ASSESSMENT OF PHYTOCHEMICAL INDEX IN DIET OF UNIVERSITY STUDENTS: A CROSS-SECTIONAL STUDY

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A Dissertation Submitted in Partial Fulfilment of the Requirement for the Degree of Masters 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 Maitri Kulkarni under the guidance of Dr. Shonima Venugopal in pursuit of Degree of Masters of Science (Family and Community Sciences) with major in Foods and Nutrition (Dietetics) and this is her original work.

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~Maitri Kulkarni

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ABSTRACT

ABSTRACT

As young adults enter college or university life and deal with stress and time constraints, poor eating habits are a serious public health problem. These variables might lead to unhealthy eating patterns since they make it difficult to adopt healthy behaviours. Phytochemicals are plant-based bioactive compounds produced by plants for their protection. They can be derived from various sources such as whole grains, fruits, vegetables, nuts, and herbs, and more than a thousand phytochemicals have been discovered to date. Some of the significant phytochemicals are carotenoids, polyphenols, isoprenoids, phytosterols, saponins, dietary fibers, and certain polysaccharides. These phytochemicals possess strong antioxidant activities and exhibit antimicrobial, antidiarrheal, anthelmintic, antiallergic, antispasmodic, and antiviral activities. They also help to regulate gene transcription, enhance gap junction communication, improve immunity, and provide protection against lung and prostate cancers. Phytochemicals refers to the variety and concentration of bioactive compounds found in plant-based foods, which are known to contribute to health and well-being. Phytochemicals are associated with various health benefits, including antioxidant, anti-inflammatory, and anticancer properties. With rising concerns about diet-related health issues among young adults, particularly university students, assessing the phytochemical index of their diets is crucial for understanding its potential impact on their health. Assessing the phytochemical index among university students is a necessary step toward improving health outcomes in a population that is often at risk for poor dietary choices. By understanding their phytochemical intake, we can better support students in achieving optimal health and nutritional status. The study was thus planned with an objective to assess Phytochemical Index in the Diets of University Students.

A cross-sectional study was carried out in the Faculty of Family and Community Sciences. Data was collected from 401 subjects. Data regarding anthropometry, dietary pattern, nutrient intake (24-hour dietary recall), Physical activity (IPAQ), Blood pressure and Fasting blood glucose was collected from the subjects. Anthropometric measurements was collected by standard methods, Blood pressure by sphygmomanometer, FBS sample from glucometer. The phytochemical index was calculated from 24-hour dietary recall.

The mean age of the subjects was 20.2 years. On the basis of Kuppuswamy SES classification. Around 12.96%, 68.34%, 13.46% and 4.76% of the subjects fell in the upper, upper middle, lower middle and upper lower classes respectively.

Majority of the male (47.75%) and female (37.42%) subjects belonged to the normal BMI category. Among the male subjects 28.81% belonged to the underweight category and 5.08% and 18.64% belonged to the overweight and obese categories respectively, whereas among the female subjects 23.09% belonged to the underweight category and 13.15% and 26.31% belonged to the overweight and obese category respectively.

Male subjects 11.86% had waist circumference ≥90 cm. Female subjects 36.54% had waist circumference ≥80cm. Also, 35.59% of male subjects had ≥0.90 waist-hip ratio and 29.23% of female participants had ≥0.85 of waist hip ratio.

Majority i.e. (36.15%) of subjects consumed packaged and junk foods 2-3 times a week. Consumption frequency of junk and packaged foods daily, once a week, once in 15 days, once a month, occasionally and never by students was 10.47%,19.20%,15.46%,5.23%, 11.22% and 2.24% respectively. Majority of the subjects (28.67%) consumed cold drinks and beverages occasionally. Majority of subjects that is 21.94% ordered/ takeaway food once a week. . In the female subjects mean energy intake was 1264 Kcal which met 76.15% of the required EAR. In the male subjects mean energy intake was 1338 Kcal which was 63.14% of the required EAR.

Mean PI was 45.59. Mean PI of male subjects was 45.37. Mean PI for female subjects was 46.85. for normal BMI female subjects was 43.96. for normal BMI male subjects mean PI was 47.2.

Mean PI score for female subjects from normal category was 45.20 and for mean PI score for pre-diabetic female subjects is 48.33. None of the female subjects had diabetic FBS value. Mean PI for normal male subjects were 47.29 and for prediabetic is 48.33.

Among the female subjects 50.58% and among the male 69.3% were at low risk of diabetes. Among female subjects 35.29% and 32.20% of male subjects were at slightly elevated risk of diabetes. Among the total subjects 13.52% female and 6.77% male subjects fell under moderate risk category. Out of the total subjects 0.58% of female subjects were under high-risk category while no male subjects were under this category. Lastly, none of the subjects were in the very high-risk category of the score card.

Mean PI for female and male subjects in <7 score category is 44.77 and 48.44 respectively. For score 7-11 the PI among female and male subjects is 46.17 and 43.93 respectively. For the score 12-14 the PI among female and male subjects is 44.73 and 46.37 respectively. None of the male subjects fall in the category of 15-20 and >20 (high risk and very high risk). Among

the female subjects mean PI for 15-20 (high risk) is 41.82 and none of the female subjects fall in the very high-risk category.

On assessment of physical activity, 74.81% of the subjects were indulged in low physical activity, 20.33% were indulged in moderate physical activity and 2.99% were indulged in heavy physical activity.

Thus, the present study concludes that calorie consumption from CHO and fats was double then the requirement in both female and male subjects. The phytochemical index obtained by the assessment of diet of the students was almost half of the considered best phytochemical index score. Among the phytochemical rich food groups cereals, pulses and vegetables were the main calorie contributor in the index. By IDF diabetes risk score card assessment it was found that considerable number of subjects among the total subjects were at slightly elevated risk and moderate risk of diabetes. On assessment of physical activity via IPAQ it was found that majority of the students were inactive and were living a sedentary lifestyle.

INTRODUCTION

INTRODUCTION

Non-Communicable Diseases:

Noncommunicable diseases (NCDs), also known as chronic diseases, are not transmissible from person to person. They are of long duration and generally progress slowly. They are also referred to as a "lifestyle" diseases because the majority of these diseases are preventable illnesses with risk factors include tobacco use (smoking), alcohol abuse, poor diets (high consumption of sugar, salt, saturated fats, and trans fatty acids), and physical inactivity. Most NCDs are non-infectious and are the result of several factors, including genetic, physiological, behavioral, and environmental factors. The main types of NCDs are cardiovascular diseases (such as heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease (COPD) and asthma) and diabetes (WHO NCDs report, 2019).

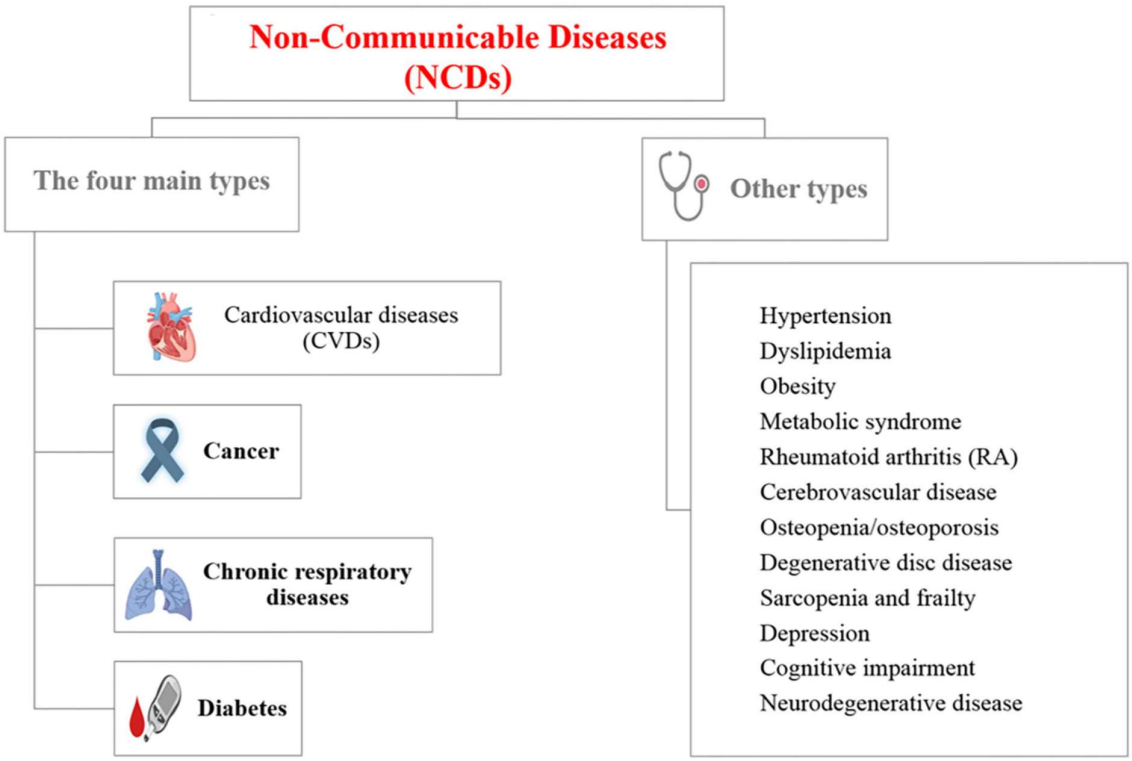

Figure 1.1 Classification of non-communicable diseases

(Source: Budreviciute et al. 2020)

According to the study report "India: Health of the Nation's States"- The India State-Level Disease Burden Initiative in 2017 by Indian Council of Medical Research (ICMR),

it is estimated that the proportion of deaths due in India have increased from 37.9% in 1990 to 61.8% in 2016 (Status of Non-Communicable Diseases in India report, Ministry of Health and Family Welfare, Government of India, 2022).

Ischaemic heart diseases, COPD & Diabetes Mellitus Type 2 are the major causes of disability adjusted life years (DALYs) in the state of Gujarat. NCDs contribute to 59.77% of DALYs in Gujarat (NFHS health dossier, 2021).

Among women (mildly elevated Blood Pressure (Systolic 140-159 mm of Hg and/or Diastolic 90-99 mm of Hg) (%) was 11.7(Gujarat-NFHS-5) and 12.4 (India-NFHS-5) respectively. For men (mildly elevated Blood Pressure (Systolic 140-159 mm of Hg and/or Diastolic 90-99 mm of Hg) (%) was 13.1(Gujarat-NFHS-5) and 15.7 (India-NFHS-5) respectively. In women - Blood sugar level - high (141-160 mg/dl) (%) were 8.1 (Gujarat-NFHS-5) and 6.1 (India-NFHS-5) respectively. In men - Blood sugar level - high (141-160 mg/dl) (%) were 9 (Gujarat-NFHS-5) and 7.3 (India-NFHS-5) respectively (NFHS health dossier, 2021).

Several factors can increase the number of chances to develop NCDs and can be classified in different ways. In one approach, risk factors are classified as modifiable or nonmodifiable factors that can have changeable or non-changeable conditions, respectively. The modifiable risk factors involve high blood pressure, smoking, diabetes mellitus, physical inactivity, obesity, and high blood cholesterol, while the non-modifiable risk factors involve age, gender, genetic factors, race, and ethnicity. The modifiable factors can also be classified into three classes: (i) biological factors, such as being overweight, dyslipidaemia, hyper-insulinemic, and hypertension; (ii) behavioural factors, such as diet, lack of physical activity, tobacco smoking, and alcohol consumption; and (iii) societal factors, which involve complex combinations of interacting socioeconomic, cultural and environmental parameters (Diet, Nutrition and Prevention of chronic diseases, WHO, 2003)

According to the American Heart Association, there are seven key health factors and behaviors that contribute to the increasing risks of heart disease and stroke: nutrition, smoking, overweight/obesity, physical inactivity, uncontrolled blood pressure, elevated levels of cholesterol, and blood sugar.

Most cardio-vascular diseases can be prevented by addressing the seven risk factors, which involves healthy diets, regular physical activity, avoiding smoking and second-

hand smoking, reaching and maintaining a healthy weight, and keeping blood pressure, cholesterol, and blood sugar levels under control (WHO NCDs report, 2018).

The main risk factors contributing to NCDs involve unhealthy diets, physical inactivity, tobacco use, and alcohol misuse. Hence, most of these diseases are preventable as they eventually progress in early life due to lifestyle aspects. There is an increasing concern that poor diet has increased the potential risk, causing chronic diseases, and nutrition problems in the public health sector (Noor et al., 2014; Sithey et al., 2018).

Diet is a common risk factor among most NCDs. Traditional food in most countries is healthier, natural, and richer in fibre, and cereal has been replaced by unhealthy processed food that is rich in sugars and fats, animal-source foods, and refined carbohydrates. Hence, low- and middle-income countries have seen rapid changes in nutrition transition and rapid increases in NCDs. High food consumption and declining physical activity rates occur simultaneously, resulting in NCDs (Popkin, 2015).

Transition in lifestyle, changes in food consumption pattern combined with a high level of mental stress has resulted increased prevalence of risk factors of lifestyle related problems like heart disease, obesity, diabetes, cancer and hypertension (Hasler et al., 2003; Sharma and Joshi et al., 2015).

