	161.2 ± 4.08	172.93 ± 8.87	164.55 ± 7.74	159.05 ± 6.23	171.93 ± 7.66	165.32 ± 9.48	158.1 ± 7.02	171.91 ± 5.59	166.57 ± 9.13	156.45 ± 6.47	168.1 ± 6.63	161.63 ± 8.73	7.31*
BMI	16.95 ± 1.09	16.94 ± 1.2	16.95 ± 1.08	21.34 ± 1.07	21.27 ± 1.11	21.31 ± 1.08	23.98 ± 0.64	24.1 ± 0.56	24.05 ± 0.59	29.43 ± 3.88	28.25 ± 3.11	28.9 ± 3.6	262.14*
WC (cm)	67.68 ± 7.48	80.38 ± 8.75	71.31 ± 9.58	77.98 ± 6.39	87.27 ± 7.28	82.5 ± 8.25	86.3 ± 6.9	91.3 ± 6.37	89.37 ± 6.98	94.18 ± 9.05	94.68 ± 6.79	94.4 ± 8.11	77.373*
HC cm)	87.07 ± 5.25	89 ± 4.55	87.62 ± 4.97	94.18 ± 6.02	96.41 ± 5.97	95.26 ± 6.07	100.26 ± 5.85	99.45 ± 6.22	99.76 ± 6.05	108.73 ± 9.01	103.65 ± 6.33	106.47 ± 8.31	77.223*
WHR	0.78 ± 0.05	0.9 ± 0.06	0.81 ± 0.08	0.83 ± 0.06	0.91 ± 0.06	0.87 ± 0.07	0.86 ± 0.04	0.92 ± 0.05	0.9 ± 0.06	0.87 ± 0.06	0.91 ± 0.05	0.89 ± 0.06	9.76*
WSR	0.42 ± 0.04	0.46 ± 0.04	0.43 ± 0.05	0.49 ± 0.04	0.51 ± 0.04	0.5 ± 0.04	0.55 ± 0.03	0.53 ± 0.04	0.54 ± 0.04	0.6 ± 0.06	0.56 ± 0.04	0.59 ± 0.06	105.60*
SBP mmHg	110.3 ± 9.92	109.75 ± 8.66	110.14 ± 9.25	116.11 ± 15.58	122.19 ± 11.15	119.06 ± 13.89	125.52 ± 20.48	122.8 ± 8.97	123.85 ± 14.47	123.72 ± 17.39	128.38 ± 11.31	125.8 ± 15.1	8.94*
DBP mmHg	78.3 ± 9.73	81.5 ± 5.45	79.21 ± 8.64	80.51 ± 10.21	81.81 ± 7.21	81.14 ± 8.86	86.66 ± 10.2	83.39 ± 7.5	84.65 ± 8.74	87.06 ± 12.52	87.44 ± 9	87.23 ± 11.07	10.33*

****Significantly different at p<0.001*

TABLE 4.8 AGE WISE PREVALENCE OF UNDERWEIGHT, OVERWEIGHT AND OBESITY (N,%)

BMI Category	Age Category											
	20 to 35 years						36 to 50 years					
	Female N= 89		Male N=73		Total N=162		Female N=118		Male N=120		Total N=238	
	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %
Underweight	8	9.0	3	4.1	11	6.8	2	1.7	1	0.8	3	1.3
Normal	35	39.3	29	39.7	64	39.5	22	18.6	25	20.8	47	19.7
Overweight	14	15.7	15	20.5	29	17.9	15	12.7	31	25.8	46	19.3
Obese	32	36.0	26	35.6	58	35.8	79	66.9	63	52.5	142	59.7
Chi Square Test	**$\chi 2$**=1.929						**$\chi 2$**= 7.877*					

**Significantly different at p<0.05*

TABLE 4.9 AGE SEGREGATED ANTHROPOMETRIC PROFILE (MEAN ± SD)

VARIABLES	20 to 35 years			36 to 50 years			F -value
	Female	Male	Total	Female	Male	Total	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Weight (kg)	61.28 ± 11.87	70.12 ± 11.98	65.27 ± 12.68	66.09 ± 11.85	73.93 ± 10.07	70.04 ± 11.65	15.060*
Height (cm)	158.88 ± 6.27	169.88 ± 7.36	163.84 ± 8.71	156.68 ± 6.54	170.36 ± 6.75	163.57 ± 9.54	0.079
BMI	24.35 ± 4.90	24.38 ± 4.54	24.36 ± 4.73	26.96 ± 4.85	25.50 ± 3.41	26.22 ± 4.24	16.794*
WC (cm)	82.80 ± 10.52	88.19 ± 7.70	85.23 ± 9.71	90.76 ± 11.05	93.52 ± 6.93	92.15 ± 9.29	51.665*
HC (cm)	99.40 ± 9.69	98.35 ± 7.62	98.93 ± 8.80	104.83 ± 10.63	101.51 ± 6.45	103.16 ± 8.91	21.950*
WHR	0.83 ± 0.06	0.90 ± 0.05	0.86 ± 0.06	0.87 ± 0.06	0.92 ± 0.06	0.89 ± 0.07	25.030*
WSR	0.52 ± 0.07	0.52 ± 0.05	0.52 ± 0.06	0.58 ± 0.07	0.55 ± 0.04	0.56 ± 0.06	48.245*
SBP (mmHg)	114.85 ± 13.77	122.19 ± 9.89	118.16 ±12.68	126.03 ± 18.58	126.60 ± 11.73	126.32 ± 15.48	30.894*
DBP (mmHg)	81.03 ± 8.73	82.56 ± 7.73	81.72 ± 8.30	87.60 ± 13.11	86.12 ± 8.63	86.86 ± 11.08	25.168*

****Significantly different at p<0.001*

TABLE 4.10 PREVALENCE OF HYPERTENSION (N,%)

Blood pressure Classification	Female N=207		Male N=193		Total N=400		Chi Square Test
	N	N %	N	N%	N	N%	
Normal	51	24.64	28	14.51	79	19.75	
Prehypertensive	93	44.93	103	53.37	196	49.00	$\chi 2$=
Stage 1 Hypertension	34	16.43	49	25.39	83	20.75	15.542***
Stage 2 Hypertension	29	14.01	13	6.74	42	10.50	

****Significantly different at p<0.001*

FIGURE 4.3 PREVALENCE OF HYPERTENSION ACROSS BMI (%)

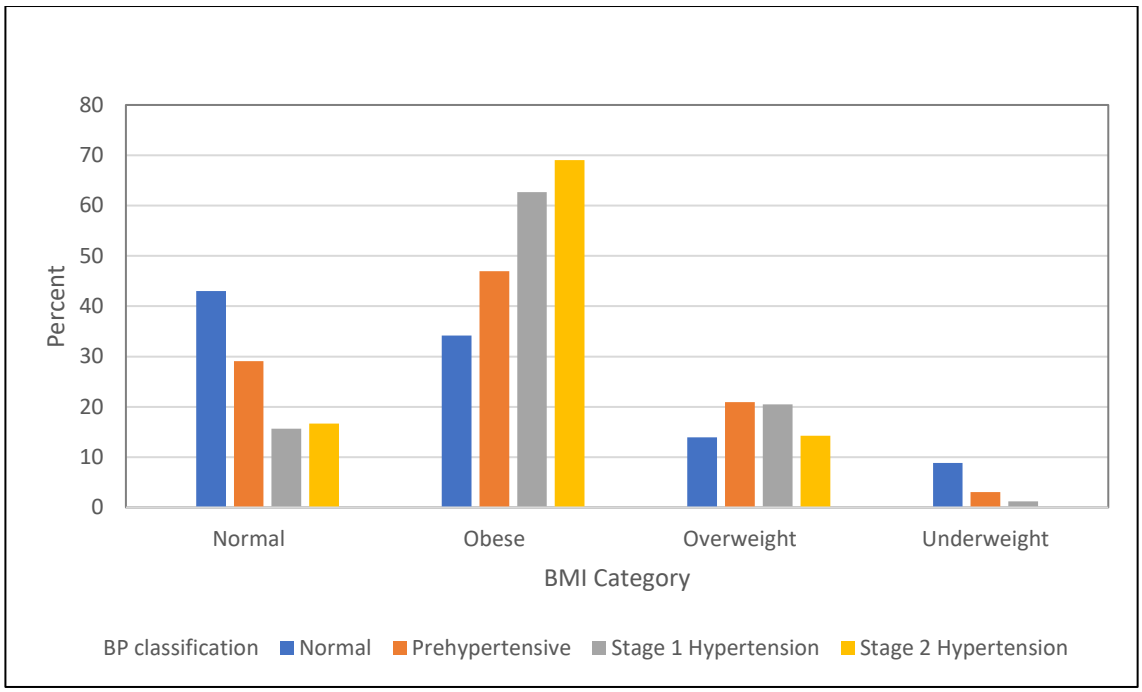
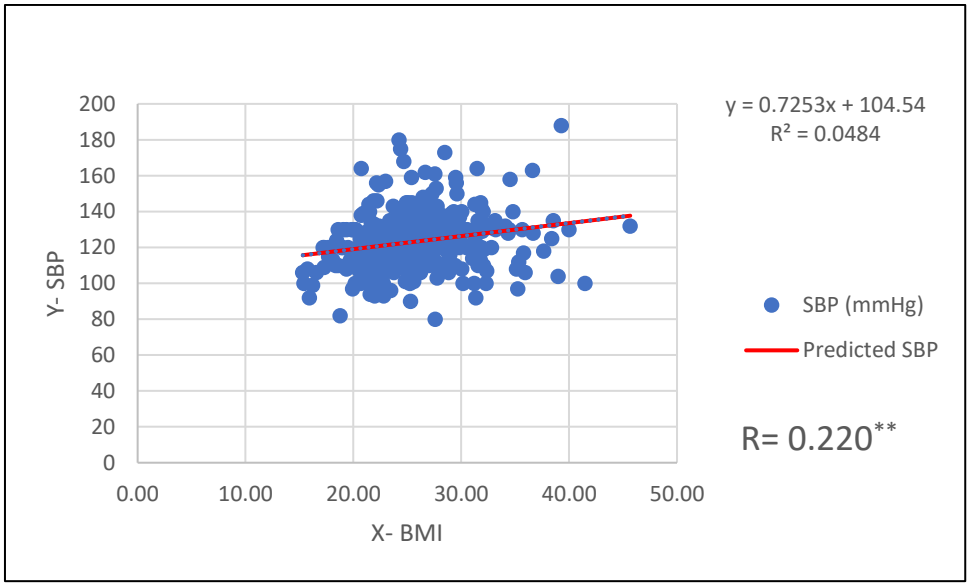


TABLE 4.11 CORRELATION BETWEEN BMI AND BLOOD PRESSURE

Pearson Correlation	SBP (mmHg)	DBP (mmHg)
BMI	R= 0.220**	R=0.281**
** Correlation is significant at the 0.01 level (2-tailed).		

FIGURE 4.4 CORRELATION BETWEEN BMI AND BLOOD PRESSURE



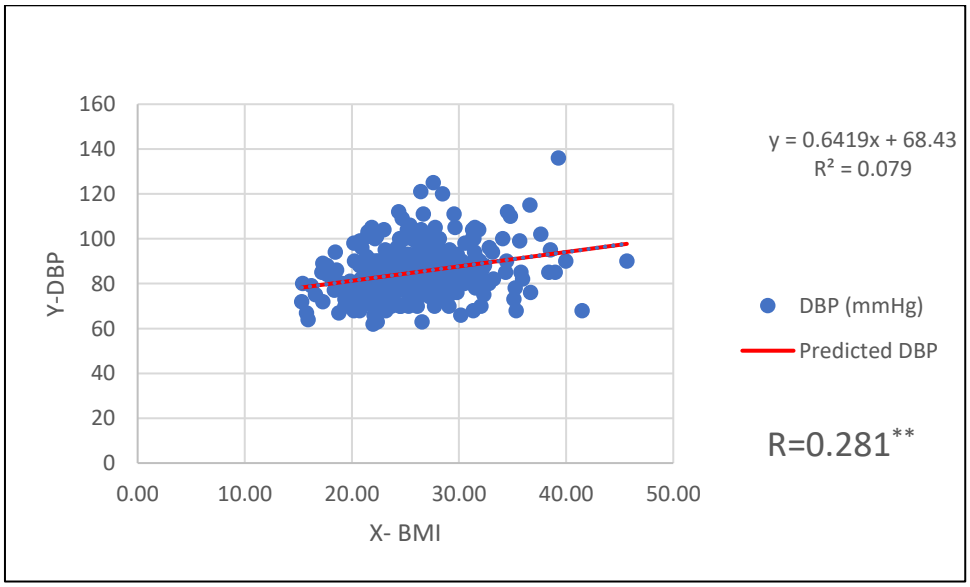


TABLE 4.12 PHYSICAL ACTIVITY PROFILE OF THE SUBJECTS (MEAN, SD)