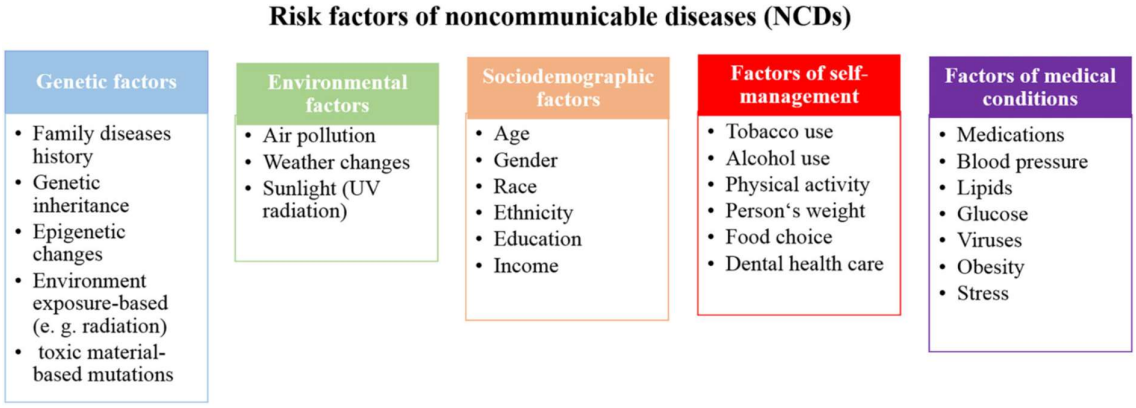

Figure.1.2 Risk factors of non-communicable diseases

(Source: Budreviciute et al.,2020)

Metabolic Risk factors of NCDs:

The years between 18 and 24 are generally considered transitional years during which college-students experience weight gain and decline in physical activity (Racette et al., 2009).

The high rates of overweight/obesity and lack of physical activity have been shown to contribute towards increasing risk of various chronic diseases including metabolic syndrome (MetS), type 2 diabetes (T2D), and coronary heart diseases (CHD). Thus, the increasing rates of overweight/obesity and physical inactivity are very likely positioning this young sector of the population at a greater risk of developing chronic disease (Garber et al.,2009)

Overweight is a condition of excessive fat deposits.

Obesity is a chronic complex disease defined by excessive fat deposits that can impair health. Obesity can lead to increased risk of T2DM and heart disease; it can affect bone health and reproduction and it increases the risk of certain cancers. Obesity influences the quality of living.

Global Prevalence of Overweight and Obesity:

- In 2022, 1 in 8 people in the world were living with obesity.
- Worldwide adult obesity has more than doubled since 1990, and adolescent obesity has quadrupled.
- In 2022, 2.5 billion adults (18 years and older) were overweight. Of these, 890 million were living with obesity (WHO overweight and obesity fact sheets, 2024; Global Burden of Diseases (GBD), 2019).

In India, according to National Family Health Survey (NFHS-5) (2019-21), 6.4 % of women and 4.0% of men, aged 15-49 years were obese. In Gujarat, according to NFHS-5, 2019-21 percentage of women and men aged 15-49 years who were obese (Body Mass Index(BMI) $\geq$ 30.0) was 6.9% and 4.4% respectively.

Obesity acts as one of the biological risk factors, which can lead to NCDs (NFHS health dossier, 2021).

A suboptimal diet is the leading risk factor for NCDs and consumption of specific foods, rather than macronutrients or micronutrients; it may be the most significant risk factor for NCDs (Mutie et al., 2017).

Lifestyle activities include healthy diets and focus on limiting the use of salt, sugar, and saturated fats (Springmann et al., 2018).

Prevalence of risk factors of NCDs among young adults:

Non-Communicable Diseases (NCDs) resulting from lifestyle factors are sometimes called disease of affluence. NCDs such as obesity, diabetes mellitus, hypertension, coronary artery disease, and stroke in the later part of life have been related to the prevalence of risk factors in childhood and in adolescence (Freedman et al., 1999).

In today's world obesity is not only common among the middle aged, but is becoming increasingly prevalent among younger adults and adolescents (Sujatha and Dass et al., 2004).

Young people in the adolescence stage can acquire new and harmful habits, such as unhealthy diets, physical inactivity, smoking and drinking alcohol, which can significantly contribute to NCD risk. These bad habits may continue during adulthood with additional aspects facing adults in workplaces, including financial stressors, unemployment, unsatisfying careers, and low social engagement, which influence the progress of NCDs (Mikkelsen et al., 2019; Pechmann et al., 2005; WHO Europe report, 2018).

Dietary and Lifestyle Pattern of University Students:

Entry to university brings new responsibilities to students in regards to food, housing and financial management. Within this context, the risk factors of an inappropriate lifestyle, represented by a sedentary lifestyle, psychosocial factors and the high demands of academia can contribute to the adoption of nutritionally unbalanced eating habits. Therefore, the risk of the development of chronic, NCDs (Monteiro et al., 2002).

As young adults enter college or university life and deal with stress and time constraints, poor eating habits are a serious public health problem. These variables might lead to unhealthy eating patterns since they make it difficult to adopt healthy behaviours.

The time spent in college is crucial for developing positive attitudes and good eating habits. However, a number of circumstances, such as the state of the economy, the pressures of academic life, and a lack of knowledge about nutritional principles, put university students at risk for adopting unhealthy eating habits. Malnutrition or overnutrition brought on by a poor diet raises the risk of preventable diseases.

A number of factors, including hectic schedules, stress, a lack of access to nutritious food alternatives, and poor eating habits, make it difficult for many students to maintain a balanced diet.

The beginning of independence and the growth of a student lifestyle typically coincide with returning to school. During this time, either entirely new behavioural patterns are formed or previously acquired behaviours pertaining to dietary demands are reinforced. Due to a number of variables, such as distance from the family home, financial circumstances, heavy academic workloads, time limits, and a lack of knowledge about nutritional principles, students' eating habits frequently diverge greatly from a healthy, balanced diet.

University students display several common eating habits, including frequently snacking on energy-dense foods, skipping meals – especially breakfast, eating a lot of junk food and few fruits and vegetables, and tending to consume fast-cooked foods that take only minutes to prepare. These, in addition to low physical activity and prolonged computer and TV use, can lead to malnutrition or overnutrition, which increase a person’s vulnerability to preventable diseases. Thus, assessing the nutritional issues and eating behaviours among university students is crucial for promoting good health and academic performance (Almorie et al., 2024).

Phytochemicals:

Phytochemicals, are non-nutritive plant chemicals that have either defensive or disease protective properties. They are nonessential nutrients and mainly produced by plants to provide them protection (Dhanpraksh et al., 2012).

Phytochemicals play an important role in protecting plants from environmental hazards such as stress, drought and pathogenic attack etc. They also contribute to plant colour, aroma and flavour (Thakur and Sharma et al.,2018).

Phytochemicals (derived from Greek word Phyto, meaning "plant") are bio chemicals produced in plants by primary or secondary metabolic processes and possess biological activity and are important in plant growth or defence against pathogens or predators (Sharma et al., 2019).

Dietary intake of phytochemicals may promote health benefits, protecting against chronic degenerative disorders, such as cardiovascular and neurodegenerative diseases. Majority of foods, such as whole grains, beans, fruits, vegetables and herbs contain phytonutrients/ phytochemicals. These phytochemicals, either alone and/or in combination, have tremendous therapeutic potential in curing various ailments. Phytochemicals with nutraceutical properties present in food are of enormous significance due to their beneficial effects on human health since they offer protection against numerous diseases or disorders such as cancers, coronary heart disease, diabetes, high blood pressure, inflammation, microbial, viral and parasitic infections, psychotic diseases, spasmodic conditions, ulcers, osteoporosis and associated disorders (Dhanprakash et al.,2012).

Phytochemicals are constituents of plants and have certain pharmacological and/or physiological effects in the ethnomedical treatment of various disorders. Phytochemicals play an important role in human health as antioxidants, antibacterial, antifungal, anti-inflammatory, anti-allergic, antispasmodic, chemo preventive, hepatoprotective, hypolipidemic, neuroprotective, hypotensive, prevent aging, diabetes, osteoporosis, cancer and heart diseases, induce apoptosis, diuretic, CNS stimulant, analgesic, protects from UVB-induced carcinogenesis, immuno-modulator and carminative.

Classification of Phytochemicals

Phytochemicals are plant-based bioactive compounds produced by plants for their protection. They can be derived from various sources such as whole grains, fruits, vegetables, nuts, and herbs, and more than a thousand phytochemicals have been discovered to date. Phytochemicals are broadly described as polyphenols, flavonoids, isoflavonoids, anthocyanidins, phytoestrogens, terpenoids, carotenoids, limonoids, phytosterols, glucosinolates and fibers. Some of the significant phytochemicals are carotenoids, polyphenols, isoprenoids, phytosterols, saponins, dietary fibers, and certain polysaccharides. These phytochemicals possess strong antioxidant activities and exhibit antimicrobial, antidiarrheal, anthelmintic, antiallergic, antispasmodic, and antiviral activities. They also help to regulate gene transcription, enhance gap junction

communication, improve immunity, and provide protection against lung and prostate cancers (Kumar et al., 2018).

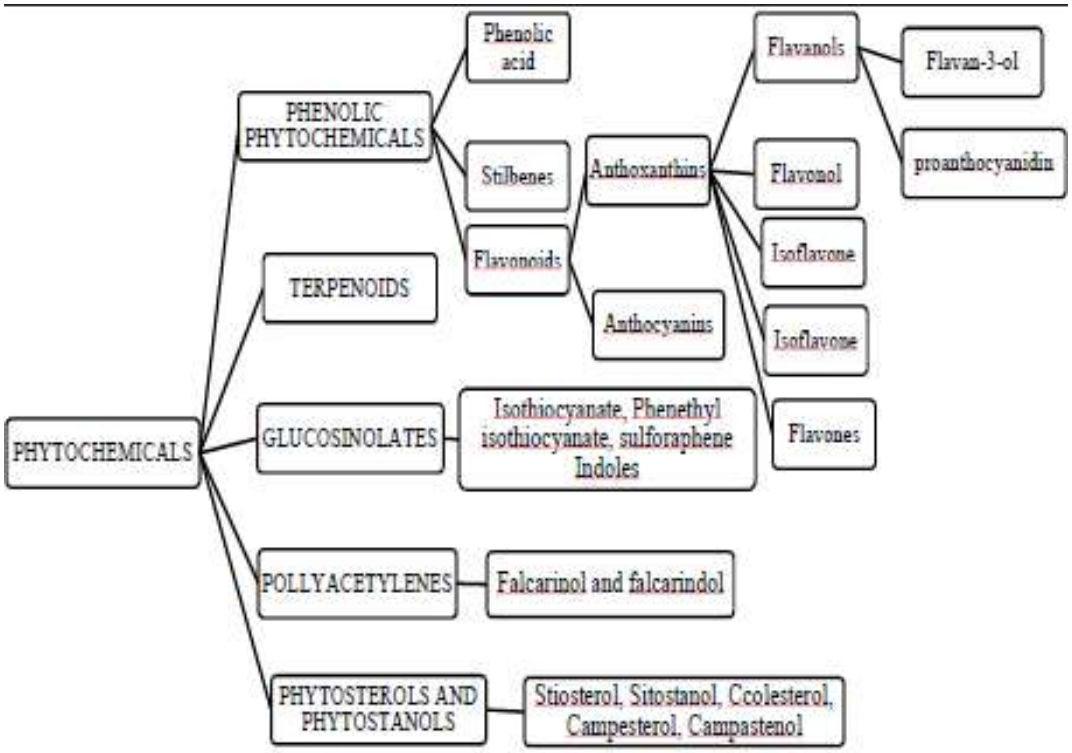

Figure 1.3 Classification of Phytochemicals

Source: Marta and Casado, 2011.

Sources of Phytochemicals and their advantages

Plant-based foods that are rich in phytochemicals include whole grains, vegetables and fruits, nuts, and legumes. Among these, fruits and vegetables contribute to the significant sources of phytochemicals (Sharma et al, 2019).

Phytochemicals are an important component of the human body, particularly in their role as antioxidants. These substances serve as a protective shield for cells, defending them against the harm caused by free radicals. Free radicals are unstable molecules that create oxidative stress, which can lead to cell damage and increase the risk of chronic illnesses such as cancer, cardiovascular disease, and diabetes. The antioxidant properties of certain phytochemicals, such as carotenoids and polyphenols, are especially strong, enabling them to neutralize free radicals and reduce oxidative stress. The results of several meta-analyses demonstrate that higher levels of carotenoids, such as alpha-carotene, beta-carotene, beta-cryptoxanthin, lycopene, and lutein/zeaxanthin, and polyphenols in the diet or plasma are linked to lower frailty and a reduced risk of cardiovascular disease. In addition, terpenes, present in nuts and crude pressed oils, have been associated with improved cardiovascular health, and phytosterols, which can be found in nuts and unrefined pressed oils, have been linked to cholesterol reduction (Kocyigit et al., 2018).

Dietary Phytochemical Index (DPI):

In recognition of the key role of phytochemicals in health promotion, Mark F. McCarty proposed that diets be characterized by a "phytochemical index" (PI), defined as that percentage of dietary calories supplied by foods typically high in phytochemicals: fruits, vegetables (not including potatoes, but including other tubers), legumes, nuts, seeds, whole grains, and foods compounded therefrom (Mark F. McCarty, 2004).

It was stated by Mark F. McCarty that fruit and vegetable juices, although lacking fibre and some of the phytochemical content of rinds or peels, are often rich in phytochemicals, and thus should be counted in the index. Similarly, wine, beer, and cider qualify in this regard, but not distilled hard liquors. Soy protein, though evidently not a whole food, is usually a good source of isoflavones, and thus should be counted. Extra virgin olive oil is relatively rich in absorbable antioxidants and thus might be given "partial credit", but most other oils used in cooking, although containing some fat-soluble phytochemicals, are low in phytochemicals on a per-calorie basis, and thus should be excluded from the index (Mark F. McCarty, 2004).

Thus, Dietary Phytochemical index (DPI) score can be calculated using the given formula

Phytochemical Index = Calories from Phytochemical rich sources / Total Calories x 100

Phytochemical index (PI), has been developed to efficiently evaluate the health effects of phytochemical-rich foods in large population. Phytochemical index serves as a convenient surrogate measure of phytochemical intake.

Studying DPI will provide a deeper understanding of the impact of phytochemical-rich foods on human health and develop more effective dietary recommendations and interventions. It will be easier to identify the optimal intake levels of phytochemicals and to make informed choices about diet to improve overall health and well-being.

Assessing the phytochemical index in diet will help understand connection between phytochemicals and human health (Park et al., 2023).

BROAD OBJECTIVE: To assess Phytochemical Index in the Diets of University Students.

SPECIFIC OBJECTIVES:

1. To assess dietary pattern and nutrient intake of the university students.
2. To assess physical activity levels among university students.
3. To assess diabetes risk among university students
4. To investigate the association between dietary phytochemical (PI) and anthropometric measurements, blood pressure, diabetes risk, fasting blood sugar (FBS).

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REVIEW OF LITERATURE

REVIEW OF LITERATURE

Non-Communicable Diseases (NCDs) are chronic diseases that are not transmissible from one person to another. Taking this definition into account, NCDs may thus include wide spectrum of medical disorders both acute and chronic like Cancers, Diabetes, Hypertension, Cardiovascular Diseases and Stroke, Chronic Kidney Diseases (CKDs), Chronic Obstructive Pulmonary Diseases (COPDs) and Asthma, Non-Alcoholic Fatty Liver Disease (NAFLD), and a gamut of other diseases (**NCDs operational guidelines handbook, MoHFW, India, 2023).**

As per WHO, the NCDs are collectively responsible for more than 74 percent of all deaths worldwide including heart disease, stroke, cancer, chronic respiratory diseases and diabetes **(WHO,2022).** These diseases have public health importance globally and in India. NCDs cause significant morbidity and mortality, both in urban and rural population and across all socio-economic strata, with considerable loss in potentially productive years of life. NCDs are also responsible for the maximum out-of-pocket expenditure on health **(WHO,2011).**

Burden of Non-Communicable Diseases

Global Scenario:

The global NCD burden remains unacceptably high. NCDs are responsible for 41 million of the world's annual deaths. 17 million of these deaths were premature (30 to 70 years). Burden is greatest within low- and middle-income countries, where 77 percent of all NCD deaths and 80% of premature deaths occurred. Among NCDs, the four top killers that together account for more than 80% of all premature NCD deaths annually include cardiovascular diseases (17·9 million), cancers (9.3 million), chronic respiratory diseases (4.1 million), and diabetes (2.0 million) **(WHO,2022)**.

Indian Scenario:

As per the WHO – NCD India profile - 2018, NCDs are estimated to account for 63% of all deaths in country of which the cardiovascular diseases lead with 27% overall mortality cause followed by chronic respiratory diseases (11%), cancers (9%), diabetes (3%) and others (13%). **(WHO,2018)**.

As per India State-Level Disease Burden Initiative CVD Collaborators - 2016, there were 54.5 million cases of cardiovascular diseases, 23.8 million cases of ischemic heart diseases, 6.5 million cases of stroke, 55 million cases of COPD, 38 million cases of asthma and 65 million cases of diabetes (**India: Health of the Nation's States, The India State-Level Disease Burden Initiative, 2017)**.

In 2016, cardiovascular diseases were responsible for 28.1 percent deaths, while chronic respiratory diseases contributed to 10.9 percent deaths and cancers contributed to 8.3 percent deaths **(Non-Communicable Diseases Country Profiles 2018).**

Four common NCDs (Cardiovascular Diseases, Cancers, Chronic Respiratory Diseases and Diabetes) account for 23 percent of the total premature mortality in 30-70 years age group **(WHO, 2022)**.

As per the report of National Cancer Registry Program (2020), the incidence of cancer in India is 13.92 lakhs. Among males, cancers of lung, mouth, oesophagus and stomach are the leading sites across most of the registries. Among females, breast cancer is the commonest cancer followed by cervical cancer **(Report of National Cancer Registry Programme, 2020).**

Risk factors:

Most NCDs are strongly associated with major risk factors such as:

1. Tobacco use (smoking and smokeless)
2. Alcohol use
3. Unhealthy diets
4. Insufficient physical activity
5. Air pollution (indoor and outdoor)

If the above risk factors are not managed/modified, they may lead to the following biological risk factors:

1. Overweight/obesity
2. Raised blood pressure
3. Raised blood sugar
4. Raised total cholesterol/lipids

The other factors due to which an individual might develop NCDs are:

1. Stress
2. Hereditary factors (**NCDs operational guidelines handbook, MoHFW, India, 2023)**

As per National NCD Monitoring Survey (NNMS), 2017-18, the prevalence of risk factors associated with NCDs amongst adults (18-69 years) such as current tobacco use, current alcohol use, inadequate intake of fruits and/or vegetables intake and insufficient physical activity are 32.8%, 15.9%, 98.4% and 41.3% respectively in India **(Comprehensive National Nutrition Survey).**

However, as per the report of the 2nd round of the Global Adult Tobacco Survey (GATS-2) conducted in 2016-2017 among 15 years and above, there are 266.8 million tobacco users in India, i.e., around 28.6 percent of all adults use tobacco in any form (smoking or smokeless) **(Global Adult Tobacco Survey 2, 2016-17).**

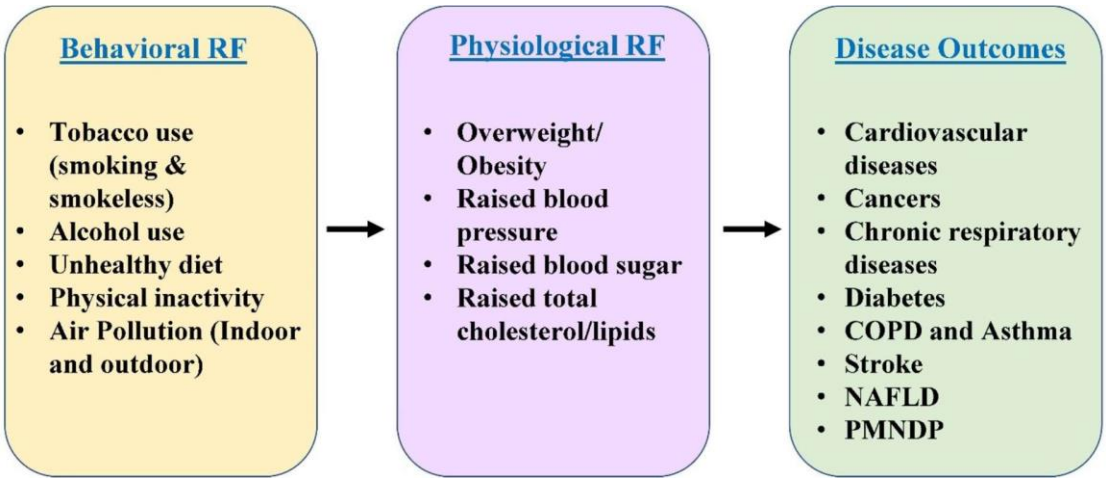

Figure 2.1 Types of risk factors in non-communicable diseases

Source: NCDs operational guidelines handbook, MoHFW, India, 2023

Dietary and lifestyle pattern of university students:

Undergraduate students encompass a substantial portion of the total population, that are likely to make poor judgement regarding their dietary habits. Tendency for consumption of unhealthy foods and poor dietary patterns is high, greatly due to lack of parental supervision, inadequate or incorrect knowledge regarding food habits and due to the stress of academic and professional as well as social life (Kapka et al., 2012).

Patterns of nutritional behaviours adopted in childhood and adolescents are mostly continued in adult life and hence their assessment becomes important to understand the risk for developing chronic diseases in the future. Poor eating habits is a major public health concern among young adults who transition into college or university life, when they are exposed to stress and lack of time. These factors pose an obstacle against the adoption of healthy behaviours and can therefore result in poor eating habits. Hence, to study further about the same a cross-sectional study was conducted at AIIMS, Patna over 2100 university students. The mean Dietary diversity score (DDS) was found to be 3.4, which was less than the good DDS category of 5 and above. 1057 (34.7%) had poor DDS (Dietary Diversity Score) whereas 868 (28.5%) had good DDS. 62.2% of the participants had normal BMI, 20.2% were overweight, 5.3% were obese and 12.3% were underweight, according to WHO criteria for BMI. The study found that most of the students in this study had healthy eating habits, including 3 timely major meals and 1 snack per day, except about 70% of total participants skipping breakfast at least once a week and about two-thirds eating fast food and beverages as their means of tackling short term hunger (Kumar et al, 2020).

In face-to-face interviews conducted in five universities in Ankara, Turkey it was found that breakfast and lunch were the most frequently skipped meals, with a total of 47.7% of students skipping breakfast and 25.2% skipping lunch. 25.1% for males and 5.6% for females were overweight. Also, 1.8% of male and 16.3% of female students were found to be underweight, probably because desire for a thin body size affects especially the nutritional status in women. Instead of DDS, nutritional intake was measured and it was found that 78.4% men and 81.1% women had energy deficiency, pointing towards poor nutritional status (Neslişah et al., 2011).

Addressing the nutritional issues and eating behaviours among university students is crucial for promoting good health and academic performance. University students are a target group for public health initiatives as they are at risk of developing poor eating habits due to various factors, including economic conditions, time constraints, and lack of information about nutritional concepts. These behaviours can lead to malnutrition or overnutrition, increasing the risk of preventable diseases. University students are susceptible to developing disordered eating attitudes and body dissatisfaction issues due to various sociocultural, biological, genetic and psychological factors. These attitudes can lead to the development of eating disorders, which are a range of food-related behaviours and attitudes that can cause bodily self-destruction. Eating habits and attitudes may also be influenced by gender, income, living arrangements and other environmental factors (Almorie et al, 2024).

A cross-sectional study was conducted at a public university in Brazil to study dietary pattern among nutrition students. 125 students studying at the campus were part of this study. The average age of students was 22.3 years. According to the analysis of the BMI, the healthy status was predominant in 70.4% of the students, however, after entering university, the students reported a change in weight. It was observed that in periods of greater academic activity there was a downward trend in the volume of meals in among 60.5% students. The pattern entitled “Traditional” consisted of roots/tubers legumes, dairy products, meat and eggs, fruits/natural juices and vegetables and explained 21.53% of the variability of food consumption. Pattern 2, labeled as ‘Exam Days” was made up of breads/cereals, sausages and artificial beverage accounted for 13.85% of the variability of food consumption. Pattern 3, entitled “End of the semester” was characterized predominately by candy/sugar and snacks and represented 13.39% of the variability of food consumption. Pattern 4 labeled “Anxiety” which was made up of coffee/tea and fats, explained 11.08% of the variation of food consumption. The factorial scores of candy/sugars and fruit were high and the group of fats (butter and margarine) presented a low factorial score. It was observed that 38.1% of the variation in food consumption considered inappropriate (exam days, end of the semester days and anxiety). Hence, the study concluded that the three patterns of food consumption were identified when associated with improper lifestyle, characterized by high academic demands, and physical inactivity can be considered risk factors for the onset of chronic diseases in adulthood or in later life (Pereira et al.,2016).

A cross-sectional study with 1448 university students was conducted in five universities of UK. It was found in the study that in terms of eating behaviours just two-thirds of students described themselves as regular meat-eaters, whilst approximately 10% of students identified themselves as vegetarian. Just over half (55%) of students reported that they were able to cook a wide range of meals from raw ingredients, and 73% consumed self-cooked meals from raw ingredients 'every' or 'most' days. One in four students reported that they consumed meals cooked from pre-prepared foods, which could be assumed to represent convenience foods, 'most days' or 'everyday'. Approximately 30% of students reported that they skipped breakfast at least most days. Just less than one quarter of students spent less than £20 on food each week; a weekly food budget of £20–29 was most common. Almost one in five students spent over £40 on food each week.