VARIABLE	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
TOTAL MET minutes/week	1165.7	1038.6	998.7	1051.0	1085.1	1046.6

TABLE 4.13 PHYSICAL ACTIVITY PROFILE OF THE SUBJECTS (N,%)

IPAQ CUT OFF	Female N=207		Male N=193		Total N=400	
	N	N%	N	N%	N	N
HEPA Active (>3000 MET minutes/week)	12	5.8	14	7.3	26	6.5
Minimally Active (600-3000 MET minutes/week)	130	62.8	99	51.3	229	57.3
Inactive (<600 MET minutes/week)	65	31.4	80	41.5	145	36.3

FIGURE 4.5 RELATION BETWEEN BMI AND PHYSICAL ACTIVITY (N)

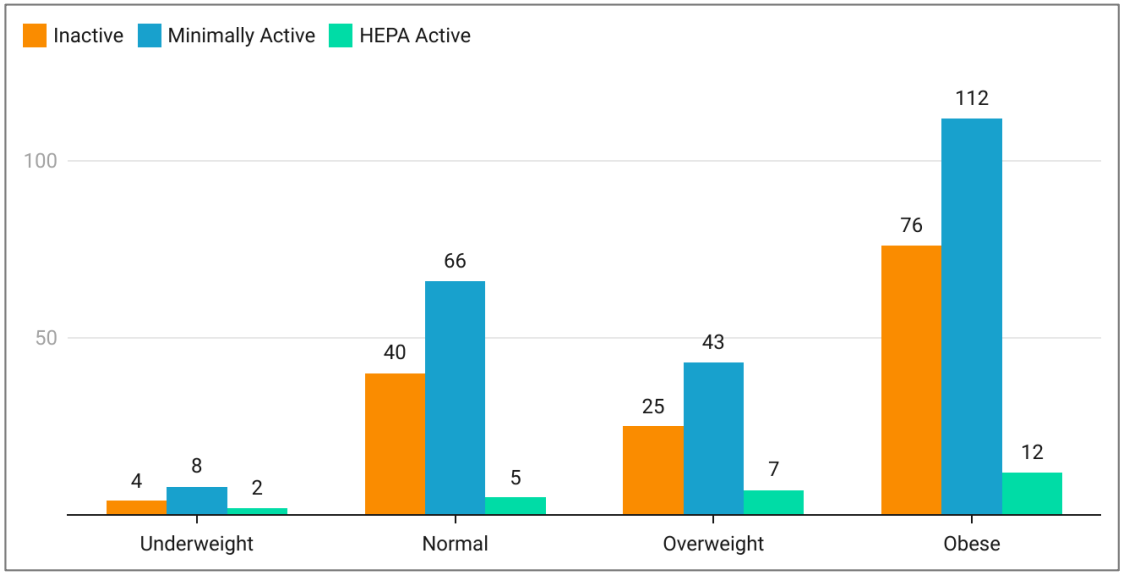


TABLE 4.14 PHYSICAL ACTIVITY PROFILE ACROSS BMI (N,%)

IPAQ CUT OFF	BMI Category																							
	Underweight						Normal						Overweight						Obese					
	Female N= 10		Male N=4		Total N=14		Female N=57		Male N=54		Total N=111		Female N=29		Male N=46		Total N=75		Female N=111		Male N=89		Total N=200	
	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%
Inactive	3	30	1	25	4	28.6	16	28.1	24	44.4	40	36	6	20.7	19	41.3	25	33.3	40	36.0	36	40.4	76	38
Minimally Active	5	50	3	75	8	57.1	40	70.2	26	48.1	66	59.5	22	75.9	21	45.7	43	57.3	63	56.8	49	55.1	112	56
HEPA Active	2	20	0	0	2	14.3	1	1.8	4	7.4	5	4.5	1	3.4	6	13.0	7	9.3	8	7.2	4	4.5	12	6
Chi Square Test	**$\chi 2$= 1.13**						**$\chi 2$= 6.29***						**$\chi 2$= 6.85***						**$\chi 2$=0.88**					

**Significantly different at p<0.05*

5. DIETARY INTAKE ANALYSIS FROM GDQS AND 24-HOUR RECALL

GLOBAL DIET QUALITY SCORE

The overall GDQS is a sum of the points across 25 GDQS food groups *(Annexure IV).* The GDQS has a possible range of 0 to 49. There are 16 healthy food groups in the metrics which constitute the GDQS+ score, along with 7 Unhealthy food groups which constitute the GDQS- score, and 2 food groups which are considered unhealthy if consumed in excess, and are accordingly scored. GDQS is a semiquantitative tool, where scoring is done according to the quantity of consumption (Low/Medium/High) of the particular food group. The overall scoring helps categorising the subjects under 3 heads of either High risk (GDQS<15), Moderate Risk and Low Risk (GDQS≥23) of poor dietary outcomes.

Table 4.15 shows the mean of GDQS overall, mean GDQS+ and mean GDQS- scores. Mean GDQS overall of the subjects was 22.10 ± 3.42, while mean GDQS+ was 10.75±2.83 and mean GDQS- was 11.35±1.83, depicting that contribution to the overall GDQS is more from negative score, meaning more from Unhealthy Food groups than Healthy food groups. It was observed that Overall GDQS of male subjects (22.45±3.25) was significantly higher than female subjects (21.77±3.54). The distribution of mean GDQS + and GDQS- can be observed in Figure 4.6. The maximum value of mean GDQS+ (score from healthy food groups) can be 32 and mean GDQS – (score from unhealthy food groups) can be 17, hence ideally, mean GDQS + should be higher in value, but as observed mean GDQS- is higher across all categorisations indicating the higher intake of unhealthy food groups across all genders, age groups and subjects with various NCD risk factors.

On categorisation of the scores in Table 4.15, Majority (60%) of the subjects belonged to the Moderate risk category, followed by 39.3% in Low-risk category and 0.8% who were in the High-risk category, with GDQS lower than 15, having a very high risk of developing NCDs. It was observed that out of the 0.8% subjects who belonged to the high-risk category of poor dietary outcomes according to GDQS, all were having high BMI and were in the obese category. 71% of all the underweight subjects fell in the moderate risk category, followed by 62% of the obese subjects, 58.7% of the Overweight subjects and 55.9% of the normal BMI subjects as observed in Table 4.16. Table 4.16 shows GDQS profiling across age groups. It was observed that 63% of the

younger subjects fell in the moderate risk category, and 1.2% in the high-risk category. While in older age groups, 58% of the subjects fell in the moderate risk category, and 0.4% in high-risk category. The poor diet quality outcomes were observed to be more prevalent in subjects of younger age group of 20-35 years of age.

Table 4.19(a),(b) presents the quantity of consumption for each of the 25 GDQS food groups. For the following food groups, most of the study population fell into the lowest category for quantity of consumption: Fish and shell fish (100%), Deep orange vegetables(100%), Red meat (100%), Poultry and game meat (99.75%), Processed meat (99.75%), Citrus fruits (98.5%), Juice (98.25%), Sugar sweetened beverage (97%), Deep Orange fruits (96.25%) and Eggs (96.25%). Whereas for the following food groups most of the subjects occupied the highest category for quantity of consumption: Liquid oils (99.75%), Whole grains (93.5%), Refined grains and baked goods (91.5%), Legumes (91.25%),and High Fat dairy (80% and 13% with very high consumption). In the study population, most of the healthy food groups were recorded with a low intake from the majority of subjects as observed in Figure 4.7(a),(b). It was observed that most subjects had either high consumption or low consumption of different food groups, indicating lack of moderation and dietary diversity in average consumption of food groups(Healthy and Unhealthy). Amongst Healthy Food groups, highest consumption was of Liquid Oils (N= 399) and lowest consumption was of Deep Orange vegetables and sea food (N=400). In Unhealthy food groups, very high consumption was of High fat dairy (N=52), high consumption was of Refined grains and baked goods (N=366) and lowest consumption was of red meat (N=400).

24 HOUR DIETARY RECALL

A detailed one day 24-hour dietary recall from a subset of the study population was taken, N=100. A total intake of 65 females and 35 male subjects was recorded and analysed. Table 4.20 shows the Mean Macronutrient intake in subjects. For energy (measured in kcal), the mean intake was 1245.81 kcal for females and 1301.04 kcal for males, with a total mean intake of 1265.14 kcal. For carbohydrate (measured in grams), the mean intake was 163.50 g for females and 170.25 g for males, with a total mean intake of 165.86 g. For protein (measured in grams), the mean intake was 39.80 g for females and 42.35 g for males, with a total mean intake of 40.69 g. The Table 4.21 displays the mean and standard deviation of various micronutrient intake of the subjects

of a day (24hrs). The table 4.22 depicts the mean and standard deviation values for various types of fatty acids (saturated, mono-unsaturated, poly-unsaturated, and trans) and total fat intake of the subjects of a day (24 hrs).

Nutrient adequacy

Nutrient Adequacy Ratio (NAR), is simply calculated by dividing the nutrient intake of an individual with the recommended allowance (EARs according to the subject's age, gender, physical activity status). The value ranges from 0 to 1, it is capped at 1 so that when calculating the mean adequacy, it does not mask the inadequacies of other nutrients.

Table 4.23 shows that the mean NARs for carbohydrate, protein, and total fat are close to 1 for both females and males, indicating that the average intake of these nutrients was adequate. However, the mean NARs for calcium, zinc, thiamine, riboflavin, niacin, and vitamin A are lower than 1, suggesting that the average intake of these nutrients was inadequate. It was also observed that the standard deviation (SD) values were relatively high for some nutrients, indicating that there was a large variation in nutrient intake among the population. For example, the SD for iron NAR was observed 0.20 for the total population, suggesting that some people had a much lower intake of iron than others.

MAR(%) refers to the Mean Adequacy Ratio in terms of percentage, which is computed by taking an average of nutrient adequacy ratios (NARs). It reflects the overall Nutrient adequacy of an individual's dietary intake. Here, MAR (%) was calculated with 14 nutrient adequacies from the subject's 24-hour diet. The table 4.24 shows that, on average, female subjects met 63.39% of their RDA for energy intake, with a standard deviation of 22.32%, while males met 54.69% of their RDA for energy intake, with a standard deviation of 14.29%. The total average for Energy RDA intake is 60.34%, with a standard deviation of 20.24%. The table shows that, on average, females had a MAR of 73.23%, with a standard deviation of 10.99%, while males had a MAR of 71.30%, with a standard deviation of 10.13%. The total average for MAR (%) was 72.56%, with a standard deviation of 10.69%.

CORRELATION BETWEEN DIET QUALITY AND NUTRIENT ADEQUACY

The Diet Quality as computed by GDQS and Nutrient Adequacy as computed by mean Nutrient Adequacy from 24-hour recall, were found to have a significant correlation as shown in Table 4.25. Mean Adequacy Ratio was found to have significant positive correlation with GDQS + SCORE *($p<0.01$),* and significant negative correlation with GDQS – SCORE *($p<0.05$).* This depicts, on increase in GDQS+ , MAR will increase, indicating increase in nutrient adequacy, while on decrease in GDQS+, MAR will decrease, indicating nutrient inadequacy. Figure 4.8 shows the linear correlation between the variables. The correlation also signifies that the GDQS cut offs are also indicative of the nutrient adequacy as shown in Figure 4.9, Subjects with high risk GDQS profile had lower nutrient adequacy and subjects with low risk GDQS profile had higher nutrient adequacy. Table 4.26 shows that on computing individual Nutrient adequacy ratios with the GDQS, significant correlations between nutrient intake and GDQS Scores were observed. The significant positive values indicated higher adequacy of Magnesium, Total B6, Total folates, Total Ascorbic Acid and Vitamin A with higher positive GDQS(Healthy Food group intake). The significant negative values indicated higher adequacy of Iron, Zinc, Riboflavin and Niacin with lower negative GDQS (Unhealthy food group intake).