Also, to study dietary patterns four principal components were retained, which explained 21.7% of the total variance in food intake. The first component explained 8.4% variance; the three remaining components explained 5.7%, 4.2% and 3.4% of the variance in food intake respectively. The first dietary component had high positive factor loadings for pulses, beans and lentils, tofu, meat alternatives, hummus, nuts, and other green vegetables and salad items. It had high negative factor loadings for poultry, processed meat, and red meat and offal. This dietary pattern was labelled 'vegetarian', because there was a clear tendency towards consumption of non-meat protein sources and avoidance of all meat and fish products. The second dietary component had high positive factor loadings for biscuits, cakes and sweet pastries, milk- and cream-based desserts, confectionery, crisps and savoury snacks, fruit juice, other bread, pizza and fizzy drinks. This component was labelled 'snacking', because it was mainly characterised by snack-type foods that generally did not represent components of main meals, require no preparation and offer many options for mobile consumption. The third component had high positive factor loadings for fatty fish and canned tuna, white- and shellfish, nuts, eggs, fresh fruit, other green vegetables and salad items, oat- and bran-based breakfast cereals, herbal and green tea, and low fat/low calorie yogurts. This dietary pattern was labelled 'health-conscious', because it was characterised by foods typically associated with improved health, and was congruent with dietary components labelled 'health-conscious' or 'prudent' in other dietary pattern studies. Finally, the fourth component was labelled 'convenience, red meat & alcohol', because it had high factor loadings for

red meat and savoury foods requiring little or no preparation, and it was the only component with a positive loading on alcoholic drinks. There were also high factor loadings for fried food, pasta and rice, ready-made sauces, pizza, chips, alcoholic drinks, processed meat, red meat and offal, and eggs; there was a strong negative factor loading for low fat/low calorie yogurts. Hence in this study, four patterns emerged, with evidence of more healthful dietary practices amongst female and older students, and those with greater self-reported cooking ability. Male students tended towards a diet founded on convenience food, red meat and alcohol; this pattern was relevant to all participating universities (Sprake et al,2018).

A cross-sectional study conducted in the campus of Alagappa university located in Karaikudi, Tamilnadu, India studied Nutritional Status and Dietary Profile of College Students. The students were majority in the age category of 21-25 years (73.7 %) and minority in the age category of 26-30 years (12.3%). About Twenty-one (36.8%) of the respondents expressed to have unexplained weight loss/gain and 43 (75.4%) had good eating habits. Over 20 (35.1%) of the respondents skipped their meals and 13 (22.8%) had sleeping troubles. Over three-quarters of the respondents 49 (86.0%) reported that they had no food allergies and 8 (14.0%) had food allergies. Only four (7.0%) of respondents were getting up in the middle of the night to eat. More than half of the students 37 (64.9%) had to feel tired and weak and had done exercise regularly. According with the mini nutritional assessment scale scores, about 45.6 % of females and 5.3% of males, totally 50.9% of the students were belonged to normal nutritional status. Malnutrition category was seen among only female at the rate of 12.3 % and 36.8% of women and 3.5 % of men were at risk of undernutrition. Over half of the students 33 (57.9%) had a normal BMI, seventeen (29.8%) were overweight and Seven (12.3%) were underweight. Based on the assessment through Broca's Index, 26.3% of females and 3.5% of males were at good nutritional status while 38.6% of females and 5.3% were classified as undernutrition, and 26.3% of women were at risk of overnutrition. Based on all three assessment techniques, almost 50 % of the students were at the risk of either undernutrition or overnutrition. It is reported that only 50.9 % were good nutritional status according to mini nutrition assessment scale and 57.9% good nutrition grades were observed through Gomez classification and a minimum of 29.8 % good nutrition standard was observed through Broca's Index. The study found that poor nutritional status was

observed among almost 50 % of the college students particularly among girls (Gomathirajyashyamala et al., 2023).

Dietary diversity among university students:

The diet diversity also varies across geographical regions, as is evident by the research carried out at Athens Agricultural University in Greece, where a comparison had been done between students living at home and those who stay away from home. Students at home did not show major changes in their eating habits since starting University. But students living away from home decreased their weekly consumption of fresh fruit, cooked and raw vegetables, oily fish, seafood, pulses and olive oil, which are readily available in these regions and increased their sugar, wine, alcohol and fast food intake, suggesting that shifting away from home and taking responsibility for food preparation and purchasing for the first time affect dietary habits of students, consequently showing significant difference of food habits and consumption during comparison between the groups (Papadaki et al, 2007).

In a Southern Nigerian study carried out among undergraduate students in Igbinedion University, Okada, 49.0% of the respondents had high dietary diversity score (≥6) while 26.5% had low dietary diversity score (≤3), among whom more males (51.8%) had a significantly higher dietary diversity score compared to the females (47.0%) (Omage et *al.*, 2018).

A Chinese study showed increasing diet diversity with rapid urbanization in the past decades. As DDS increased, consumption also increased excessively in most food groups like grains, meat and oil, while consumption of other six food groups including cereals and vegetables were inadequate. In this way, people with medium (5) and high (≥6) DDS ingested more energy than the recommended quantity. The eating pattern was not balanced and 25.2% of the respondents had low DDS score (Zhang et al., 2017).

Physical activity status of university students:

A cross-sectional study was conducted in Banaras Hindu University (BHU), Varanasi, India titled ‘Patterns of physical activity among university students and their perceptions about the curricular content concerned with health’ recorded physical activity data via

International Physical Activity Questionnaire (IPAQ) of 4586 on-campus university students. 2828 (61.7%) were male and 1758 (38.3%) were female. The study reported that 14.5% of all students fall under the "inactive" category (14.4% among all male and 14.7% among all female students), about 71.3% of all students (72.1% among all male and 70% among all female students) fall under the "highly active" category, and about 14.2% of all students (13.5% of all male and 15.3% of female students) fall under the "active" category. It was concluded in the study that physical activity levels go on decreasing as the age increases (i.e students with the lowest physical activity rates belong to higher age groups, and highly active students belong to lower age groups) (Verma et al, 2022).

Overweight and Obesity among university students:

In a cross-sectional diet diversity study carried out in Ogun and Lagos states of South west Nigeria, 8% of the students were overweight and 3% were obese. The total dietary diversity score for male was 4.07± 1.84 while female had 4.53 ± 3.07, the difference being significant and the score being done for 9 food groups (Akinlua OAJ et al, 2014).

A study was conducted on 50 hostelites and 50 localites undergraduate medical students from Indira Gandhi Medical College (IGGMC), Nagpur to document both quantitative and qualitative dietary pattern among the students. From anthropometric measurements, it was calculated that 40% of students residing at hostel were underweight as compared to localites (10%). Also, 6% hostelites were found to be overweight compared to 4% of localites. There was statistically significant difference found between the two groups with respect to frequency of consumption of junk foods (Khan et al, 2015).

A study titled 'Assessing overweight/obesity, dietary habits, and physical activity in Hispanic college students' was conducted over 87 students aged between 18 to 45 years. In this study the average age of the Hispanic students was 24.03 years and 51.7% were male (n=45) and 49.4% were females (n=42). In this study it was found that the mean BMI was in the overweight range (27.29 kg/m2), male mean BMI (27.77 kg/ m2) was slightly higher than female mean BMI (26.78 kg/m2). Approximately 40.2 % of students were in the normal BMI range. 5.7% of students were in extremely obese range, 22.9% of students were obese, and 28.7% of students were in the overweight range. The remaining 2.29% students were underweight.

The results of the DSQ survey revealed that only 34% students consumed fruits-fresh, frozen or canned- 3-4 times per week or less in the past month. Not only fruit, but also green leafy or salad consumption was below recommended amount. Green leafy or lettuce salad consumption reported as two times per week or less in a month for the majority of study participants (73%). Similarly, milk consumption was well below the suggested amount, only 40% reported having milk 2-3 times or less in the past month. On the contrary, one time per week or more, 61% of students reported eating chocolate or candy, 36% of them eating cookies, cakes, pie, brownies, 29% of them having doughnuts. Overall, DSQ survey results in the current study revealed inadequate intake of fruits and vegetables as well as dairy, however, high sugary food consumption was rampant among Hispanic college students.

According to Godin scale score, it was estimated that 65% of the participants were physically active. However, female PA level was considerably lower than male PA level. Only 25% females were in the active category as opposed to 40% of males. Similarly, 15% of females were in the sedentary category but only 2.5% of males were identified as such. Hence, the key findings of this study were overweight and obese for Hispanics young adults may be due to a decrease in PA throughout their college career. Moreover, food consumption data also revealed an important insight regarding their preference on key food group consumption: frequent consumption of high sugary food groups rather than dairy, fruits and vegetables **(**Karabulut et al, 2018).

A cross-sectional study was conducted in 5 colleges of Vadodara and Patan city of Gujarat to study the prevalence and determinants of obesity and overweight among the college students. 1330 students aged between 18-23 years were part of the study. In this study overall, the total number of obese students identified in the population were 81 (6.1%) and numbers of overweight students were 146 (11.0%). Overall prevalence of obesity was more among male population (6.4%) as compared to that in females (5.8%). Though the prevalence of overweight was more among males (11.3%). The prevalence of obesity was found to be highest among 23 years age group (9.1%). The prevalence of overweight was maximum in 21-year age group (15.8%). The prevalence of obesity and overweight was higher amongst less active group (6.5% and 13.4% respectively). The numbers of students with total sports-physical activity time per week $\leq$2 hour was only 382. The prevalence of obesity and overweight was higher amongst less active group

(6.5% and 13.4% respectively) as compared to more active group. The number of students, who spent above 2 hours in front of television or computers for any purpose, was 277. The prevalence of obesity and overweight was significantly higher (17.7% and 21.3%) amongst those who spent greater time in front of television, mobiles and computers as compared to the other group who spent ≤2 hours in front of television or computers per day. The number of students with daily calorie intake >RDA (Recommended Dietary Allowance) was 241. The prevalence of obesity and overweight was significantly higher amongst group who took daily calories above RDA (21.5% and 22.8% respectively) as compared to the other group. The numbers of students taking junk foods more than twice a week were 696. The prevalence of obesity and overweight was significantly higher in them (9.3% and 14.8%) as compared to those who took junk food less than or equal to 2 times per week (2.5% and 6.8% respectively). The number of students taking vegetarian diet was 765 as compared to those who took mix diet who were 565. The prevalence of obesity and overweight was significantly higher amongst those who took mix diet (8.1% and 13.1%, respectively) as compared to vegetarians. The number of students with either parent having history of obesity was 98. The prevalence of obesity and overweight among students having parents with history of obesity was 225.5% and 23.4%, respectively which was significantly higher than those without parental history of obesity (4.5% and 9.9%). The study concluded that the prevalence of obesity and overweight was significantly higher in students with sedentary lifestyle, high consumption of junk food and high calorie diet with positive family history of obesity (Panchal et al, 2019).

Phytochemicals

Phytochemicals exist as long as plants exist but we only know about hundred years about their existence. Phytochemicals are basically categorized as primary or secondary constituents, depending on their role in plant metabolism. Primary constituents include the common sugars, amino acids, proteins, purines and pyrimidines of nucleic acids, chlorophyll's etc. Whereas, the secondary constituents are the remaining plant chemicals such as alkaloids, terpenes, flavonoids, lignans, plant steroids, curcumins, saponins, phenolics, flavonoids and glucosides

(Saxena *et al.* 2013; Thakur *et al.* 2018). The main classes of the phytochemicals are shown in the following figure 2.2