TABLE 4.15 GDQS OF THE SUBJECTS (MEAN, SD)

VARIABLE	Female		Male		Total		T test value
	Mean	SD	Mean	SD	Mean	SD	
GDQS +	10.58	2.77	10.93	2.89	10.75	2.83	1.21
GDQS -	11.19	1.97	11.52	1.66	11.35	1.83	1.83
GDQS overall	21.77	3.54	22.45	3.25	22.10	3.42	1.99*

**Significantly different at p<0.05*

TABLE 4.16 GDQS PROFILE OF THE SUBJECTS (N,%)

GDQS cut off	Female N=207		Male N=193		Total N=400	
	N	N%	N	N%	N	N%
High risk	2	1.0	1	0.5	3	0.8
Moderate risk	130	62.8	110	57.0	240	60.0
Low risk	75	36.2	82	42.5	157	39.3

FIGURE 4.6 DISTRIBUTION OF MEAN GDQS SCORES ACROSS DIFFERENT CATEGORIES OF SUBJECTS

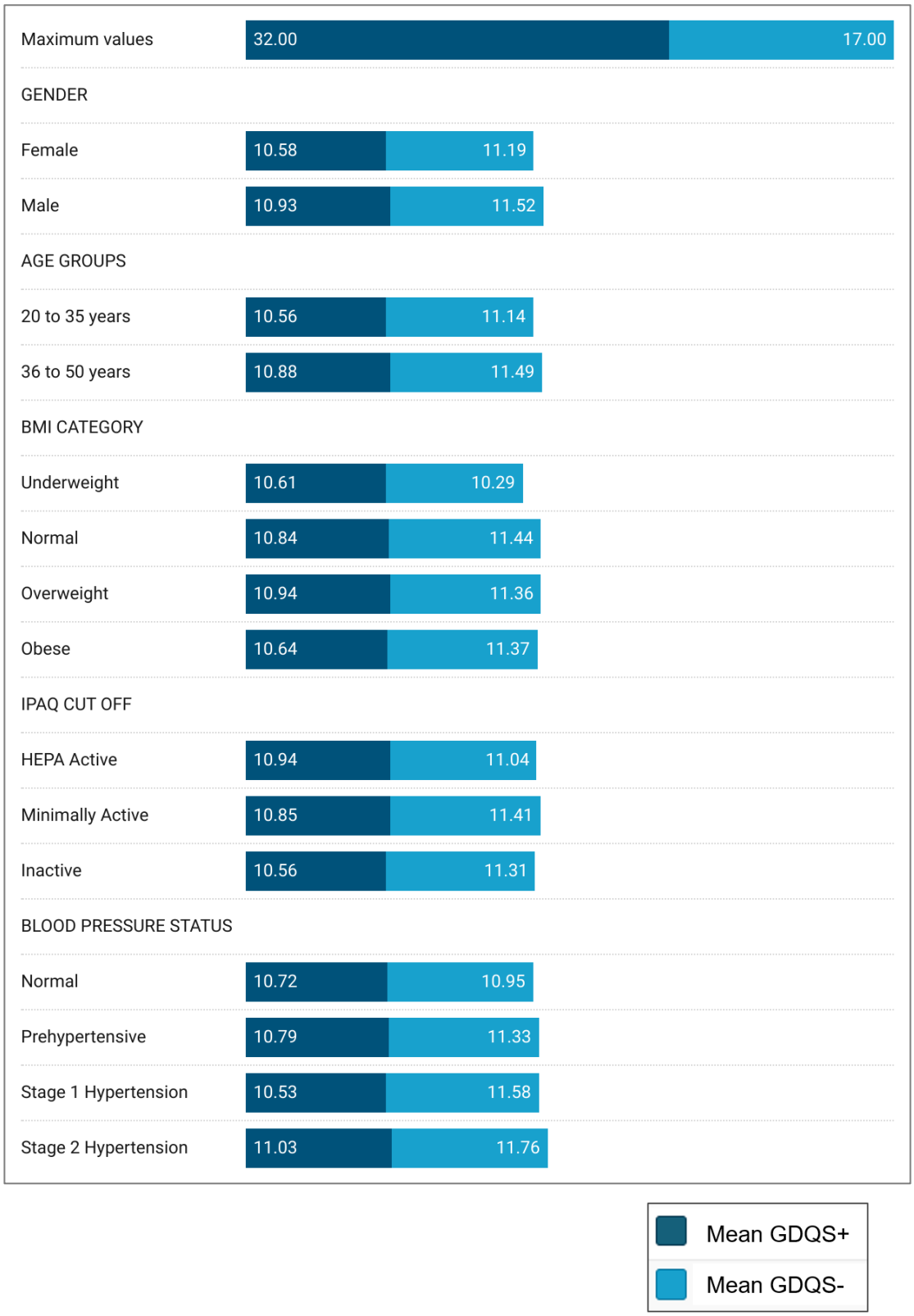


TABLE 4.17 GDQS PROFILE ACROSS BMI (N,%)

GDQS cut off	Underweight						Normal						Overweight						Obese					
	Female N= 10		Male N=4		Total N=14		Female N=57		Male N=54		Total N=111		Female N=29		Male N=46		Total N=75		Female N=111		Male N=89		Total N=200	
	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %	N	N %
High risk <15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1.8	1	1.1	3	1.5
Moderate Risk	8	80	2	50	10	71.4	35	61.4	27	50	62	55.9	17	58.6	27	58.7	44	58.7	70	63.1	54	60.7	124	62
Low risk >=23	2	20	2	50	4	28.6	22	38.6	27	50	49	44.1	12	41.4	19	41.3	31	41.3	39	35.1	34	38.2	73	36.5

TABLE 4.18 GDQS PROFILE ACROSS AGE GROUPS (N,%)

GDQS cut off	20 to 35 years						36 to 50 years					
	Female N=89		Male N=73		Total N=162		Female N=118		Male N=120		Total N=238	
	N	N%	N	N%	N	N%	N	N%	N	N%	N	N%
High risk <15	1	1.1	1	1.4	2	1.2	1	0.8	0	0	1	0.4
Moderate Risk	60	67.4	42	57.5	102	63	70	59.3	68	56.7	138	58
Low risk >=23	28	31.5	30	41.1	58	35.8	47	39.8	52	43.3	99	41.6

TABLE 4.19(a) DISTRIBUTION OF THE CATEGORIES FOR GDQS HEALTHY FOOD GROUP CONSUMPTION (N,%) (Total N= 400)

GDQS Sub metric	GDQS FOOD GROUPS	Low		Middle		High	
		N	N%	N	N%	N	N%
Positive	Citrus fruits	394	98.5	1	0.25	5	1.25
	Deep orange fruits	385	96.25	3	0.75	12	3
	Other fruits	318	79.5	17	4.25	65	16.25
	Dark green leafy vegetables	310	77.5	58	14.5	32	8
	Cruciferous vegetables	235	58.75	28	7	137	34.25
	Deep orange vegetables	400	100	0	0	0	0
	Other vegetables	36	9	177	44.25	187	46.75
	Legumes	29	7.25	6	1.5	365	91.25
	Deep orange tubers	312	78	81	20.25	7	1.75
	Nuts and seeds	287	71.75	32	8	81	20.25
	Whole grains	26	6.5	0	0	374	93.5
	Liquid oils	0	0	1	0.25	399	99.75
	Fish and shellfish	400	100	0	0	0	0
	Poultry and game meat	399	99.75	0	0	1	0.25
	Low-fat dairy	301	75.25	2	0.5	97	24.25
	Eggs	385	96.25	1	0.25	14	3.5

TABLE 4.19(b) DISTRIBUTION OF THE CATEGORIES FOR GDQS HEALTHY FOOD GROUP CONSUMPTION (N,%)
(Total N= 400)

GDQS Sub metric	GDQS FOOD GROUPS	Low		Middle		High		Very High	
		N	N%	N	N%	N	N%	N	N%
Negative	**Unhealthy in excessive amounts**								
	High-fat dairy	20	5	8	2	320	80	52	13
	Red meat	400	100	0	0	0	0	-	-
	Unhealthy								
	Processed meat	399	99.75	0	0	1	0.25	-	-
	Refined grains and baked goods	30	7.5	4	1	366	91.5	-	-
	Sweets and ice cream	130	32.5	195	48.75	75	18.75	-	-
	Sugar-sweetened beverage	388	97	0	0	12	3	-	-
	Juice	393	98.25	0	0	7	1.75	-	-
	White roots and tubers	122	30.5	160	40	118	29.5	-	-
	Purchased fried	291	72.75	27	6.75	82	20.5	-	-

('Very High' consumption category is exclusive to the High fat dairy food group)

FIGURE 4.7(a) LOW, MEDIUM AND HIGH GDQS HEALTHY FOOD GROUP CONSUMPTION (N) (Total N= 400)

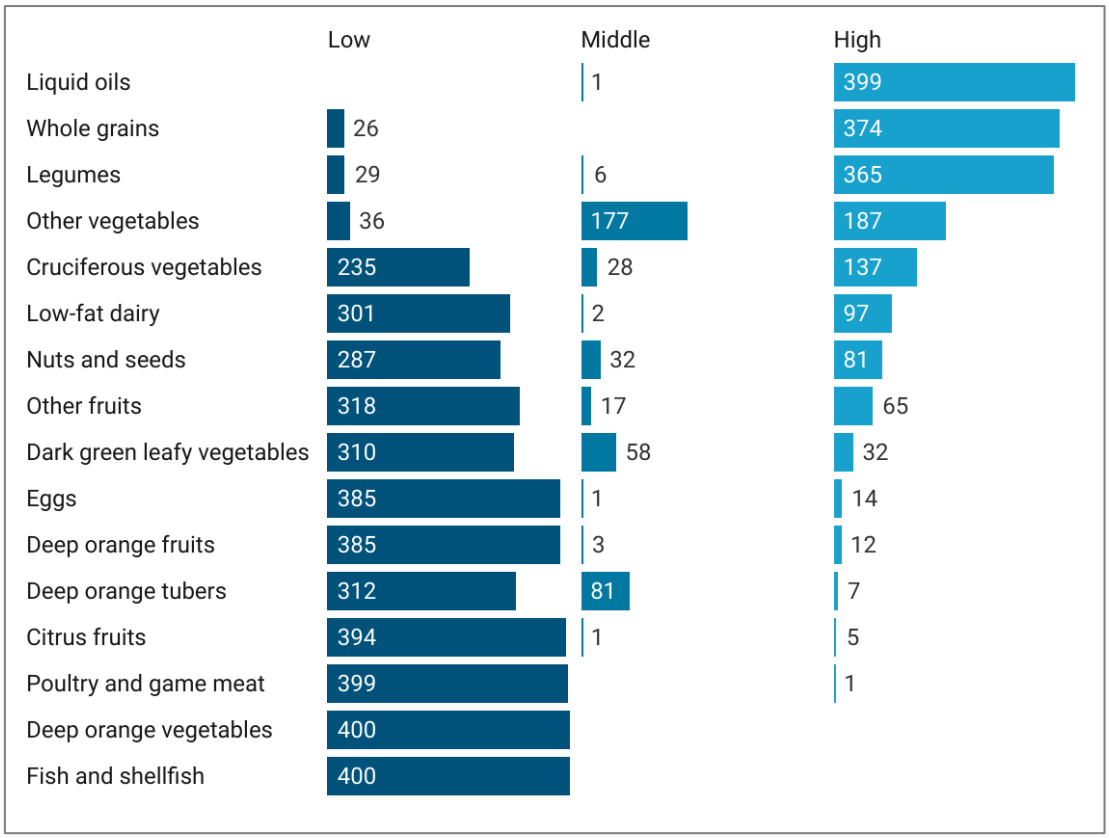


FIGURE 4.7 (b) LOW, MEDIUM, AND HIGH GDQS UNHEALTHY FOOD GROUP CONSUMPTION (N) (Total N= 400)

TABLE 4.20 MACRONUTRIENT INTAKE IN SUBJECTS (MEAN,SD)

MACRONUTRIENTS	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
Energy (Kcal)	1245.81	356.06	1301.04	286.04	1265.14	332.80
Carbohydrate (g)	163.50	47.14	170.25	39.14	165.86	44.42
Protein (g)	39.80	10.25	42.35	13.53	40.69	11.50
Total Fat (g)	46.31	19.49	48.00	13.12	46.90	17.47

TABLE 4.21 MICRONUTRIENT INTAKE IN SUBJECTS (MEAN, SD)

MICRONUTRIENTS	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
Calcium (mg)	488.49	170.89	490.01	196.16	489.02	179.15
Magnesium (mg)	266.33	75.23	289.14	78.94	274.31	76.93
Iron (mg)	9.81	2.87	10.77	3.54	10.15	3.14
Zinc (mg)	6.51	1.71	6.87	1.61	6.63	1.68
Thiamine (B1)(mg)	1.23	2.26	0.92	0.22	1.12	1.83
Riboflavin (B2) (mg)	0.72	.23	0.75	0.22	0.73	0.23
Niacin (B3) (mg)	6.08	1.99	6.31	1.65	6.16	1.87
Total B6 (mg)	0.84	0.22	0.87	0.25	0.85	0.23
Total Folates (B9) (µg)	188.60	63.57	218.29	96.71	198.99	77.64
Total Ascorbic Acid (mg)	65.64	45.70	64.95	45.87	65.40	45.53
Vitamin A, RAE (µg)	406.06	288.86	361.63	157.54	390.51	250.83

TABLE 4.22 FAT INTAKE IN SUBJECTS (MEAN, SD)

VARIABLE	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
Total Saturated Fatty Acids (mg)	17781.4	7115.14	18020.9	6340.48	17865.3	6822.55
Total Mono Unsaturated Fatty Acids (mg)	15934.6	9273.86	16113.9	6556.09	15997.4	8388.55
Total Poly Unsaturated Fatty Acids (mg)	9689.54	5867.53	10810	3717.67	10081.7	5224.13
Total Trans Fatty Acids (mg)	34.45	110.79	52.97	200.12	40.93	147.54
Total Fat (g)	46.31	19.49	48	13.12	46.9	17.47

TABLE 4.23 NUTRIENT ADEQUACY RATIOS (NAR) FROM THE 24-HOUR DIETARY INTAKE OF SUBJECTS (MEAN,SD)

NUTRIENT	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
Carbohydrate	0.99	0.03	1	0	1	0.02
Protein	0.93	0.12	0.88	0.13	0.91	0.13
Total fat	0.99	0.04	0.99	0.03	0.99	0.04
Calcium	0.61	0.20	0.61	0.23	0.61	0.21
Magnesium	0.88	0.16	0.84	0.17	0.87	0.16
Iron	0.65	0.19	0.86	0.16	0.72	0.20
Zinc	0.59	0.16	0.49	0.12	0.56	0.15
Thiamine	0.64	0.18	0.68	0.18	0.66	0.18
Riboflavin	0.39	0.14	0.41	0.15	0.40	0.14
Niacin	0.54	0.18	0.47	0.14	0.52	0.17
Total B6	0.52	0.14	0.48	0.15	0.51	0.15
Total Folate	0.89	0.18	0.77	0.21	0.85	0.20
Total Ascorbic Acid	0.83	0.25	0.76	0.25	0.81	0.25
Vitamin A	0.78	0.25	0.72	0.25	0.76	0.25

TABLE 4.24 MEAN PERCENT ADEQUACY FROM THE 24-HOUR DIETARY INTAKE OF SUBJECTS (MEAN, SD)

	Female		Male		Total	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
RDA ENERGY(%)	63.39	22.32	54.69	14.29	60.34	20.24
MAR (%) (From 14 nutrients)	73.23	10.99	71.30	10.13	72.56	10.69

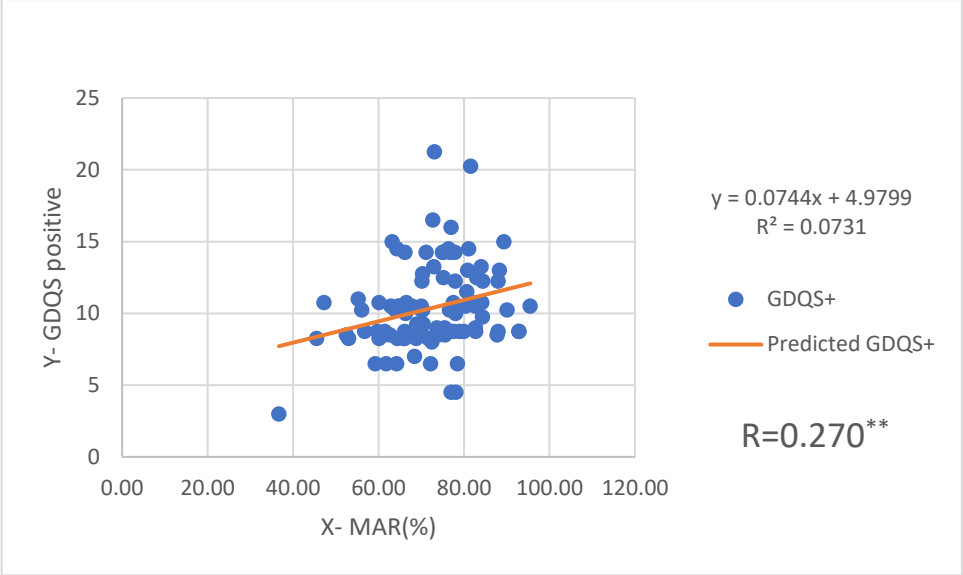
TABLE 4.25 : CORRELATION BETWEEN DIET QUALITY SCORES(GDQS, GDQS+,GDQS-) AND NUTRIENT ADEQUACY (MAR%) (N=100)

Pearson Correlations	**GDQS overall**	**GDQS+**	**GDQS-**
MAR% (Mean Adequacy Ratio)	0.115	0.270**	-0.197*

** *Correlation is significant at the 0.01 level (2-tailed)*

* *Correlation is significant at the 0.05 level (2-tailed)*

FIGURE 4.8 CORRELATION BETWEEN GDQS SUBMETRICS AND MEAN ADEQUACY RATIO (%)



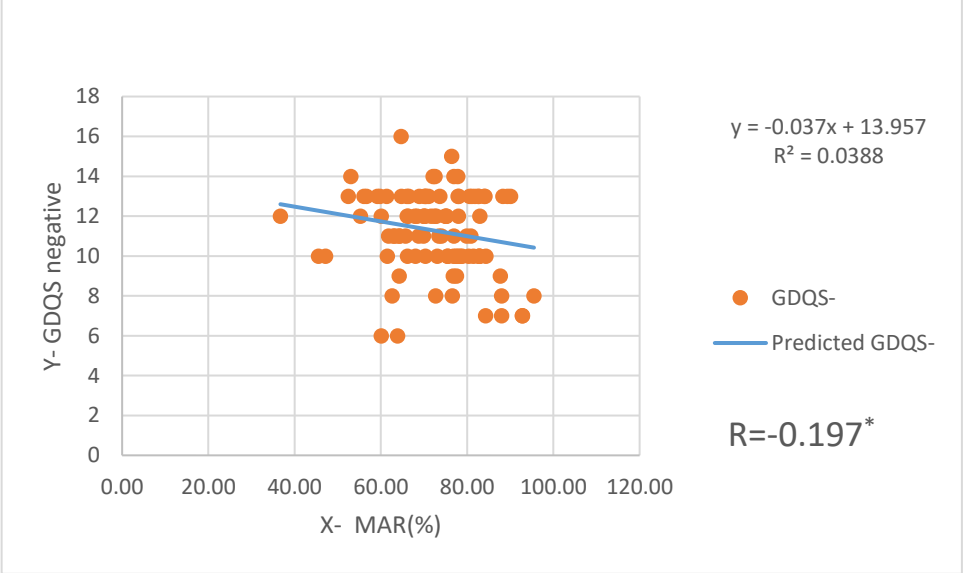


FIGURE 4.9 RELATION BETWEEN GDQS PROFILE AND NUTRIENT ADEQUACY OF SUBJECTS (%)

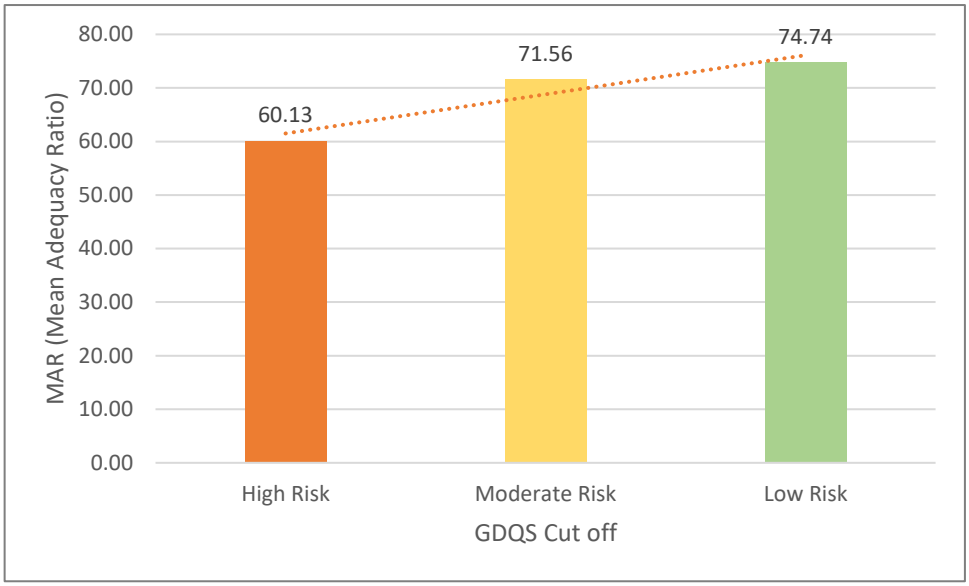


TABLE 4.26 CORRELATION BETWEEN DIET QUALITY SCORES AND NUTRIENT ADEQUACY (N=100)

NUTRIENT ADEQUACY RATIO	R VALUES		
	GDQS+	GDQS-	GDQS overall
NAR Carbohydrate	0.195	-0.087	0.115
NAR Protein	0.158	-0.164	0.039
NAR Total fat	-0.018	0.094	0.039
NAR Calcium	0.031	-0.046	-0.001
NAR Magnesium	0.312**	-0.192	0.154
NAR Iron	0.176	-.272**	-0.008
NAR Zinc	0.108	-.273**	-0.066
NAR Riboflavin	0.038	-.267**	-0.123
NAR Niacin	0.130	-.370**	-0.104
NAR Total B6	0.255*	-0.194	0.104
NAR Total Folate	0.285**	-0.032	0.224*
NAR Total Ascorbic Acid	0.249*	0.039	0.234*
NAR Vitamin A	0.230*	0.134	0.273**
**. Correlation is significant at the 0.01 level (2-tailed).			
*. Correlation is significant at the 0.05 level (2-tailed).			

DISCUSSION

India is a diverse country and is currently passing through an epidemiological health transition with high rates of urbanisation, which has led to economic improvement, the consequences of which are increased food consumption, tobacco-use, and decreased physical activity. One of the effects of this economic transition is a shift in the disease spectrum from communicable to non-communicable diseases (NCDs) (Bhagyalaxmi, 2013).

Hence the present study was conducted in adult population of Urban Vadodara to assess the NCD risk and Diet Quality among the participants, and the results of the same are discussed here. Previous attempts to characterise dietary patterns in India have several shortcomings in terms of data availability or analysis methods and have typically focused either on undernutrition or NCD risks but not both(Joy et al., 2017). In the present study both quality of diet and associated health outcomes among Indian adults were determined to examine the association of the identified diet quality profile with macro- and micronutrient intakes and key NCD risk factors: BMI, WC, WHR, WSR, systolic or diastolic blood pressure, physical inactivity.

In the present study, the mean age of the subjects was 37± 10 years. Majority of the subjects were graduates. 72% of the subjects were married and 32.8% were involved in service. Nearly 50.5% of the subjects had per capita income between Rs. 10,000 to 20,000.

On analysing the socioeconomic status of the subjects, most subjects (72.25%) belonged to Upper Middle class. All subjects resided in an urban locality, 76.75% owned at least one four wheeled vehicle. All subjects had adequate water and electricity resources with proper drinking water, drainage, and garbage disposal facilities. This suggested the possible less risk of the population for communicable disease burden with respect to proper sanitation and hygiene.

Majority of the subjects had a strong history for Hypertension, Diabetes, and stroke. Past studies reveal that the risk of becoming hypertensive for an individual with a family history of hypertension has been estimated to be up to four times higher than average and similarly having a parent with non-insulin-dependent diabetes mellitus (NIDDM) increases offspring's chance of developing this condition two- to four-fold. (Van Der Sande et al., 2001)

In the present study, prevalence of self-reported Hypertension (7%) was highest, followed by 4.25% for diabetes. The mean height of the subjects was 163.68 ± 9.20 cm, average weight was 68.11 ±12.29 kg, and mean BMI was 25.47 ± 4.53, which is categorised as obese. About 50% of the study population was categorised as obese. Abdominal obesity parameters were also observed on higher side, most subjects had an average waist circumference (WC) as 89.35 ±

10.04 cm, average hip circumference (HC) as 101.44 ± 9.10 cm, average waist height ratio (WHR) as 0.88 ± 0.07, and an average waist stature ratio (WSR) as 0.55 ± 0.06.

In a study conducted by ICMR- INDIA B in 3 states and 1 union territory, the prevalence of obesity observed was significantly higher among Urban residents than rural residents in all regions studied, along with significantly higher weight, BMI, waist circumference, Diastolic BP and fasting and 2h post glucose CBG. Along with that, a higher mean BMI was found in women than men, while higher mean Waist Circumference were found in men. Another study conducted in adult population of Urban Delhi rural Haryana revealed that overweight prevalence was more in urban areas (M= 35.1%, F=47.6%) than rural areas (M=7.7%, F=11.3%) (Mohan et al., 2016).

The abdominal obesity in subjects, according to WC cut off (69.50%), WHR cut off (53%) and WSR cut off (67.25%) was found to be highly prevalent, which indicated a high risk of NCDs in the subjects. Abdominal Obesity (AO) has seen a definite increase over the years and its consequences have been reported in the form of NCDs in many studies. The concept of "Thin Fat Indian" has arisen as a result of its frequency among Indians, which has its roots in pregnancy and the foetal stage. It has been positively related to non-communicable diseases (NCDs) in various researches, as excess of visceral fat facilitates high dosage of adipokines in the portal vein to liver and other body tissues having serious implications seen in the form NCDs like diabetes, hypertension, heart diseases, non-alcoholic fatty liver diseases, kidney disorders, cancer and other health problems (Dhawan & Sharma, 2020).