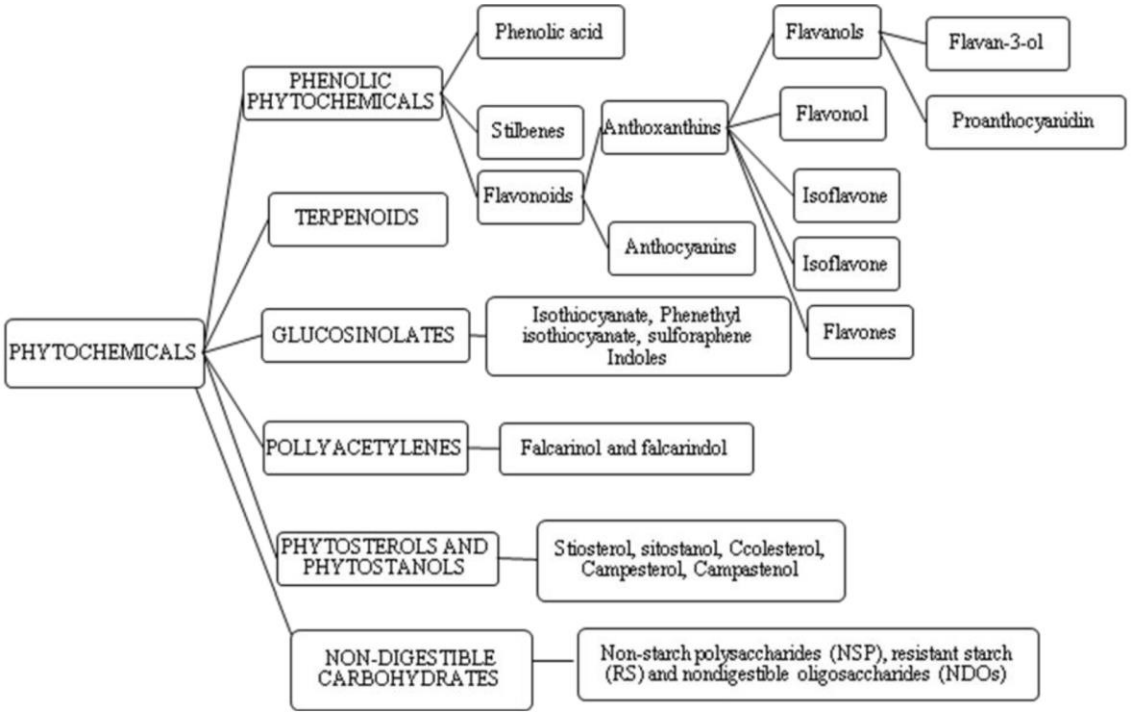

Figure 2.2. Classification of Phytochemicals

Source: Thakur and Sharma et al, 2018

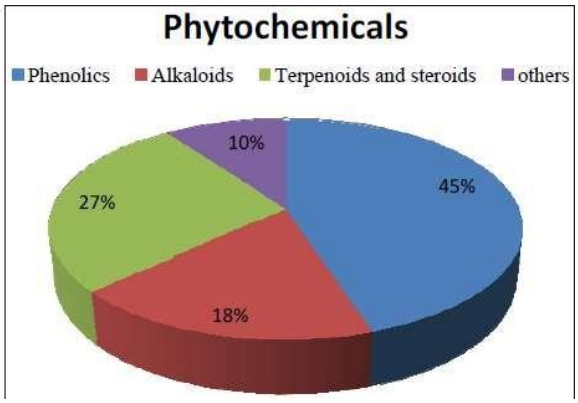

Figure 2.3 Sub-divided categories of Phytochemicals

Further, based on their chemical structure, phytochemicals are classified into the categories but basically they are subdivided into three main categories i.e. phenolic acids, flavonoids and stilbenes or ligans. These flavonoids are further subdivided into anthocyanins, flavones, flavanones, isoflavones as well as flavonols and flavanols (Wen and Walle, 2006). The percent share of main phytochemicals present in plants especially fruits and vegetables are represented in the figure above (Thakur and Sharma *et al*, 2018). Phytochemicals, are non-nutritive plant chemicals that have either defensive or disease protective properties. They are nonessential nutrients and mainly produced by plants to provide them protection. Dietary intake of phytochemicals may promote health benefits, protecting against chronic degenerative disorders, such as cancer, cardiovascular and neurodegenerative diseases. Majority of foods, such as whole grains, beans, fruits, vegetables and herbs contain phytonutrients/ phytochemicals. These phytochemicals, either alone and/or in combination, have tremendous therapeutic potential in curing various ailments. Phytochemicals with nutraceutical properties present in food are of enormous significance due to their beneficial effects on human health since they offer protection against numerous diseases or disorders such as cancers, coronary heart disease, diabetes, high blood pressure, inflammation, microbial, viral and parasitic infections, psychotic diseases, spasmodic conditions, ulcers, osteoporosis and associated disorders (Dhanprakash et al, 2012).

Phytochemical Index:

In recognition of the key role of phytochemicals in health promotion, Mark F McCarty proposed that diets be characterized by a "phytochemical index" (PI), defined as that percentage of dietary calories supplied by foods typically high in phytochemicals: fruits, vegetables (not including potatoes, but including other tubers), legumes, nuts, seeds, whole grains, and foods compounded therefrom. Fruit and vegetable juices, although lacking fiber and some of the phytochemical content of rinds or peels, are often rich in phytochemicals, and thus should be counted in the index. Similarly, wine, beer, and cider qualify in this regard, but not distilled hard liquors. Soy protein, though evidently not a whole food, is usually a good source of isoflavones, and thus should be counted. Extra virgin olive oil is relatively rich in absorbable antioxidants and thus might be given

“partial credit”, but most other oils used in cooking, although containing some fat-soluble phytochemicals, are low in phytochemicals on a per-calorie basis, and thus should be excluded from the index. Theoretically, a vegan diet that excluded refined grains, potato products, hard liquors, and added sugars and oils could have a PI of 100. Sadly, the PI of most current American diets would be unlikely to be as high as 20 – which means that there would bequite ample room for improvement (Mark F McCarty et al,2002).

Association of Phytochemical index with overweight and obesity:

A cross-sectional study was conducted to evaluate the association between the dietary phytochemical index (DPI), refelecting the phytochemical content of the diet , and general and central obesity in Iranian adults. In this cross-sectional study**,** 850 men and women, aged between 18 and 59 years, from different health care centers in five areas of Tehran, Iran were recruited. Out of the total subjects 31% were male and 69% were female.The prevalence of central obesity defined by WHtR, WHR, and WC was 81.1%, 42.2%, and 48.6%, respectively. General obesity (BMI ≥ 30 kg/m2) had a prevalence of 28.2%. For BMI and age, the mean ± SD of participants was 27.9 ± 5.6 kg/m2 and 44.7 ± 10.7 years, respectively. The DPI score in men and women were 33.7 ± 24.7 and 36.2 ± 26.8, respectively.Women in the top quartile of the DPI (i.e DPI= 45.74-205.45) had a lower odd of central obesity by waist circumference.Men in the third quartile(i.DPI=28.93-45.7) of the DPI were at lower risk of central obesity by waist-to-hip ratio. The study concluded significant inverse association between DPI and central obesity in women (Asgari et al., 2021).

A cross-sectional study was conducted to determine whether the phytochemical index(PI) score is related to adiposity,weight gain,oxidative stress and inflammation. For this study fifty-four men and women (18–30 years of age; 19 men,35 women) were part of this study. Participants were placed into one of two groups based on body mass index (BMI) values: normal weight (BMI<25 kg m)2) and being overweight (>=25 kg m). Among the participants, 26 were normal weight and 28 were overweight/obese (BMI values in the range 25.7–52.5 kg m)2). The obese group had a PI value 10.3% lower than that of the normal weight group. The PI score was also positively correlated with the total carotenoid intake [a sum of all carotenoids carotenes, lutien,lycopene, lutein (+ Zeaxanthin), b-cryptoxanthin]. Among all participants, significant inverse correlations were found between the PI value and BMI, body weight, waist-circumference, waist-to-hip and body

fat percentage. PEROX values were found to be correlated with the PI value. An inverse association between the PI index and weight gain over the last year was significant. Hence, the study found out that the PI score was inversely related to several indices of adiposity, weight gain and oxidative stress (Vincent et al,2009).

A nation- wide cross sectional study conducted on 4296 students aged 6-18 years old in 30 provinces of Iran to determine the association of total dietary phytochemical intake with generalized and abdominal obesity in children and adolescents. From the given subjects 52.5% were male and 47.5% were female. The mean (SD) age of the participants was 11.39 ± 3.20 years. DPI scores in the first, second, third and fourth quartiles varied as < 17.14, 17.14–23.59, 23.59–32.07 and >32.07. The mean DPI scores were 24.99 ± 11.56, 25.62 ±11.60, and 25.03 ± 11.18 in underweight, normal weight, and overweight/obese children and adolescents, respectively. In this study, it was found that the anthropometric measures including weight, weight Z-score, BMI, BMI Z-score, WC, HC, and NC were significantly lower among participants in the upper DPI quartile compared with lower quartiles. There were significant differences in the mean levels of BMI, HC, and NC across DPI quartiles in overweight and obese children and adolescents. Overweight and obese children and adolescents in the 4th quartile of DPI had lower BMI, HC, and NC compared with those in the first quartile. The study concluded that DPI is inversely related to anthropometric measures of general and abdominal obesity in children and adolescents. Although, the results were not statistically significant. This relationship was particularly more evident in overweight and obese individuals (Azizi and Soleiman et al.,2021).

A cross-sectional study was conducted to examine the relationship between the dietary phytochemical index (DPI) and overweight/obesity in children. The study comprised of 356 children aged 7 to 10 years old study in the city of Tehran, Iran. Out of the total

subjects 53.6% were boys and 46.4% were girls. The mean age of children was 8.61. The prevalence of overweight and obesity was 21.6% and 13.5%, respectively. The mean (SD) of the DPI was 14.25 (4.13), 24.12 (2.64), 35.41 (3.62) and 61.52 (16.47) in the first, second, third and fourth quartiles, respectively. It was found that that a higher load of phytochemicals in the diet was inversely associated with the risk of being overweight/obesity in children. Higher DPI was also accompanied by a better diet quality characterized by a higher intake of dietary fiber, vitamin C and potassium in the study population. The study concluded that a diet loaded with high phytochemical-rich foods was associated with a lower risk of overweight/obesity in a sample of school-aged children in Iran (Eslami et al., 2020).

To study the the dietary phytochemical index (PI) in relation to 3-year change in weight, waist circumference (WC), body adiposity index (BAI) among Tehranian adults a longitudinal study was conducted in the framework of Tehran Lipid and Glucose Study, between 2006–2008 and 2009–2011, on 1938 adults, aged 19–70 y. The mean age of participants was 40.4 ± 13.0 y, and mean BMI was 27.03 ± 4.9 kg/m2 at baseline; 47% of participants were men and 53% participants were female. The mean weight gain was 1.49 ± 5.06 kg (1.65 ± 5.3 kg in men and 1.34 ± 4.9 kg in women) during the 3-year period. The means for WC of participants at baseline and 3-year change in WC were 89.6 ± 13.2 cm (94.8 ± 10.8 in men, and 85.6 ± 13.6 in women), and 4.3 ± 6.9 cm (1.8 ± 4.8 in men, and 6.3 ± 7.7 in women), respectively. The means for BAI at baseline and BAI change during 3 years were 30.6 ± 6.3% (26.0 ± 3.4 in men, and 34.2 ± 5.8 in women), and −0.02 ± 2.28% (0.42 ± 1.71 in men, and −0.37 ± 2.5 in women), respectively. The mean PI was 29.8 ± 12.3 (28.5 ± 12.1 in men, and 30.9 ± 12.3 in women), and dietary PI ranged from 20.9 to 37. The DPI quartiles were Q1= <20.9, Q2= 20.9-28.3, Q3= 28.4-37.1 and Q4=>37.1 respectively. It was observed in the study that increased energy intakes, more than 37% of energy, from phytochemical rich foods could prevent weight gain and decrease body adiposity in adults during 3 year follow-up. Higher intakes of whole grains and fruits appeared to benefit more than other phytochemical-rich foods in prevention of weight and body fat gain. It was also observed that higher intakes of phytochemical-rich foods and dietary PI in older; it suggesting that older participants are more likely to have healthy diets characterized by the consumption of plant foods. The results showed that dietary PI

was inversely associated with change in body adiposity during the study follow-up; participants with higher dietary PI had 1.47% decrease in BAI as compared with the reference group. In addition to dietary PI, higher intake of whole grains in this study was inversely associated with 3-year changes in weight and BAI; higher intake of fruit was also related with lower weight gain. Thus, the study concluded that that increased dietary PI score as energy intake from phytochemical rich foods, especially whole grains and fruits, had favourable effects on prevention of weight gain and decrease of body adiposity during 3-year follow-up, as main factors contributing to development of chronic disease (Mirmiran et al.,2012).

Association of Phytochemical index with cardiovascular risk factors and disease: To investigate the relationship between DPI and oxidative stress status and cardiovascular risk factors in adults with obesity a cross-sectional study was conducted on 140 obese male and female subjects with a body mass index (BMI) of ≥ 30 kg/m2 and the age range of 20–60 years who attended the out-patient clinics affiliated to Zabol University of Medical Sciences, Tehran, Iran. In this study, 140 obese subjects were included in the study. The mean age of participants were 41.0 ±7.3 years and 55.0% of them were males. The DPI in this study ranged from 14.9 to 56.0 with the mean ± SD of 30.7 ±7.1. The DPI in the first, second, and third tertiles was < 27.3, 27.3 to 33.9 and > 33.9, respectively. The results of the present study indicated a positive correlation between DPI and consuming olives, olive oils, grains, fruits, and vegetables. DPI was inversely associated with serum concentrations of TG, MDA, erythrocyte SOD activity, and hs-CRP levels. In addition, TAC was positively associated with DPI score. In the study, DPI score was positively associated with serum TAC levels, but inversely correlated with SOD activity. Since, SOD enzyme is part of the first line of defence against free radicals, it is expected that this inverse correlation may indicate the compensatory response to decreased oxidative stress by increasing phytochemical intakes through DPI tertiles. These findings support a role for dietary phytochemicals in the antioxidant defence system. The study confirmed that there was a significant inverse association between DPI and oxidative stress, inflammation, and hypertriglyceridemia as CVD risk factors in obese population (Shahraki, et al.,2023).

With an objective to evaluate the association between the PI and risk factors for cardiovascular disease in adults a cross-sectional study with 141 adults, between 20 and 59 years of age was conducted in Brazil. The mean PI in the this study was 11.72. The study found out that showed that PI was inversely associated with BMI and positively associated with HDL-cholesterol. Thus, the study concluded that a higher intake of phytochemicals, expressed by PI, was inversely associated with BMI and positively associated with HDL-cholesterol (Carvalhaes et al, 2023).