The mean systolic blood pressure was 123.01 ± 14.94 mmHg and mean diastolic blood pressure was 84.78 ± 10.35 mmHg. 49% of the subjects were Prehypertensive and 31.25% was reported Hypertensive (Stage 1 and 2), indicating the subjects having high risk of developing Hypertension in near future. Significant correlation was found between BMI and Hypertension, indicating that with increase in BMI there was an increase in the SBP and DBP.

A study on prevalence and correlates of prehypertension among adults was conducted in Urban South India, on 624people >20 years of age, showed similar results and reported 55% prevalence of prehypertension and 30% prevalence of Hypertension. The study concluded that Increasing age, male gender, lack of physical activity, obesity, tobacco and alcohol use, and family history of chronic diseases are associated with prehypertension and hypertension(Parthaje et al., 2016).

Another cross-sectional study in Indian population of 5347 adults of an established urban longitudinal population cohort of West Bengal reported nearly one third of the adult cohort as

hypertensive and only one fifth was doctor diagnosed. Obese persons were significantly associated with diagnosed hypertensive people [AOR = 3.21, 95% CI: (2.48–4.16), p < .0001] (Chand Chauhan et al., 2016).

Obesity is found to be significantly associated with Hypertension, many intervention studies also suggest that modest weight loss can help to prevent two of the most common conditions associated with obesity: hypertension and type 2 diabetes (J Vidal, 2002).

Physical Activity of the subjects were assessed based on the categorisation of their MET minutes/week. Mean MET minutes/week observed in the subjects was 1085.1 ± 1046.6. Majority of the subjects (57.3%) were categorised as "Minimally Active" while 36.3% were classified as "Inactive".

Reports from LMIC World Health Survey data from 2002–04, in which 232056 participants from 48 countries (23 of which were LMICs) were reported suggested that those with more education and assets were more likely to be physically inactive and consume insufficient fruit and vegetables, and less likely to smoke daily than were those with a lower level of education and of low socioeconomic status (Allen MPH et al., 2017). Similar results were found in the present study population, as self-reported alcohol and smoking addiction were negligible, and only 6.5% were found to be HEPA active or physically active with MET minutes/week>3000.

Similar results were again found in ICMR- INDIA-B study, where 54.4% out of the 14227 subjects were inactive and it was reported that subjects were more inactive in urban, compared to rural, areas (65.0% vs. 50.0%; p < 0.001) (Mohan et al., 2016).

It is evident from the observations that family history of various chronic diseases, Obesity, Hypertension, Physical Inactivity all are key risk factors associated with burden of NCDs in a population. Poor nutrition has also been identified as a major modifiable risk factor in the Global targets for NCD prevention.

A study was conducted amongst the 7067 migrant factory workers, their rural dwelling siblings and urban non migrants, the results showed that Dietary pattern membership was associated with several NCD risk factors. Mean (unadjusted) levels of NCD risk factors differed between the dietary patterns and suggested that despite its high total energy content, consumers of the mixed ‘Wheat, rice & oils’ pattern had the most favourable health profile(Joy et al., 2017). This suggests the concept of Diet Quality as a measure of assessment, where along with the quantity the aspect of quality (healthy/unhealthy) food group consumption is taken into consideration.

Across the literature, diet quality has been described as an umbrella term frequently used to describe how well an individual's diet conforms to dietary recommendations. To reflect different facets of diet quality, many dietary indicators have been created, evaluated, and validated. These range in complexity from straightforward methods for tracking dietary guidelines to intricate indexes requiring in-depth examination of macronutrient and micronutrient consumption (Alkerwi, 2014).

Although many diet quality metrics have been developed and used, there is still not a widely acceptable, relatively simple, and validated metric to measure diet quality [defined as both adequate in nutrients and protective against diet-related noncommunicable disease (NCD) risk outcomes] in population-based surveys in settings across the country. The Global Diet Quality Score (GDQS) was designed to fill this absence, thereby providing a simple, standardized metric appropriate for population-based measurement of diet quality globally.(Deitchler & Bromage, 2021)

In the present study, GDQS were used to determine quality of diet and further correlate with prevalence of NCD risk factors and nutrient adequacy. GDQS consists of GDQS overall and GDQS sub metric scores- positive and negative. GDQS+ consists of scoring from consumption of 16 'healthy' food groups, GDQS- consists of scoring from consumption of 7 'unhealthy' food groups and 2 'unhealthy in excess amount' food groups. Mean GDQS overall of subjects was 22.10 ± 3.42, mean GDQS+ was 10.75±2.83 and mean GDQS- was 11.35±1.83. It was observed that contribution to overall GDQS is more from negative score, indicating more intake of unhealthy food groups than healthy food groups.

On categorisation based on overall scores, Majority (60%) of the subjects belonged to the Moderate risk category, followed by 39.3% in Low-risk category and 0.8% in the High-risk category.

On analysing GDQS profile across BMI cut offs, all subjects in the high-risk category of poor dietary outcomes according to GDQS were obese(1.5% of total obese subjects). Most percentile of subjects in the moderate risk category were Overweight (58.7% of total overweight subjects) and most percentile of subjects in the low risk category were normal subjects (44.1% of total normal subjects). This clearly depicts direct association of GDQS with NCD risk factor of Obesity and Overweight. Similar association was seen in a study conducted to test the utility of the GDQS, where secondary data of a Nurses' Health Study II was used, where Health, lifestyle, and diet information were collected from US women (n = 68,336) for 4 years. For each 5-point increase in GDQS, weight gain was 0.83 kg less for age <50 y compared with 0.71 kg less for

age >= 50 y *($p < 0.05$).*This depicted a significant association of Obesity with GDQS scores (Deitchler & Bromage, 2021).

GDQS profile across age groups depicted more percentage of younger subjects (20 to 35 years) in high risk and moderate risk category, depicting poor diet quality outcomes to be more prevalent in younger subjects.

In the scoring of GDQS, each of the food groups in GDQS sub metrics (healthy and unhealthy) have a fixed cut off allotted, according to which the consumption of the food group is categorised as Low/ Medium/High, which further has points encoded, the sum of which constitutes the GDQS overall value. With the food group consumption rates, the overall dietary pattern of the population could be analysed. In the present study, highest consumption amongst healthy food groups was of liquid oils and lowest consumption was of deep orange vegetables and seafood. Amongst unhealthy food groups, very high consumption was of high-fat dairy, high consumption was of refined grains and baked goods, and lowest consumption was of red meat. An overall high consumption of whole grains and oils and high fat dairy was seen in the population, whereas consumption of meats and seafood was negligible.

To correlate GDQS with nutrient adequacy, 24-hour dietary recall was collected on a subsample of 100 subjects. The Mean energy intake was 1245.81 ± 356.06 kcal for females and 1301.04 ± 286.04 kcal for males, with a total mean intake of 1265.14 ± 332.80 kcal. Mean carbohydrate intake was 163.50 ± 47.14g for females and 170.25 ± 39.14g for males, with a total mean intake of 165.86 ± 44.42 g. Mean protein intake was 39.80 ± 10.25g for females and 42.35 ± 13.53g for males, with a total mean intake of 40.69 ± 11.50g. The mean values when compared with recommended requirements of the macronutrients , clearly depicts the prevalence of energy deficit diet in the population. The mean values of fat intake showed high intake, while mean intake values of micronutrients leaned more towards inadequacy. To clearly understand the adequacy levels, Nutrient adequacy Ratios(NARs) were computed using the Estimated average requirements according to the age, gender and physical activity of the individual. The value of NAR was between 0 to 1, it was capped at 1 to avoid masking inadequacies of other nutrients while calculating mean values. Mean NARs for carbohydrate, protein, and total fat were close to 1 for both females and males, indicating adequate intake of these nutrients in subjects. Mean NARs for calcium, zinc, thiamine, riboflavin, niacin, and vitamin A were lower than 1, suggesting inadequate intake. Standard deviation values were relatively high for some nutrients, indicating a large variation in nutrient intake among the population.

Using the NARs, a Mean Adequacy Score was computed to define the overall nutrient adequacy of the subjects. Females had a mean MAR of 73.2 ±10.99%, while males had a mean MAR of 71.3±10.13%.The total average for MAR (%) was 72.5±10.69% in the population of the study.

Correlation of GDQS, GDQS+ and GDQS- with nutrient adequacy in terms of MAR% and NAR values was done. Methods involved included computing Pearson correlation between the metrics and continuous diet adequacy values. A positive correlation *(R=0.270**)* with *(p<0.01)* indicating an increase in GDQS+ led to an increase in MAR, conversely, a decrease in GDQS+ leads to a decrease in MAR. A minimally significant negative correlation *(R=-0.197*)* was also observed between *GDQS*- and MAR values, indicating inverse relation between unhealthy food group consumption with nutrient adequacy. On analysing GDQS profiles of Low/ high and moderate risk of poor dietary outcomes with continuous nutrient adequacy values, it was concluded Subjects with a high-risk GDQS profile have lower nutrient adequacy, while those with a low-risk GDQS profile have higher nutrient adequacy.

On computing correlations between individual nutrient adequacies with metric scores, higher adequacy of Magnesium *(R=0.312**)* , Total B6 *(R=0.255**)*, Total folates *(R=0.285**)*, Total Ascorbic Acid *(R=0.249*)*, and Vitamin A *(R=0.230*)* was observed with higher positive GDQS (Healthy Food group intake). While Higher adequacy of Iron *(R= -0.272**),* Zinc*(R= -273**),* Riboflavin*(R= -0.267**)*, and Niacin*(R= -0.370**)* was observed with lower negative GDQS (Unhealthy food group intake).
Similar study to evaluate GDQS against other diet metrics in capturing nutrient adequacy and undernutrition in rural SSA adults reported The Global Diet Quality Score is inversely associated with nutrient inadequacy, Low Mid upper Arm Circumference, and Anaemia. Results stated similar positive Correlations between the GDQS and an energy-adjusted aggregate measure of dietary protein, fiber, calcium, iron, zinc, vitamin A, folate, and vitamin B-12 adequacy were 0.34 in men and 0.37 in women. It was concluded that GDQS performed comparably with the MDD-W in capturing nutrient adequacy–related outcomes in rural SSA (Deitchler & Bromage, 2021).

More similar findings were observed from secondary analysis of diet intake from Andhra Pradesh Children and Parents Study (APCAPS) and the Indian Migration Study (IMS) which included data from 3041 nonpregnant women of reproductive age (15–49 years), the results reported mean GDQS as 23 points (SD, 3.6; maximum, 46.5). In energy-adjusted models, positive associations were found between the overall GDQS and GDQS+ and intakes of calcium, fiber, folate, iron, monounsaturated fatty acid (MUFA), protein, polyunsaturated fatty acid (PUFA), saturated fatty acid (SFA), total fat, and zinc ($\rho = 0.12–0.39$; $P < 0.001$). Quintile

analyses showed that the GDQS was associated with better nutrient adequacy. At the same time, the GDQS was associated with higher TC, lower HDL, and higher BMI (Deitchler & Bromage, 2021).

Thus, from the evidence of the various validation studies and findings of the present study, the NCD risk and prevalence of various risk factors could be understood in the study population, and a need for a novel diet assessment tool to understand the dietary patterns for the further management and interventions on population level was identified. Diet Quality assessment tool GDQS was correlated with nutrient adequacy and it was found to be indicative of the poor diet outcomes and NR-NCDs. Thus, the results of this study shows that the GDQS is a simple novel tool to assess diet quality which would be helpful in assessing the NCD risk among the Indian population.

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

With the increased Global burden of Non – Communicable diseases, the need of the hour is to understand the risk factors associated with the rise, and work on effective interventions to combat it. Dietary deficiencies in protein, energy, and micronutrients continue to add to the dual burden of undernutrition in the majority of LMIC (Low-and-Middle income Countries) including India, and pose a further threat to people's health and way of life. These deficiencies also increase the risk of noncommunicable disease (NCD) mortality and metabolic risks. Hence, it becomes crucial to have a method for performing routine nutritional assessments and comprehending population patterns and take steps towards necessary interventions. Numerous nutritional assessment techniques, including food records, food diaries, 24 hour recalls, FFQ, etc., have traditionally been employed; nevertheless, most of these have a significant respondent burden for a population-based assessment. A few new approaches are already emerging that use diet diversity and diet quality measurement as a basis for population based. The phrase "diet quality" has become popular in the last two decades in the scientific literature, most frequently in nutritional epidemiology, to assess dietary practices and the effectiveness of dietary treatments.

Two such tools which use minimum dietary diversity and diet quality scores as the means of analysis are DDQ (Diet Diversity Questionnaire) and GDQS (Global Diet Quality Score), they are said to place less strain on respondents while data collection. A completely food-based metric and semi-quantitative method for evaluating diet quality is the GDQS. It is designed to be sensitive to diet-related outcomes associated with both undernutrition and overnutrition. To enable a more sensitive evaluation of healthy diets, GDQS incorporates a measure of consumption quantity into the metric scoring and uses an expanded selection of food groups compared to most other basic food-based metrics.

With this background, the current study was planned to assess the quality of diet, anthropometric, biophysical parameters and physical activity patterns and understand the prevalence of NCD risk factors of adults residing in urban Vadodara. The study also aimed to correlate the GDQS as a diet quality assessment tool in adult Indian population and with 24-hour dietary recall data. The study was conducted on 400 subjects enrolled from 4 administrative zones of Vadodara. The subjects in the most productive age group of 20-50 years were enrolled for the study and data was collected with respect to General Information, Socio Economic Status, Medical History, Anthropometric and Bio-physical Measurements, Physical Activity and Dietary recall using GDQS tool and 24 hr recall (for a subset of 100 subjects).

The observations obtained in the study are summarised under the following sub heads:

1. Background Information and Socio-economic Status
2. Medical and Family History
3. Anthropometric and Bio-physical Measurements
4. Physical Activity level
5. Dietary Intake analysis from GDQS and 24-hour recall

1. BACKGROUND INFORMATION AND SOCIO-ECONOMIC STATUS

The background information was assessed using a semi structured questionnaire and the socio-economic status was assessed using a pre tested questionnaire and categorised with Aggarwal Scale (2005).

BACKGROUND INFORMATION

- The gender distribution was almost equal, with 207 females and 193 males.
- The mean age of the subjects was 37 ± 10 years
- Most of the subjects (96.5%) followed Hindu religion, while only 0.5% followed Muslim religion.
- 56.8% of the subjects were graduates, and 0.3% were illiterate.
- 72% of the subjects were married.
- 47% of the subjects lived in an extended family setup, while 41% lived in a nuclear family setup.
- 32.8% of the subjects were involved in service as an occupation.
- 87% of the subjects had a family monthly income > 46,095 income slab.
- 50.5%, that is most of the subjects had a per capita income between 10,000 to 19,999.
- 85.3% of the subjects had no significant other source of income, while 7.3% had agriculture as another source of income in the family.

SOCIO ECONOMIC STATUS

- All subjects were classified into three categories of socio-economic status (SES): High, Upper Middle, and Lower Middle.
- Majority (72.25%) of the subjects were from Upper Middle SES.
- The head of the family (HOF) for most subjects were graduates (52.5%) and were employed in the private sector or independent business (47.25%).
- 66% of the subjects lived in their own house with 3-4 rooms.

- 76.75% of the subjects owned a four-wheeled vehicle.
- All subjects had water and electricity supply, private tap as water supply, Aquagaurd/RO as drinking water type, private toilet facility, closed drainage facility, and the majority (98.5%) had VMSS van as the garbage disposal facility.
- All subjects resided in an urban locality, and all children in the house were going to school/college.
- Most subjects (40.25%) had only one family member earning.

2. MEDICAL AND FAMILY HISTORY

The medical and family history of the subjects was reported using a semi structured questionnaire.

FAMILY HISTORY OF DISEASES AMONG THE SUBJECTS

- The family history of the subjects showed the highest prevalence of hypertension (67.5%) and diabetes mellitus (40.3%), followed by stroke (11.8%).
- Diabetes was equally prevalent in the mothers and fathers of the subjects (13.25%), while hypertension (23%) and hypo/hyperthyroidism (4.75%) were more prevalent in mothers.
- CHD (3%) and Hyperlipidemia (2.75%) were observed to have a higher prevalence rate in fathers of the subjects.
- Stroke (7.75%), asthma (1%), and cancer (3.75%) were more prevalent in grandparents of the subjects.

MEDICAL HISTORY OF SUBJECTS

- The prevalence of hypertension was found to be 7%, followed by 4.25% for diabetes.
- The prevalence of self-reported alcohol and smoking addiction was negligible.
- More than 3/4th of the subjects (76.5%) had at least one disease present in their family history or were suffering from one themselves.

3. ANTHROPOMETRIC AND BIO-PHYSICAL MEASUREMENTS

The Anthropometric measurements of the subjects was taken using standardised tools, a non-stretchable fiberglass measuring tape for WC, HC, and height of the subject and bathroom scale for weight. Sphygmomanometer was used to record blood pressure parameters.

- Mean height: 163.68 ± 9.20 cm, average weight: 68.11 ±12.29 kg, and mean BMI: 25.47 ± 4.53, categorised as obese.

PREVALENCE OF UNDERWEIGHT, OVERWEIGHT AND OBESITY AMONG THE SUBJECTS

- Abdominal obesity was prevalent in most subjects, having an average waist circumference (WC) to be 89.35 ± 10.04 cm, average hip circumference (HC) as 101.44 ± 9.10 cm, average waist height ratio (WHR) to be 0.88 ± 0.07, and an average waist stature ratio (WSR) of 0.55 ± 0.06.
- Obesity was found to be prevalent amongst 50% of subjects, followed by 18.75% overweight and 3.5% underweight.
- The prevalence of overweight was higher in males (23.83% vs. 14.01%) while the prevalence of obesity (53.62%) and underweight (4.83%) was higher in females.
- Majority of obese subjects (71.50%) fell in the Obesity class 1 category.
- All anthropometric indices except height were significantly higher in the older age group (36 to 50 years) compared to the younger age group (20 to 35 years).
- Prevalence of overweight was similar in both age groups, but obesity prevalence was higher in the older age group (59.7% vs. 35.8%).

PREVALENCE OF PREHYPERTENSION AND HYPERTENSION

- The mean systolic blood pressure was 123.01 ± 14.94 mmHg and mean diastolic blood pressure was 84.78 ± 10.35 mmHg.
- Majority of subjects were Prehypertensive (49%) or in Stage 1 Hypertension (20.75%).
- Prehypertension and Stage 1 Hypertension were more prevalent in male subjects.
- Obese subjects were mostly Hypertensive (Stage 1 and 2) and pre-hypertensive, while normal BMI subjects had normal blood pressure.
- There was a significant positive correlation between BMI and both systolic and diastolic blood pressure values, indicating that as BMI increases, blood pressure tends to increase.

4. PHYSICAL ACTIVITY LEVEL

The physical activity of the subjects was assessed with the help of the IPAQ(International Physical Activity Questionnaire) and accordingly MET minutes/week were tabulated and subjects were then categorised in the three categories of activity level.

- The mean MET minutes/week of the subjects were 1085.1 ± 1046.6, categorised as "Minimally Active".
- Female subjects were found to be more active than male subjects based on mean values.
- Majority of the subjects (57.3%) were categorised as "Minimally Active" while 36.3% were classified as "Inactive".
- Only 6.5% of the subjects qualified for the HEPA Active Category.
- BMI and physical activity were found to be negatively correlated, and with decreasing physical activity, BMI tended to increase.
- Majority of normal, overweight, and obese subjects were leading a minimally active or inactive lifestyle.

5. DIETARY INTAKE ANALYSIS FROM GDQS AND 24-HOUR RECALL

The diet recall of previous day was taken for all 400 subjects with the help of GDQS tool developed by Intake. 24-hour intake was taken for a subset of the population, that is 100 subjects.

GLOBAL DIET QUALITY SCORE

- Mean GDQS overall of subjects was 22.10 ± 3.42.
- Mean GDQS+ was 10.75±2.83 and mean GDQS- was 11.35±1.83.
- Contribution to overall GDQS is more from negative score, indicating more from unhealthy food groups than healthy food groups.
- Overall GDQS of male subjects (22.45±3.25) was significantly higher than female subjects (21.77±3.54).
- Majority (60%) of the subjects belonged to the Moderate risk category, followed by 39.3% in Low-risk category and 0.8% in the High-risk category.
- GDQS- is higher across all categorizations indicating a higher intake of unhealthy food groups across all genders, age groups and subjects with various NCD risk factors.
- All subjects in the high-risk category of poor dietary outcomes according to GDQS were obese.
- 71% of underweight subjects fell in the moderate risk category.
- Poor diet quality outcomes were observed to be more prevalent in younger age groups of 20-35 years of age.
- Most of the study population fell into the lowest category for quantity of consumption for fish and shellfish, deep orange vegetables, red meat, poultry and game meat,

processed meat, citrus fruits, juice, sugar-sweetened beverage, deep orange fruits, and eggs.

- Most of the subjects occupied the highest category for quantity of consumption for liquid oils, whole grains, refined grains and baked goods, legumes, and high-fat dairy.
- Highest consumption amongst healthy food groups was of liquid oils and lowest consumption was of deep orange vegetables and seafood.
- Amongst unhealthy food groups, very high consumption was of high-fat dairy, high consumption was of refined grains and baked goods, and lowest consumption was of red meat.

24 HOUR DIETARY RECALL

- Mean energy intake was 1245.81 ± 356.06 kcal for females and 1301.04 ± 286.04 kcal for males, with a total mean intake of 1265.14 ± 332.80 kcal.
- Mean carbohydrate intake was 163.50 ± 47.14g for females and 170.25 ± 39.14g for males, with a total mean intake of 165.86 ± 44.42 g.
- Mean protein intake was 39.80 ± 10.25g for females and 42.35 ± 13.53g for males, with a total mean intake of 40.69 ± 11.50g.
- (Nutrient Adequacy Ratio) NARs for carbohydrate, protein, and total fat were close to 1 for both females and males, indicating adequate intake.
- Mean NARs for calcium, zinc, thiamine, riboflavin, niacin, and vitamin A were lower than 1, suggesting inadequate intake.
- Standard deviation values were relatively high for some nutrients, indicating a large variation in nutrient intake among the population.
- (Mean Adequacy Ratio) MAR (%) reflects overall nutrient adequacy of an individual's dietary intake.
- Females had a MAR of 73.23% on average, with a standard deviation of 10.99%.
- Males had a MAR of 71.30% on average, with a standard deviation of 10.13%.
- The total average for MAR (%) was 72.56%, with a standard deviation of 10.69%.

CORRELATION BETWEEN DIET QUALITY AND NUTRIENT ADEQUACY

- The Mean Adequacy Ratio (MAR) has a significant positive correlation with GDQS + SCORE ($p<0.01$) and a significant negative correlation with GDQS – SCORE ($p<0.05$).

- An increase in GDQS+ leads to an increase in MAR, indicating an increase in nutrient adequacy. Conversely, a decrease in GDQS+ leads to a decrease in MAR, indicating nutrient inadequacy.
- Subjects with a high-risk GDQS profile have lower nutrient adequacy, while those with a low-risk GDQS profile have higher nutrient adequacy.
- Significant correlations were observed between nutrient intake and GDQS Scores on computing individual Nutrient adequacy ratios with the GDQS.
- Higher adequacy of Magnesium, Total B6, Total folates, Total Ascorbic Acid, and Vitamin A was observed with higher positive GDQS (Healthy Food group intake).
- Higher adequacy of Iron, Zinc, Riboflavin, and Niacin was observed with lower negative GDQS (Unhealthy food group intake).

CONCLUSIONS AND RECOMMENDATIONS

The results of the study indicated that the prevalence of NCD Risk factors : Self and Family history of comorbidities, Obesity/Overweight, Abdominal Obesity, Physical inactivity and Raised blood pressure (Hypertension), Nutrient Inadequacy were significantly high, indicating that there is an increased risk of NCDs in the study population. The prevalence of Undernutrition was less but the inadequacy in percent intake of recommended dietary allowance across all macro and micronutrients was observed.

Consumption of healthy, nutrient-dense foods may serve to replace unhealthy foods in the diet, or contribute directly to improved metabolic health as depicted by mean diet quality scores (via Global Diet Quality Scores). Mean Adequacy of nutrient consumption from 24-hour recall was found significantly correlated with GDQS+ (sub metric of GDQS from healthy food group consumption). GDQS scores revealed to have more contribution from negative sub metric than the positive one, indicating more intake of food groups categorised as Unhealthy.

Diet quality indices thus can be taken as a more convenient, reliable, and indicative measure when assessing Non communicable disease risk for a population and are indicative both ends of poor diet related outcomes- Undernutrition and Overnutrition at once.

The GDQS tool, being a semi quantitative tool has a lower respondent burden than 24-hour dietary recall and other conventional dietary assessment tools, can be used to compute diet quality in population-based data, because diet quality is found to be directly associated with Nutrient adequacy, this can result in more resources being spent on interventions and actions aimed at improving population’s nutrition related NCD outcomes.