Assesment of Phytochemical index among young adults:

A cross sectional study was conducted in Mumbai on 239 subjects aged 17years to 25 years with the mean age of 19 years. Sample included 75% (n=178) of females and 25% (n=61) of male subjects. The tool used was a questionnaire that included demographic, anthropometric details and one day 24 hours diet record. 22 nutrients and dietary PI was calculated according to gender, age and body mass index (BMI). The study found out that the mean consumption of total calories in females was similar across both age groups, and in males the total energy intake was seen to be higher among the younger population. The protein and carbohydrate consumption was found to be higher among the younger subjects. The micro nutrient pattern of the older subjects was found to be better than the younger subjects. The consumption of alpha tocopherol was evident to be higher among the subjects aged above 20years. The magnesium intake was also found to be better among the older subjects as compared to the younger subjects. The macronutrient consumption across the four BMI categories was found to be in the similar range. The higher total energy and protein intake was seen in the over-weight subjects. The carbohydrate consumption was found to be higher in the obese subjects and higher fat intake was evident in the over-weight subjects. The pattern of micro nutrient intake was found to be in the similar range across the BMI categories. The intake of magnesium and total polyphenols was seen to be the higher among the obese subjects and second highest among the normal weight subjects. The consumption of nuts and seeds was seen to be better among the older subjects as compared to the younger group of subjects. A better dietary Phytochemical Index (PI) score was evident in the older age group of subjects in the age range of 20 years or above. PI score for male (17-19 years of age-group) was 45.5 and that for female (17-19 years of age-group) was 46.1. Similarly the PI score for male and female (20-25 years of age group) was 47.1 and 51.9 respectively. PI score for BMI

categories (<18.50kg/m^2, 18.50-22.99kg/m^2,23-24.99 kg/m^2, >25kg/m^2) were 48.88,48.1,43.5 and 49.9 respectively.

The present study revealed that the nutrient pattern across male and female subjects was found to be lower than the recommended intakes. The macro nutrient pattern across age group was found to be better among the younger subjects and the pattern of micro nutrients was seen to be better in the older subjects. The dietary phytochemical index score was found to be better among the female subjects as compared to the male subjects. The PI score improves with age and a better score was found in the older subjects (S. Khandagale et al, 2018).

Association of Phytochemical index with prediabetes, types of diabetes mellitus and diabetic nephropathy:

A case-control study was conducted in Kowsar Diabetes Clinic in Semnan, Iran.105 women were chosen as cases with DN. 105 controls were selected by a 1:1 matching to 105 cases by age at 1-year intervals and diabetes duration at 6-month intervals without DN. In this study, the mean ±SD of age in group of case were 55.33±7.04 (years), whilst the mean ±SD of FBS and serum creatinine, albumin, and dietary PI in (case and control) groups were (167.10 ±50.62–154.19 ±45.03) (mg/dl), (0.92±0.16–0.87±0.17) (mg/dl), (14.40±11.94–8.37±6.76) (mg/dl) and (88.01±29.96–103.28±43.83), respectively. In addition, in the case group, those in the higher adherence of median of dietary PI had a lower level of FBS. In the control group those in higher adherence of median of dietary PI had a lower level of albumin. The results of the study showed that compared to the control group, case group participants had a lower daily intake of vegetables, fruits, grains, legumes, and olives. In addition, higher intakes of mentioned food groups in the higher adherence of median of dietary PI in controls may have an effective influence in the decreasing risk of DN in control group. Also, the findings of study suggest that phytochemicals could have a protective effect on DN, as we observed a negative relationship between dietary PI and the risk of DN. The study drew a conclusion that there is inverse relationship between consumption of foods rich in phytochemicals and risk of diabetic nephropathy in a sample of Iranian women (Bahrampour et al, 2023).

To investigate the relationship between DPI and the risk of prediabetes a case- control study was conducted among 300 men and women including 150 healthy and 150 prediabetic participants from diabetes screening center in Shahreza, Iran. 150 participants

with prediabetes (cases) and 150 healthy individuals with normal fasting blood glucose (FBG) (control) were recruited.The results found out that prediabetic participants consumed fewer phytochemical-rich foods from all the food groups, and subsequently, had lower DPI score than their control counterparts. Furthermore, other characteristics such as energy intake (2433.1 ± 290.7 vs. 2231.4 ± 297.5 kcal/d), fasting blood glucose (FBG) (109.2 ± 6.5 vs. 82.1 ± 7.1 mg/dl), and OGTT (143.6 ± 18.3 vs. 120.4 ± 9.5 mg/dl) were also higher in prediabetic participants in comparison with control group. Participants in the upper quartiles had lower FBG, OGTT and and higher physical activity level. The relative contributions of different phytochemical-rich food groups to DPI were relatively similar in men and women. Regarding the sources of DPI, fruits (approximately 46%) were the main contributor to DPI, followed by the legumes, vegetables, nuts and seeds, olive, olive oil, and whole grains. The results also showed that compared to the control group, prediabetic participants had fewer daily intake of fruits, vegetables, whole grains, nuts and seeds, legumes, olive, and olive oil. Mean score of DPI in control group were significantly higher than prediabetic group (mean DPI of control= 40.6± 23.3 and mean DPI of pre-diabetic= 28.6±13.4). Thus, the study concluded that lower PI score is related to higher prediabetes (Abshirini, et al, 2018).

To assess the relationship between DPI and CVD risk factors in patients with type1 diabetes mellitus a cross- sectional study was conducted among a total of 261 participants aged 18–35 years with T1DM. The mean ±SD age of participants was 25±5.4 years and 62.1% of the participants were women. DPI in the first, second and third tertiles of energy-adjusted DPI was < 31.75, 31.75–40.06, and > 40.06, respectively for females and < 27.73, 27.73–36.05, and > 36.05, respectively for males. The study found out that participants in the highest tertile of DPI had 88 % lower chance of hyperglycemia, 81 % lower chance of low highdensity lipoprotein cholesterol (HDL-C) and 98 % lower chance of high low-density lipoprotein cholesterol to HDL-C ratio. The study concluded that higher intake of phytochemical rich food, measured by DPI score was associated with lower chance of some CVD risk factors including dyslipidemia and high FBG in patient with T1DM (Aghdam et al., 2021).

To clarify the possible causal effect of the pre-pregnancy dietary phytochemical index (DPI) on gestational diabetes mellitus (GDM) a cohort study 1,856 pregnant women aged

18–45 years who were in their first trimester, were recruited and followed up until delivery. The DPI score of the women's diet ranged from 6.1 to 89.4 with a median (IQR) of 40.3 (19.8). Also, the DPI score of women across quartile categories in the first, second and third quartiles was 30.9, 40.3, and 50.8, respectively. Pregnant women in the highest quartile had a higher frequency of pre-existing diabetes, GDM, and a family history of diabetes. Also, they had a higher pre-existing BMI and dietary caloric intake (kcal/day). The overall mean DIP in the women with and without GDM were 41.5 ± 13.6 and 41.1 ± 13.8, respectively. This prospective cohort study among pregnant women suggested that the DPI has no impact on GDM (Heidarzadeh-Esfahani et al.,2024).

Association of Phytochemical index with metablic syndrome and cardiometabolic risk factors:

A study was conducted to calculate a phytochemical index (PI) and examine its association with metabolic syndrome in the Korean population. The average PI value was higher in women than in men (16.49 ± 0.12 vs. 12.68 ± 0.11)Moreover, the caloric intake levels of all PI components except for soy products were significantly higher in women than in men. The DPI quartiles were Q1= 3.23, Q2=7.40, Q3=12.04, Q4=18.23 and Q5= 30.82 respectively. It was observed in this study that that higher PI levels were associated with a lower prevalence of various forms of metabolic dysregulation, including abdominal obesity, hyperglycemia, high blood pressure, hypertriglyceridemia, and metabolic syndrome. In this population, whole grains, vegetables, and fruits were major food sources contributing to PI. Generally, women consumed larger amounts of whole grains, vegetables, fruits, nuts and seeds, and olive oil than men and therefore, tended to have higher PI values. The study concluded that higher intakes of phytochemical-rich foods are associated with a lower prevalence of metabolic dysregulation and consequently, cardiometabolic diseases (Kim and Park et al., 2020).

To evaluated the association between DPI with cardiometabolic risk factors (CRFs) and Metabolic syndrome (MetS) and its components a cross-sectional analysis of 2009 to 2012 data of Colaus cohort study (Lausanne,Switzerland), including 3879 participants (mean age 57.6 ± 10.4 years, 53.5% women). The quartile ranges were Q1= 12.5, Q2=21.6, Q3=29.8, Q4=43.4 respectively. The median (IQR) DPI value for the included population was 25.5. The observed distribution of total and phytochemical rich foods (PRF)-derived daily energy intake across quartiles suggests that, when applying DPI,

emphasis should not only be on the quantity but also the sources of calories consumed, particularly PRFs. By prioritizing the consumption of PRFs, individuals in the higher quartiles increase their phytochemical intake without merely relying on higher caloric intake. This highlights the importance of considering the quality and composition of the diet when evaluating the association between dietary phytochemical intake and CRFs. When food groups were assessed as DPI caloric contributors, fruits were the principal contributor in each quartile, followed by whole grains, highlighting the importance of these food groups as DPI contributors. Furthermore, the relative contribution of alcoholic beverages decreased as quartiles increased. This decrease can be attributed to the higher caloric intake from other PRFs, such as whole grains and fruits, as mentioned above. The findings suggest that participants in higher DPI quartiles prioritize healthier PRFs, leading to a more balanced dietary pattern. Also, DPI was inversely associated with WC, BMI, insulin, leptin, and hs-CRP.

The study concluded that A diet high in PRFs assessed via DPI is associated with lower WC, BMI, insulin, leptin, hs-CRP values, and lower odds of central obesity, indicating a potential protective effect of phytochemical intake on these CRFs and highlighting the importance of high PRFs intake in promoting cardiometabolic health (M. Gamba et al., 2023).

RATIONALE OF THE STUDY:

- Phytochemicals refers to the variety and concentration of bioactive compounds found in plant-based foods, which are known to contribute to health and well-being. Phytochemicals are associated with various health benefits, including antioxidant, anti-inflammatory, and anticancer properties. With rising concerns about diet-related health issues among young adults, particularly university students, assessing the phytochemical index of their diets is crucial for understanding its potential impact on their health. Assessing the phytochemical index among university students is a necessary step toward improving health outcomes in a population that is often at risk for poor dietary choices. By understanding their phytochemical intake, we can better support students in achieving optimal health and nutritional status.

BROAD OBJECTIVE: To assess Phytochemical Index in the Diets of University Students.

METHODS AND MATERIALS

METHODS AND MATERIALS:

Non-communicable diseases (NCDs) among Indian youth pose a significant public health challenge due to their rising prevalence and substantial impacts on health and economic stability. This shift from infectious diseases to chronic conditions such as diabetes, cardiovascular diseases, and cancers is the primary driver of morbidity and mortality among young Indians. Critical modifiable risk factors, including unhealthy diets, sedentary lifestyles, and substance abuse, coupled with non-modifiable factors like genetics and socio-economic conditions, significantly contribute to NCD prevalence (Joshi et al, 2024).

University life is a critical period for establishing healthy eating habits and attitudes. However, university students are at risk of developing poor eating habits due to various factors, including economic conditions, academic stress and lack of information about nutritional concepts. Poor diet quality leads to malnutrition or overnutrition, increasing the risk of preventable diseases. Disordered eating habits and body dissatisfaction are prevalent among university students and can lead to eating disorders.

Major nutrients present in food are macronutrients (protein, carbohydrate, and fats) and micronutrients (minerals and vitamins) that perform important functions in maintaining human health. Some biologically active components in the food, known as phytochemicals or phytonutrients, also play a necessary role in human health.

Phytonutrients are plant-based nutrients, also known as phytochemicals, which have important positive effects on human health. They support the health and regular functioning of the human body and increase life span. Phytonutrients perform major therapeutic functions in the management and treatment of various diseases. Various types of uninvestgated species of plants are also other sources of nutrients and biologically active phytochemicals with different healthful effects.

Thus, the present study was undertaken with a broad objective to assess the phytochemical index in the diet of university students. The study will help to know phytochemical index in the diet of university students and its association with FBS, physical activity as well as anthropometric measurements. The present study will also assess the physical activity levels of university students, their nutrient intake, dietary pattern and diabetes risk as well.

The study was approved by the Institutional Ethics committee for Human Research, Faculty of Family and Community Sciences, The Maharaja Sayajirao University, Baroda. The study has been allocated an ethical approval number:

SPECIFIC OBJECTIVES OF THE STUDY:

To assess Phytochemical Index in the Diets of University Students.

BROAD OBJECTIVES OF THE STUDY:

To assess dietary pattern and nutrient intake of the university students.

To assess physical activity levels among university students.

To assess diabetes risk among university students

To investigate the association between dietary phytochemical (PI) and anthropometric measurements, blood pressure, diabetes risk, fasting blood sugar(FBS).

PLACE OF THE STUDY:

The study was carried out at the faculty of family and community sciences, The Maharaja Sayajirao University of Baroda.

SAMPLING:

Students from different departments of the Faculty of Family and Community Sciences (N = 401) were approached for the study.

Sample technique: Purposive sampling

N=500

n= Z^2xPx(1-P)/d^2

n=(1.96)^2x0.3566x(1-0.3566)/(0.05)^2

n= 352

With 10% attrition, the total sample size sums up to 387.