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ANNEXURES

ANNEXURE I

सत्यं शिवं सुन्दरम्
Estd. 1949

Institutional Ethics Committee for Human Research (IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2022 – 2023

This is to certify that Ms. Drishti Gupta's study titled, "**Diet Quality and Non-Communicable Disease Risk Assessment in Adult Population of Urban Vadodara**" from Department of Foods and Nutrition has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/MSc/2022/36.**

Prof Mini Sheth
Member Secretary
IECHR

Prof Shagufa Kapadia
Chairperson
IECHR

ANNEXURE II

QUESTIONNAIRES

BACKGROUND INFORMATION:

1. Respondent No.:
2. Name of the respondent:
3. Date of Birth (DD/MM/YYYY):
4. Age (years):
5. Gender:
6. City:
7. Address:
8. Contact No.:
9. E-mail id:
10. Religion:
    a) Hindu
    b) Muslim
    c) Sikh
    d) Christian
    e) Jain
    f) Buddhist
    g) Others (specify)
11. Educational status:

a) Professional qualification with technical degrees or diplomas e.g., Doctor, Eng. CA, MBA)
b) Postgraduation (non-technical incl. Ph.D.)
c) Graduation
d) 10th class pass but <Graduation
e) Primary pass but $<10^{th}$
f) <Primary but attended school for at least one year
g) Just literate but no schooling
h) Illiterate

12. Marital Status:
    a) Unmarried
    b) Married

c) Separated
d) Divorced
e) Widowed

13. Occupation:

a) Business
b) Service
c) Self employed
d) Student
e) Laborer
f) Retired
g) Unemployed
h) Housewife

14. Type of family:

a) Nuclear
b) Joint
c) Extended

15. Total no. of family members_____ Adult : _____ Child : _____

SOCIO- ECONOMIC STATUS BASED ON THE AGGARWAL (2005) SCALE:

Q 1. Education of HOF : _____

1. Professional qualification with technical degrees or diplomas e.g., Doctor, Eng. CA, MBA)
2. Postgraduation (non-technical incl. Ph.D.)
3. Graduation
4. 10th class pass but <Graduation
5. Primary pass but <10th
6. <Primary but attended school for at least one year
7. Just literate but no schooling
8. Illiterate

Q 2. Occupation of HOF: _____

1. Service in central/State/Public undertakings or Owner of a company employing > 20 persons or self-employed professional viz Doctors, CAs, Eng. Etc.
2. Service in Private sector or independent business employing 2-20 persons
3. Service at shops, home, transport, own cultivation of land
4. Self-employed e.g., shops, Rehdies or petty business with income >5000

5. Self-employed with income <5000 (labourer, house wife)

6. None of the family member is employed

Q 3. Total monthly income of the family : (updated income slabs)

1. ≥ 1,84,376
2. 39,033–78,062
3. 29,200 –39,032
4. 19,516–29,199
5. 11,708 – 19,515
6. 3,908 – 11,707
7. ≤ 3,907

Q 4. Other source of income : _____

1. Agriculture 2. Poultry 3. House rent 4. Others (Specify) _____

Q 5. Monthly per capita income from all sources : _____

1. >50000
2. 20000-49999
3. 10000-19999
4. 5000-9999
5. 2500 – 4999
6. 1000 - 2499
7. < 1000

Q 6. Family possessions : _____

Refrigerator ☐ TV ☐ Radio/Transistor/Music system ☐ AC ☐ Washing Machine ☐

Telephone ☐ Mobile Tel ☐ Credit card ☐ Sanitary lat. ☐

Any subscribed newspaper (month) ☐

Q 7. Living in a type of house: _____

1. Own house with 5 or more rooms
2. Own house with 3-4 rooms
3. Rented/Govt. house with 5 or more rooms
4. Own house with 1-2 rooms
5. Rented/Govt. house with 3-4 rooms
6. Rented/Govt. house with 1-2 rooms
7. Own jhuggi
8. Rented jhuggi
9. No place to live, pavement, mobile cart

Q 8. Possession of a vehicle or equivalent: _____

1. 2 or more cars/Tractors/Trucks
2. 1 Car /Tractor/Truck
3. 1 or more scooter(s)/Bullock cart (s)
4. 1 or more cycles (not baby cycle)
5. None of the above

Q 9. No. of earning members in the family (Nuclear/Joint): _____

1. 3 or more members earning and income pooled
2. 2 or both husband and wife earning
3. Only 1 family member earning
4. No earning member

Q 10. Water and toilet facility:

a) Water supply :	☐	1. Yes	2. No	
b) Electricity supply :	☐	1. Yes	2. No	
c) Type of water supply :	☐	1. Private tap	2. Common tap	3. Hand pump
d) Type of drinking water :	☐	1. Boiled	2. Aquagaurd/ RO	3. Direct
e) Toilet facility :	☐	1. Private	2. Common	3. Public
f) Drainage facility :	☐	1. Closed	2. Open	3. None
g) Garbage disposal:	☐	1. VMSS van	2. VMSS dustbin	3. Open

Q11. Education of children (in relation to head of the family) : _____

1. All children going/ever gone to school/college
2. >50% children ever gone/going to school/college
3. < 50% children ever gone/going to school/college
4. No child ever gone/going to school/college

Q 12. Employment of a domestic servant at home : _____

1. >2 full time servants on salary for domestic work
2. Only 1 full time servant on salary for domestic work
3. > 3 part time servants on salary for domestic work
4. 1-2 part time servants on salary for domestic work
5. No servants for domestic work

Q 13. Type of locality the family is residing : ___

1. Living in urban locality 2. Living in rural locality 3. Living in resettlement colony
4. Living in slums/jhuggis 5. No fixed living and mobile

Q 14. Members of family gone abroad in last three years (official or personal) : _____

1. Whole family 2. Only husband and wife 3. Only 1 family member 4. None

Q 15. Possession of agricultural land for cultivation: ___

1. Own agricultural land >100 acres
2. Own agricultural land 51-100 acres
3. Own agricultural land 21-50 acres
4. Own agricultural land 6-20 acres
5. Own agricultural land 1-5 acres
6. No agricultural land

Q 16. Possession of non-agricultural land/land for housing or other type of land : _____

1. Own non-agricultural land/land for housing>1000 Sq Yards
2. Own non-agricultural land/land for housing 501-1000 Sq. Yards
3. Own non-agricultural land/land for housing 25-500 Sq. Yards
4. Own non-agricultural land/land for housing <25 Sq. Yards –OR Does not own non-agricultural land/land for housing at all

Q 17.Presence of own milch cattles in the family for business or non-business purposes :

1. 4 or more milch cattles
2. 1-3 milch cattles
3. 1 milch cattle
4. Not own any milch cattle

Q 18. Presence of non milch cattles or pet animals in the family : _____

1. Own 2 or more 2. Own 1 3. None

Q 19. Besides the house in which the family is living, the family owns other house or shop or shed etc. of any size whether given on rent or not : _____

1. Owns 3 or more 2. Owns 2 or more 3. Owns 1 4. Does not own any

Q 20. Positions held (besides the positions as employee) by any one member in the family :__

1. 3 or more official or non-official organizations viz. president/chairman/Secretary/Treasurer
2.1-2 official or not-official organizations viz. president/chairman/Secretary/ Treasurer etc.
3. as member only of executive or other committees of official or non-official organizations.
4. Does not hold any such position

Q 21. Parental support in the form of non-movable property : ___

1. >50 acres of agricultural land -OR -a house/plot >1000 sq yards -OR -Both
2. 21-50 acres of agricultural land -OR-a house/plot 501- 1000 sq yards -OR - Both
3. 1-20 acres of agricultural land -OR -a house /plot 100-500 sq yards -OR-Both
4. No agricultural land -BUT - a house/plot 25-100 sq yards
5. No parental property

Q28. Total amount of income tax paid by the family : ___

1. >10 lacs
2. 1-10 lacs
3. >50000 but <1 lac
4. >20000 - <50000
5. >10000-<20000
6. >5000-<10000
7. <5000
8. Nil
9. No response

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:

Parameter	Value
Weight (kg)	
Height (cm)	
BMI	
Waist circumference (cm)	
Hip circumference (cm)	
Waist hip ratio	
Systolic Blood Pressure (mm of hg)	
Diastolic Blood Pressure (mm of hg)	

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (IPAQ)

The questions will ask you about the time you spent being physically active in **the last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise, or sport.

Think about all the *vigorous* activities which take *hard physical effort* that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think only about those physical activities that you did for at least 10 minutes at a time.

Q1. During the **last 7 days**, on how many days did you do **vigorous** physical activities?

_____ Days per week [VDAY; Range 0-7, 8,9]

8. Don't Know/Not Sure

9. Refused

[Think only about those physical activities that you do for at least 10 minutes at a time.]

[If respondent answers zero, refuses or does not know, skip to Question 3]

Q2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

__ __ Hours per day [VDHRS; Range: 0-16]

__ __ __ Minutes per day [VDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

Now think about activities which take *moderate physical effort* that you did in the last 7 days. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking. Again, think about only those physical activities that you did for at least 10 minutes at a time.

Q3. During the **last 7 days**, on how many days did you do **moderate** physical activities?

____ Days per week [MDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[Think only about those physical activities that you do for at least 10 minutes at a time]

[If respondent answers zero, refuses or does not know, skip to Question 5]

Q4. How much time did you usually spend doing **moderate** physical activities on one of those days?

__ __ Hours per day [MDHRS; Range: 0-16]

__ __ __ Minutes per day [MDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

Now think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

Q5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

____ Days per week [WDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure

9. Refused

[Think only about the walking that you do for at least 10 minutes at a time.]

[If respondent answers zero, refuses or does not know, skip to Question 7]

Q6. How much time did you usually spend **walking** on one of those days?

__ __ Hours per day [WDHRS; Range: 0-16]

__ __ __ Minutes per day [WDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

Now think about the time you spent sitting on week days during the last 7 days. Include time spent 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.

Q7. During the last 7 days, how much time did you usually spend ***sitting*** on a **week day**?

__ __ Hours per weekday [SDHRS; 0-16]

__ __ __ Minutes per weekday [SDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure

999. Refused

24 HOUR DIETARY RECALL

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

ANNEXURE III

CONSENT FORM

STUDY TITLE: Diet Quality and Non-Communicable Disease Risk assessment in adult population of Urban Vadodara.

Research Guide	Investigator
Dr. Swati Dhruv Assistant Professor Department of Foods and Nutrition Faculty of Family and Community Sciences The Maharaja Sayajirao University of Baroda Ph: 9898078988	Ms. Drishti Gupta M.Sc. Research Student Department of Foods and Nutrition Faculty of Family and Community Sciences The Maharaja Sayajirao University of Baroda Ph: 9711471218

PURPOSE OF THE STUDY

Over the past few years, chronic non-communicable diseases (NCDs) like cardiovascular diseases, diabetes and hypertension have become an emerging pandemic around the globe, with much higher rates in developing countries. The burden of diet related NCDs is significant in all regions of the world, and the indicators can more fully reflect diet quality relevant to policies and programs. Metrics that can be calculated simply, using low-burden survey tools, paves the way for monitoring diet quality globally and in countries. The existing studies' findings highlight major gaps in assessing Diet Quality amongst the most productive adult age group 20-50 years and addressing global diet quality scores to determine NCD Risk. The GDQS as a data collection tool has been administered with pre-existing food frequency data to determine scores but the GDQS as data collection tool itself has not been directly used in Indian setting yet.

This study thus aims to study the Diet Quality and assessment of NCD risk in adult population of Urban Vadodara.

PROTOCOL OF THE STUDY

The study is focused on adults in the age group 20-50 years. In the study, information regarding the following aspects would be collected:

1. General/ Background information
2. Socio economic status

3. Medical history
4. Physical activity level
5. Anthropometric Measurements
6. Dietary Recall via GDQS App
7. 24-hour dietary recall (1 day) – on a subset
8. Biophysical Parameters

All the above information will be assessed with the help of standardized 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 to increase scientific knowledge about the diet quality and Non-Communicable Disease Risk among adult population. There is no risk of participation in the study.

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 the 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 are 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 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. Drishti Gupta 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, physical activity, anthropometric measurements, 24 hr diet recall and blood pressure. 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 પત્ર

અભ્યાસ શીર્ષક : શહેરી વડોદરાની પુખ્ત વસ્તીમાં ખોરાકની ગુણવત્તા અને નોન કૉમ્યૂનિકેબલે ડિસિયસે જોખમનું મૂલ્યાંકન.

સંશોધન માર્ગદર્શિકા :	**તપાસકર્તા:**
ડો સ્વાતિ ધ્રુવ' આસિસ્ટન્ટ પ્રોફેસર ખાદ્ય અને પોષણ વિભાગ ફેકલ્ટી ઓફ ફેમિલી એન્ડ કોમ્યુનિટી સાયન્સ મહારાજા સયાજીરાવ યુનિવર્સિટી ઓફ બરોડા ફોન નં: ૯૮૯૮૦૭૮૯૮૮	દ્રષ્ટિ ગુપ્તા એમ.એસ.સી. સંશોધન વિદ્યાર્થી ખાદ્ય અને પોષણ વિભાગ ફેકલ્ટી ઓફ ફેમિલી એન્ડ કોમ્યુનિટી સાયન્સ મહારાજા સયાજીરાવ યુનિવર્સિટી ઓફ બરોડા ફોન નં: ૯૭૧૧૪૭૧૨૧૮

અભ્યાસનો હેતુ:

છેલ્લા કેટલાક વર્ષોમાં, હૃદયના રોગો, ડાયાબિટીસ અને હાયપરટેન્શન જેવા ક્રોનિક નોન કૉમ્યૂનિકેબલે ડિસિયસે (NCDs) નો વિશ્વભરમાં વધારો થઇ રહ્યો છે. વિકાસશીલ દેશોમાં તેના દર ઘણા ઊંચા છે. આહાર સંબંધિત NCDs નો ભાર વિશ્વના તમામ પ્રદેશોમાં નોંધપાત્ર છે, અને સૂચકાંકો નીતિઓ અને કાર્યક્રમો સાથે સંબંધિત આહાર ગુણવત્તાને વધુ સંપૂર્ણ રીતે પ્રતિબિંબિત કરી શકે છે. ઓછા ભારવાળા સર્વેક્ષણ સાધનોનો ઉપયોગ કરીને સરળ રીતે ગણતરી કરી શકાય તેવા મેટ્રિક્સ, વૈશ્વિક સ્તરે અને દેશોમાં આહારની ગુણવત્તા પર દેખરેખ રાખવાનો માર્ગ મોકળો કરે છેહાલના અભ્યાસોના તારણો ૨૦-૫૦ વર્ષની સૌથી વધુ ઉત્પાદક વય જૂથમાં આહારની ગુણવત્તાનું મૂલ્યાંકન કરવામાં અને NCD જોખમને નિર્ધારિત કરવા માટે વૈશ્વિક આહાર ગુણવત્તાના સ્કોર્સને સંબોધવામાં મુખ્ય અંતરને પ્રકાશિત કરે છે.

ડેટા કલેક્શન ટૂલ તરીકે GDQS એ સ્કોર્સ નક્કી કરવા માટે પૂર્વ-અસ્તિત્વમાં રહેલા ફૂડ ફ્રીક્વન્સી ડેટા સાથે સંચાલિત કરવામાં આવ્યું છે પરંતુ ડેટા કલેક્શન ટૂલ તરીકે GDQS નો ભારતીય સેટિંગમાં સીધો ઉપયોગ કરવામાં આવ્યો નથી.

આમ આ અભ્યાસનો હેતુ શહેરી વડોદરાની પુખ્ત વસ્તીમાં ખોરાકની ગુણવત્તા અને નોન કૉમ્યૂનિકેબલે ડિસિયસે જોખમના મૂલ્યાંકનનો અભ્યાસ કરવાનો છે.

અભ્યાસનો પ્રોટોકોલ

આ અભ્યાસ ૨૦-૫૦ વર્ષની વય જૂથના પુખ્ત વયના લોકો પર કેન્દ્રિત છે. અભ્યાસમાં, નીચેના પાસાઓ સંબંધિત માહિતી એકત્રિત કરવામાં આવશે:

1. સામાન્ય/ પૃષ્ઠભૂમિ માહિતી
2. સામાજિક આર્થિક સ્થિતિ
3. તબીબી ઇતિહાસ
4. ફૃયસીકેલ એકટીવીટી સ્તર
5. એન્થ્રોપોમેટ્રિક માપન
6. GDQS એપ દ્વારા ડાયેટરી રિકોલ
7. ૨૪-કલાક ડાયેટરી યાદ (૧ દિવસ) - સબસેટ પર
8. બાયોફ્યુસીસીઅલ પરિમાણો

ઉપરોક્ત તમામ માહિતીનું મૂલ્યાંકન પ્રમાણિત સાધનોની 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 પુખ્ત વસ્તીમાં ખોરાકની ગુણવત્તા અને બિન-ચેપી રોગના જોખમ વિશે વૈજ્ઞાનિક જ્ઞાન વધારવામાં મદદ કરશે. અભ્યાસમાં ભાગ લેવાનું કોઈ જોખમ નથી.

ગોપનીયતા:

અભ્યાસમા તમારી ઓળખ ગુપ્ત રાખવામા આવશે. અભ્યાસના પરિણામો વૈજ્ઞાનિક હેતુઓ માટે પ્રકાશિત થઈ શકે છે પરંતુ તમારું નામ જાહેર કરવામા આવશે નહીં અથવા તમારા માટે કોઈ ઓળખી શકાય તેવા સંદર્ભોનો સમાવેશ કરવામા આવશે નહીં.

પાછી ખેંચવાનો અધિકાર:

અભ્યાસમાં જોડાવાનો તમારો નિર્ણય સ્વૈચ્છિક છે. તમે કોઈપણ સમયે, કોઈપણ કારણસર, સૂચના વિના છોડી શકો છો. અમે આશા રાખીએ છીએ કે તમે સમગ્ર અભ્યાસના 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 બાયોભૌતિક પ્રોફાઇલમાં કોઈ અસામાન્યતા 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 અંગે ચર્ચા કરવાની અને કોઈપણ વધારાના પ્રશ્નો પૂછવાની તક આપવામાં આવી હતી.

_____

તારીખ સાથે તપાસકર્તાની સહી

સહભાગીનું નિવેદન:

હું પ્રમાણિત કરું છું કે મેં વાંચ્યું છે, અથવા મને વાંચવામાં આવ્યું છે, અને હું અભ્યાસનું વર્ણન સમજી શકું છું. આ પત્ર પર હસ્તાક્ષર કરીને, હું પ્રમાણિત કરું છું કે મેં ઉપર આપેલી માહિતી વાંચી અને સમજી છે. હું તપાસકર્તાઓ દ્વારા જરૂરી માહિતી પ્રદાન કરવા માટે મહારાજા સયાજીરાવ યુનિવર્સિટી ખાતે ડૉ સ્વાતિ ધ્રુવના માર્ગદર્શન હેઠળ પોસ્ટ ગ્રેજ્યુએટ વિદ્યાર્થી કુ. દ્રષ્ટી ગુપ્તા દ્વારા કરવામાં આવેલા અભ્યાસના વિષય તરીકે શામેલ થવાની સંમતિ આપું છું. હું સમજું છું કે અભ્યાસ માટે સહભાગીને સામાજિક આર્થિક સ્થિતિ, તબીબી ઇતિહાસ, ફૃયસીકેલ એકટીવીટી સ્તર, એન્થ્રોપોમેટ્રિક માપન, ૨૪ કલાકના આહાર રિકોલ અને બ્લડ પ્રેશર સંબંધિત માહિતી પ્રદાન કરવાની જરૂર છે. મને અભ્યાસ વિશે પ્રશ્નો પૂછવાની તક મળી છે, હું સમજું છું કે હું કોઈપણ સમયે વધુ પ્રશ્નો પૂછી શકું છું. મને આ

અભ્યાસના હેતુથી મારા સંતોષ માટે સમજાવવામાં આવ્યું છે અને હું કોઈપણ સમયે અભ્યાસમાંથી બહાર નીકળવાના મારા અધિકારથી પણ જાગૃત છું.

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તારીખ સાથે સહભાગીની સહી

ANNEXURE IV

Table 1. GDQS and GDQS Sub-Metric Food Groups and Scoring

Inclusion in Metrics	Scoring Classification	Food Group	Categories of Consumed Amounts (g/day)				Points Assigned			
			Low	Middle	High	Very High	Low	Middle	High	Very High
GDQS and GDQS+	Healthy	Citrus fruits	<24	24–69	>69		0	1	2	
		Deep orange fruits	<25	25–123	>123		0	1	2	
		Other fruits	<27	27–107	>107		0	1	2	
		Dark green leafy vegetables	<13	13–37	>37		0	2	4	
		Cruciferous vegetables	<13	13–36	>36		0	0.25	0.5	
		Deep orange vegetables	<9	9–45	>45		0	0.25	0.5	
		Other vegetables	<23	23–114	>114		0	0.25	0.5	
		Legumes	<9	9–42	>42		0	2	4	
		Deep orange tubers	<12	12–63	>63		0	0.25	0.5	
		Nuts and seeds	<7	7–13	>13		0	2	4	
		Whole grains	<8	8–13	>13		0	1	2	
		Liquid oils	<2	2–7.5	>7.5		0	1	2	
		Fish and shellfish	<14	14–71	>71		0	1	2	
		Poultry and game meat	<16	16–44	>44		0	1	2	
		Low-fat dairy	<33	33–132	>132		0	1	2	
		Eggs	<6	6–32	>32		0	1	2	
GDQS and GDQS–	Unhealthy in excessive amounts	High-fat dairy* (in milk equivalents)	<35	35–142	>142–734	>734	0	1	2	0
		Red meat	<9	9–46	>46		0	1	0	
	Unhealthy	Processed meat	<9	9–30	>30		2	1	0	
		Refined grains and baked goods	<7	7–33	>33		2	1	0	
		Sweets and ice cream	<13	13–37	>37		2	1	0	
		Sugar-sweetened beverages	<57	57–180	>180		2	1	0	
		Juice	<36	36–144	>144		2	1	0	
		White roots and tubers	<27	27–107	>107		2	1	0	
		Purchased deep fried foods	<9	9–45	>45		2	1	0	

Table 2. Operational Definitions of GDQS Food Groups

Food Group	Description
Citrus fruits	Whole fruits in the genus *Citrus*.
Deep orange fruits	Whole fruits (not including juice or spreads) containing ≥120 retinol equivalents per 100g.
Other fruits	Whole fruits not belonging in the other fruit categories (not including coconuts).
Dark green leafy vegetables	Leafy vegetables containing ≥120 retinol equivalents per 100g.
Cruciferous vegetables	Vegetables in the family *Brassicaceae*.
Deep orange vegetables	Non-tuberous vegetables containing ≥120 retinol equivalents per 100g.
Other vegetables	Vegetables not belonging in the other vegetable categories.
Legumes	Legumes and foods derived from legumes, such as tofu and soymilk. Does not include bean sprouts (classified in "Other vegetables") or groundnuts (classified in "Nuts and seeds").
Deep orange tubers	Tuberous vegetables containing ≥120 retinol equivalents per 100g (includes variants biofortified with vitamin A)
Nuts and seeds	Nuts, seeds, and products derived from nuts and seeds, such as nut-based butters (but not oils). Also includes groundnuts. Seeds that are used as spices are included when used in their whole (not powdered) form.
Whole grains	Whole grains and whole grain products. Does not include products with significant amounts of added sugar (classified as "Sweets and ice cream").
Liquid oils	All types of oils that are liquid at room temperature, regardless of fatty acid profile (this includes palm olein, liquid palm kernel oil, and liquid coconut oil). Does not include oil used to deep fry foods that are purchased. But does include oil used to deep fry foods prepared at home.
Fish and shellfish	Fish (whether processed or unprocessed) based on phylogenetic classificat ions (including sharks, eels, and rays), and other seafood high in n3 fatty acids (including shellfish, jellyfish, cetaceans, and pinnipeds, but not echinoderms). Includes organs.
Poultry and gamemeat	Unprocessed poultry and game, including a range of undomesticated animals and bushmeat, for example: primates, rodents, canines, felines, marsupials, leporids (rabbits and hares), wild boar, bats, bears, semiaquatic mammals (including otters and beavers), undomesticated ungulates, reptiles (aquatic and terrestrial), and amphibians. Includes organs.
Low-fat dairy	Reduced or naturally low-fat dairy products (≤2% milk fat). Includes flavored milk, and milk or cream added to coffee or tea.
Eggs	All types of eggs. Does not include mayonnaise.
High-fat dairy	High-fat milk and dairy products (>2% milk fat). Includes flavored milk, and milk or cream added to coffee or tea. Does not include butter or clarified butter. This category also does not include ice cream and whipped cream.
Red meat	Unprocessed red meat belonging to domesticated animals (i.e., not game), including organs. "Red" classification is not based on color but on nutritional characteristics, and thus includes pork and lamb.

Processed meat	Processed red meat, poultry, or game, including organs, and excluding fish or seafood. Processing is defined as per International Agency for Research on Cancer: “salting, curing, fermentation, smoking or other processes to enhance flavor or improve preservation.”
Refined grains and baked goods	Refined grains and refined grain products. Does not include products with significant amounts of added sugar, which should instead be classified as “Sweets and ice cream”.
Sweets and ice cream	Sugar-sweetened foods that are not beverages. This category includes sugar and other caloric sweeteners added to other foods and drinks. Whipped cream is also classified in this category.
Sugar-sweetened beverages	Sweetened drinks that do not contain any fruit juice at all. Includes, for example: sodas, energy drinks, and sports drinks, and beverages made using low-calorie sweeteners, such as diet sodas. Sweetened tea and coffee, and dairy or cereal-based drinks are not included.
Juice	Unsweetened or sweetened drinks that are at least partly composed of fruit jui ce. This category also includes fruit smoothies made from whole fruit.
White roots and tubers	Tuberous vegetables with <120 retinol equivalents per 100g. Includes flours such as potato or cassava flour.
Purchased deep fried foods	Deep fried foods are foods that are fried in an amount of fat or oil sufficient to cover the food completely. Only deep fried foods that are purchased (i.e., not prepared at home) are classified in this category. Foods that are classified in this category are “double classified.” The food should be classified as belonging to the purchased deep fried food category and should also be classified in the food group to which the food normally belongs if not purchased and deep fried (e.g., deep fried white potatoes that are purchased sho uld be classified in both the purchased deep fried foods category and in the white roots and tubers category).