Prevalence (case fatality rate): Prevalence of obesity and overweight among university students is 35.66%.

STUDY DESIGN:

The study was conducted in one phase. The details of the same are given below.

A cross-sectional study design was used to assess the phytochemical index in the diet of university students.

Enrollment of subjects: Those subjects were enrolled in the study who gave informed consent and filled up the questionnaire.

Inclusion criteria:

University students willing to participate in the study.

Exclusion criteria:

Students unwilling to participate.

STUDY TOOL:

A semi-structured questionnaire was used to collect data from the subjects (Appendix-III). In total the questionnaire contained 50 questions. The questionnaire was divided into 7 parts. The questions included questions about individual's background. The questionnaire included questions about individual's background, socio-economic status, habits, medical condition, family medical history, anthropometric measurements, dietary pattern, nutrient intake, physical activity, diabetes risk and food frequency.

Investigator filled up the questionnaire by conducting one-to-one interview with the subjects who gave their written consent and agreed to participate. Biophysical parameter(blood-pressure), biochemical parameter (FBS), and anthropometric measurements of the subjects were collected by the investigator. In the consent form, the study's description and purpose were stated (Appendix -II). Around 401 people agreed to participate in the study and completed the personal interview.

PRIMARY OUTCOME OF THE STUDY: The Phytochemical index of the diets taken by university student will be known.

SECONDARY OUTCOME OF THE STUDY: Association between dietary phytochemical (PI) and anthropometric measurements, blood pressure, diabetes risk, fasting blood sugar (FBS)

TOOLS AND TECHNIQUES USED

1. A semi-structured questionnaire will be used to collect data on socio-economic status, dietary pattern and nutrient intake.
2. The anthropometric measurements will be taken using standard methods.
3. Dietary assessment will be assessed by using 24- hour dietary recall method and dietary diversity score.
4. Frequency of consuming phytochemical rich foods will be assessed by food frequency questionnaire.
5. The Physical activity will be assessed by International physical activity questionnaire.
6. The diabetes risk will be assessed using the IDF risk score.

7. The blood pressure will be checked with the help of sphygmomanometer and Fasting blood sugar (FBS) will be assessed using a glucometer.

STATISTICAL METHODS USED:

The data will be entered in an excel sheet and will segregate properly. The calculation of the following will be done:

1. Mean and standard deviation

2. Percentages

3. T-test

4. Chi-square test

5. Anova

Figure 3.1 EXPERIMENTAL PLAN FOR THE ASSESSMENT OF PHYTOCHEMICAL INDEX IN DIET OF UNIVERSITY STUDENTS.

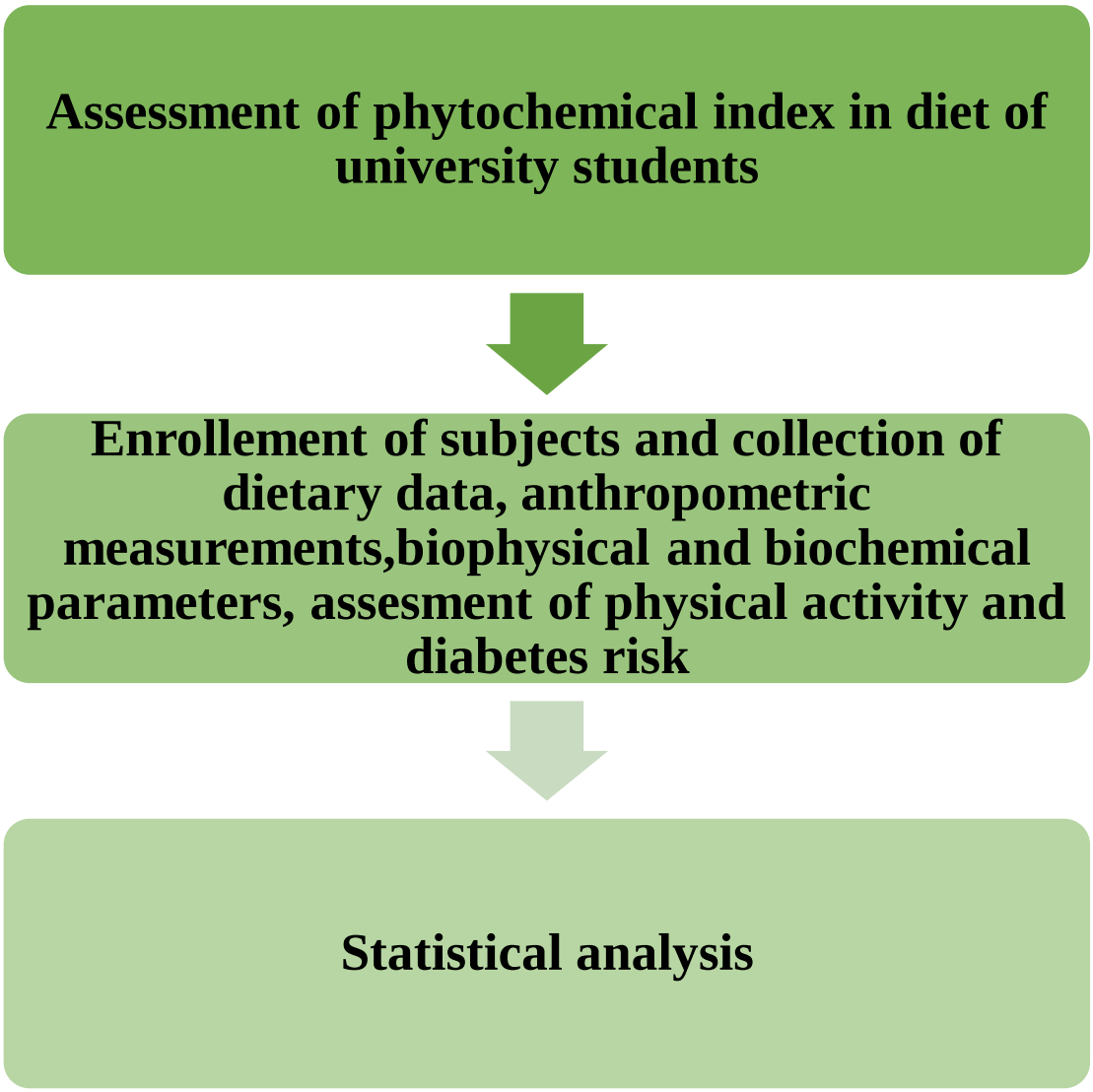

Table 3.1 METHODS, TOOLS AND TECHNIQUES FOR DATA COLLECTION

PARAMETERS	METHODS/TOOLS
General information	Pre-tested questionnaire
Anthropometric measurements	Pre-tested questionnaire
Medical and Family history	Pre-tested questionnaire
Dietary pattern	Pre-tested questionnaire
Nutrient intake	24-hour dietary recall
Physical activity	IPAQ
Dietary diversity	Food-frequency questionnaire
Diabetes risk	IDF risk score card

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Adolescence and young adulthood are generally considered healthy times of life, several important public health and social behaviors and problems either start or peak during these years. NCDs include a number of conditions that are behavior linked and lifestyle related in nature. Indian population, especially young people, is passing through a nutritional transition and is expected to witness higher prevalence of adult non-communicable diseases such as hypertension, diabetes and chronic lung diseases in the coming years.

Addressing the nutritional issues and eating behaviors among university students is crucial for promoting good health and academic performance. University students are at risk of developing poor eating habits due to various factors, including economic conditions, time constraints, and lack of information about nutritional concepts. These behaviors can lead to malnutrition or overnutrition, increasing the risk of preventable diseases.

University students tend to consume energy-dense foods, skip meals, eat junk and fast-cooked foods, and engage in low physical activity and prolonged computer and TV use. Cultural and socioeconomic factors also influence food intake in different countries. Poor diet quality is linked to many chronic diseases, such as cardiovascular disease and type 2 diabetes.

Phytochemicals are naturally occurring chemical compounds found in plants that provide health benefits for humans. Majority of foods, such as whole grains, beans, fruits, vegetables and herbs contain varied types and amounts of phytochemicals. Among these, fruits and vegetables contribute to the significant sources of phytochemicals. Phytochemicals have tremendous impact on the health care system and may provide medical health benefits including the prevention and treatment of diseases and physiological disorders. Foods containing these phytochemicals are known as functional foods which play an increasingly important role in the treatment of various chronic diseases. Hence, phytochemicals are potentially involved as protective compounds for a number of chronic diseases and also used as good health food.

As mentioned earlier due to the dietary and lifestyle pattern of university students they are more susceptible to non-communicable diseases. Phytochemicals are potentially involved as protective compounds for a number of chronic diseases and also used as good health food hence their assessment in the diet of university students can help to

understand the quality of their diet.

Thus, the present study was undertaken with a broad objective to assess the phytochemical index in the diet of university students. Along with phytochemical index this study will assess the nutrient intake of students, their dietary pattern, physical activity and diabetes. The study will also investigate if there are any associations of phytochemical index with FBS, physical activity and anthropometric profile of the students.

The following results are discussed in this section:

1. Socio-demographic information, anthropometric data, medical and family history and the dietary pattern of the subjects.
2. Nutrients and phytochemical intake of the subjects.
3. Phytochemical index across gender and BMI categories.
4. Calories from phytochemical rich food groups.
5. Type-2 diabetes risk among non-diabetic subject.

BACKGROUND INFORMATION

Background information of the subjects is shown in the table 4.1. The age of the subject's ranged from 17 years to 35 years. From the total 14.71% subjects were male and 85.28% of the subjects were female. From the total number of subjects 47.13% were <20years of age whereas 52.86% were ≥20 years of age. The mean age of the subjects was 20.2 years. Mean age of the male subjects was 19.6 years and that of female subjects was 20.3 years. Out of the total subjects 83.04% were Hindus, 2.46%were Muslims and rest of the subjects (4.46%) followed other religions. From the total, highest number of subjects were undergraduate students (75.09%) and 22.19% and 2.74% were post-graduate students and PhD scholars respectively. Out of the total subjects 17.70% were on-campus residents, 11.72% were off-campus residents and 70.57% subjects were living at home with family. Majority of the students (61.34%) belonged to nuclear families. Around 29.17% and 9.47% of the subjects belonged to joint and extended families respectively.

SOCIO-ECONOMIC STATUS

Socio-economic status of the subjects is given in the table 4.2. From the given subjects 33.9% had monthly family income between 10,703-53,360 rupees, 56.34% of the subjects had monthly family income between 53,360-2,13,814 rupees and 9.72% had a monthly family income of 2,13,814 rupees and above. Socio-economic status of the participants was elicited on the basis of Kuppuswamy SES classification. Around 12.96%, 68.34%, 13.46% and 4.76% of the subjects fell in the upper, upper middle, lower middle and upper lower classes respectively.

TABLE 4.1 BACKGROUND INFORMATION

Variables	N= 401	%
Age		
<20years	**189**	**47.13**
≥20 years	**212**	**52.86**
<20years	**189**	**47.13**
Gender		
Male	**59**	**14.71**
Female	**342**	**85.28**
Religion		
Hindu	**333**	**83.04**
Muslim	**50**	**12.46**
Christian	**7**	**1.74**
Buddhist	**1**	**0.24**
Sikh	**2**	**0.49**
Parsi	**0**	**0**
Jain	**8**	**1.99**
Education level		
Under graduate	**301**	**75.09**
Post-graduate/ P.G. Diploma	**89**	**22.19**
PhD scholar	**11**	**2.74**
Place of residence		
On-campus accommodation	**71**	**17.70**
Off- campus accommodation	**47**	**11.72**
At-home with family	**283**	**70.57**
Family Type		
Nuclear	**246**	**61.34**
Joint	**117**	**29.17**
Extended	**38**	**9.47**

TABLE 4.2 SOCIOECONOMIC STATUS

Qualification of the Head of Family		
Profession or honors	**50**	**12.46**
Graduate	**171**	**42.64**
Intermediate or diploma	**33**	**8.22**
High School certificate	**111**	**27.68**
Middle School certificate	**25**	**6.23**
Primary School certificate	**10**	**2.49**
Illiterate	**1**	**0.24**
Occupation of the Head of Family		
Legislators, senior officials, managers	**72**	**17.95**
Professionals	**231**	**57.60**
Technicians and associate professional	**8**	**1.99**
Clerks	**12**	**2.99**
Skilled workers and shop and market sales workers	**23**	**5.73**
Skilled agricultural and fishery worker	**13**	**3.24**
Craft and related trade workers	**0**	**0**
Plant and machine operators	**2**	**0.49**
Elementary occupation	**4**	**0.99**
Unemployed	**36**	**8.97**
Total Monthly Family Income		
2,13,814 and above	**39**	**9.72**
1,06,850 – 2,13,814	**82**	**20.44**
80,110-1,06,850	**78**	**19.45**
53,360 – 80,109	**66**	**16.45**
31,978 – 53,360	**83**	**20.69**
10,703 – 31,77	**41**	**10.22**
<10,703	**12**	**2.99**
Socioeconomic Class		
Upper (I)	**52**	**12.96**
Upper Middle (II)	**274**	**68.34**
Lower Middle (III)	**56**	**13.96**
Upper Lower (IV)	**19**	**4.73**
Lower (V)	**0**	**0**

ANTHROPOMETRIC INFORMATION:

Anthropometric measurements

The anthropometric profile of the subjects is shown in the table 4.3. The mean height, weight and BMI of the subjects is 160.1cm, 56.7 Kgs and 22.1Kg/m² respectively. The mean BMI values for male subjects was 21.1Kg/m² and that for the female subjects was 22.3Kg/m² respectively. Mean stature ratio for females was 0.5 and that for male subjects was 0.45 respectively.

Overweight and obesity

Based on the Asia-pacific classification of BMI, majority of the male (47.75%) and female (37.42%) subjects belonged to the normal BMI category. Among the male subjects 28.81% belonged to the underweight category and 5.08% and 18.64% belonged to the overweight and obese categories respectively, whereas among the female subjects 23.09% belonged to the underweight category and 13.15% and 26.31% belonged to the overweight and obese category respectively. (Table 4.4)

A study was conducted among college students to assess their diabetes knowledge, awareness and risk. It was found that prevalence of underweight was 28% comparatively higher than the prevalence of overweight and obesity which was 13% and 18% respectively. Most of the study participants fall in the category of normal weight (41%) (Shah and Venugopal et al., 2022).

In a study conducted at Delhi University over 450 university students in the age group of 18-26 years found that 31.55% of the subjects were in the category of overweight and obese and 8.22% underweight.

Abdominal obesity

Out of the total male subjects 11.86% had waist circumference ≥90 cm to identify the prevalence of abdominal obesity Waist circumference and Waist-hip ratio was considered. Similarly, among the female subjects 36.54% had waist circumference ≥80cm. Also, 35.59% of male subjects had ≥0.90 waist-hip ratio and 29.23% of female participants had ≥0.85 of waist hip ratio. (Table 4.5)

A study was conducted among college students to assess their diabetes knowledge, awareness and risk Abdominal obesity was quite common, around 42% in females and 23% in males (Shah and Venugopal et al., 2022).

TABLE 4.3 ANTHROPOMETRIC PROFILE OF THE SUBJECTS (MEAN ± SD)

Variable	Female (N =342)	Male (N = 59)	Total (N = 401)
Weight (Kg)	55.8±12.9	61.94±12.57	56.7±13.1
Height (cm)	158.2±6.3	171.28±7.09	160.1±7.9
BMI (Kg/m^2)	22.3±5.1	21.1±4.07	22.1±5.0
Waist Circumference (cm)	75.8±12.1	77.32±10.07	76.0±11.8
Hip Circumference (cm)	94.9±10.8	89.7±9.09	94.1±107
Waist to Hip Ratio (WHR)	0.8±0.1	0.86±0.06	0.8±0.1
Waist Stature Ratio (WSR)	0.5±0.1	0.45±0.05	0.5±0.1

TABLE 4.4 PREVALENCE OF OVERWEIGHT AND OBESITY AMONG THE SUBJECTS BASED ON THE ASIA-PACIFIC CLASSIFICATION

N (%)

Variable	BMI	Female (N=342)	Male (N=59)	Total (N=401)
Underweight	< 18.5	79 (23.09)	17 (28.81)	96 (23.94)
Normal Weight	18.5 - 22.9	128 (37.42)	28 (47.75)	156 (38.90)
Overweight	23 - 24.9	45 (13.15)	3 (5.08)	48 (11.97)
Obesity	≥ 25	90 (26.31)	11 (18.64)	101 (25.18)

Value in parentheses indicate percentage

4.5 PREVALENCE OF ABDOMINAL OBESITY AMONG THE SUBJECTS (N, %)

Variable	Gender	Cut off	N	%
Waist Circumference	**Female (N=342)**	**≥80**	**125**	**36.54**
	Male (N=59)	**≥90**	**7**	**11.86**
Waist to Hip Ratio	**Female (N=342)**	**≥0.85**	**100**	**29.23**
	Male (N=59)	**≥0.90**	**21**	**35.59**

BIOPHYSICAL AND BIOCHEMICAL PARAMETERS

Blood pressure

Mean systolic and diastolic blood pressure for females was 105.6 mmHg and 71.9 mmHg respectively, while for male subjects it was 115.42mmHg and 77.54mmHg respectively. (Table 4.6)

Fasting blood glucose

Mean FBS for female subjects was 87.8 mg/dl and that for the male subjects was 91.13mg/dl. (Table 4.6)

MEDICAL CONDITION

Family history

The family medical history of the subjects has been showcased in the table 4.7. Around 52.54% and 64.32% of male and female subjects had family history of diabetes respectively and about 40.67% male subjects and 51.75% female subjects had family history of hypertension. Around 6.77% and 8.18% of male and female subjects respectively had family history of COPD. Family history of dyslipidemia was present among 15.25% of male subjects and 26.30% of female subjects. Whereas, family history of cancer was present among 19.88% of female and 17.24% of male respectively. Around 11.86% the male subjects and 12.57% female subjects had history of other medical conditions such as thyroid, NAFLD,etc.

Medical condition

Table 4.8 showcases the prevalence of medical conditions among the subjects. Among the total subjects, 0.58% female subjects had type-2 diabetes whereas none of the male subjects had diabetes. Hypothyroidism was prevalent among 1.75% of the total female population and 1.69% among the male population. None of the male subjects had hypertension, dyslipidemia or any other medical conditions, whereas hypertension and dyslipidemia was prevalent among 0.58% of female subjects and 10.81% of female subjects had other medical conditions such as PCOS and PCOD.

TABLE 4.6 BLOOD PRESSURE AND FASTING BLOOD GLUCOSE PARAMETERS (MEAN ± SD)

Parameters	Female (N=342)	Male (N=59)	Total (N=401)
SBP (mmHg)	115.42±12.53	105.6±12.0	107.0±12.5
DBP (mmHg)	77.54±8.11	71.9±105	72.7±10.4
Fasting blood glucose (mg/dl)	91.13±7.05	87.8±7.1	88.3±7.2

TABLE 4.7 MEDICAL FAMILY HISTORY OF THE SUBJECT (N, %)

Family History	Female (N=342)	Male (N=59)	Total (N=401)
Diabetes	220 (64.32)	31 (52.54)	251 (62.59)
Hypertension	177 (51.75)	24 (40.67)	201 (50.12)
COPD	28 (8.18)	4 (6.77)	32 (7.98)
Dyslipidemia	91 (26.30)	9 (15.25)	100 (24.93)
Cancer	68 (19.88)	5 (17.24)	73 (18.2)
Other	43 (12.57)	7 (11.86)	50 (12.46)

Values in parentheses indicate percentage

TABLE 4.8 MEDICAL CONDITION OF THE SUBJECTS (N, %)

Medical condition	Female (N=342)	Male (N=59)	Total (N=401)
Diabetes	**2 (0.58)**	**0**	**2 (0.49)**
Hypothyroidism	**6 (1.75)**	**1 (1.69)**	**7 (1.74)**
Hypertension	**2 (0.58)**	**0**	**2 (0.49)**
Dyslipidemia	**2 (0.58)**	**0**	**2 (0.49)**
Any other (for e.g., PCOS/PCOD)	**37 (10.81)**	**0**	**37 (9.22)**

Values in parentheses indicate percentage

DIETARY PATTERN OF UNIVERSITY STUDENTS

Type of diet consumed

As shown in the table 4.9 out of the total number of subjects 58.35% were vegetarians, 32.41% were non-vegetarians and 9.22% were ovo-vegetarians. Among the female subjects 59.35%, 31.87% and 8.77% were vegetarians, non-vegetarians and ovo-vegetarians respectively. Among the male subjects, 52.54%, 35.59% and 11.86% were vegetarian, non-vegetarian and ovo-vegetarian respectively. (Table 4.9)

Frequency of consumption of fast foods, junk foods and ordering online

Majority of the subjects (i.e. 33.66%) consumed fast foods 2-3 times a week. Around 8.97% of subjects consumed fast foods daily. Majority i.e. (36.15%) of subjects consumed packaged and junk foods 2-3 times a week. Consumption frequency of junk and packaged foods daily, once a week, once in 15 days, once a month, occasionally and never by students was 10.47%,19.20%,15.46%,5.23%, 11.22% and 2.24% respectively. Majority of the subjects (28.67%) consumed cold drinks and beverages occasionally. Consumption of these cold drinks and sugary beverages daily was by 4.48% of subjects, 2-3 times a week and once a week was by 27.92% of subjects, 15.96% and 14.46% subjects consumed it once in 15 days and once a month occasionally and 8.47% never consume these cold drinks and sugary beverages. Majority of subjects that is 21.94% ordered/ takeaway food once a week. 5.48% of subjects ordered/takeaway food daily, 11.97% 2-3 times a week, 16.95% did in once in 15 days, 18.95% once a month, 17.45% occasionally and 7.23% never order online or takeaway their meals. (Table 4.10)

DIETARY PATTERN

TABLE 4.9 TYPE OF DIET CONSUMED (N, %)

Dietary pattern	Female (N=342)	Male (N=59)	Total (N=401)
Vegetarian	203 (59.35)	31 (52.54)	234 (58.35)
Non- Vegetarian	109 (31.87)	21 (35.59)	130 (32.41)
Ovo- Vegetarian	30 (8.77)	7 (11.86)	37 (9.22)

Values in parentheses indicate percentage

TABLE 4.10 FREQUENCY OF CONSUMPTION OF PROCESSED FOODS (N, %)

Frequency	Frequency of eating fast foods	Frequency of eating junk/packaged foods	Frequency of drinking sugary beverages	Frequency of meals takeaway or ordering online
		(N=401)		
Daily	36 (8.97)	42 (10.47)	18 (4.48)	22 (5.48)
2-3 times a week	135 (33.66)	145 (36.15)	56 (13.96)	48 (11.97)
Once a week	108 (26.93)	77 (19.20)	56 (13.96)	88 (21.94)
Once in 15 days	70 (17.45)	62 (15.46)	64 (15.96)	68 (16.95)
Once a month	21 (5.23)	21 (5.23)	58 (14.46)	76 (18.95)
Occasionally	31 (7.73)	45 (11.22)	115 (28.67)	70 (17.56)
Never	0	9 (2.24)	34 (8.47)	29 (7.23)

Values in parentheses indicate percentage

Among the total number of subjects majority 33.66% were having fast foods 2-3 times in a week. Mainly 36.15% out of the total number of subjects were having junk/packaged foods 2-3 times a week. Majority 28.67% out of the total population were drinking sugary beverages occasionally. Mainly 21.94% were ordering online and doing takeaway once a week.

Water consumption

Out of the total 401 subjects 25.18% consumed ≤5 glasses of water, 16.20% consumed 9-11 glasses of water and 11.72% consumed 12-14 glasses of water. Majority (43.89%) of subjects consumed 6-8 glasses of water in a day. (Table 4.11)

Number of meals consumed everyday

Table 4.11 shows the number of meals consumed by the subjects. Almost all the subjects (96%) were consuming 2-4 meals in a day, and only 2.99% and 0.99% of the subjects consumed <2 meals and >4 meals a day respectively. (Table 4.12)

Practice of skipping meals

Table 4.13 shows the frequency of skipping meals by the subjects. Out of the total number of subjects 64.81% skip their meals whereas 35.19% do not skip any of their meals. Out of the subjects who skipped their meal 44.13% skipped their breakfast, 16.45% skipped their lunch and 4.23% skip their dinner respectively.

Long intervals between meals

Table 4.14 and 4.15 shows subjects who have long intervals in between their two meals. Here, 38.90% of subjects had long gaps in between their two meals, whereas 61.34% did not have long gaps in between meals. Out of the 156 subjects who had long intervals in between their meal's majority of subjects (61.53%) have 6-8 hours of intervals in between their meals. Others 28.94% and 9.61% have interval of <6 hours and >8 hours respectively.

TABLE 4.11 DAILY WATER CONSUMPTION (N, %)

Glasses of Water/Day	(N= 401)	%
≤ 5 glasses	101	25.18
6-8 glasses	176	43.89
9-11 glasses	65	16.20
12-14 glasses	47	11.72

TABLE 4.12 NUMBER OF MEALS CONSUMED IN A DAY (N, %)

Meals	(N=401)	%
<2 meals	12	2.99
2-4 meals	385	96
>4 meals	4	0.99

TABLE 4.13 FREQUENCY OF SKIPPING MEALS (N, %)

Meals	(N=401)	%
Breakfast	177	44.13
Lunch	66	16.45
Dinner	17	4.23

TABLE 4.14 LONG INTERVALS IN BETWEEN MEALS (N, %)

Long intervals in between meals:	(N=401)	%
Yes	156	38.90
No	246	61.34

TABLE 4.15 NO. OF HOURS OF INTERVAL IN BETWEEN MEALS (N, %)

No. of hours	(N=156)	%
<6 hours	45	28.84
6-8 hours	96	61.53
>8 hours	15	9.61

CONSUMPTION OF TEA/COFFEE ON DAILY BASIS:

Consumption of tea/coffee daily

Table 4.16 represents consumption of tea/coffee by the subjects on daily basis. Here, 51.87% of subjects consumed tea or coffee on daily basis and rest 48.12% did not consume tea/ coffee on daily basis.

No. of cups of coffee consumed by subjects everyday

Table 4.17 shows the no. of cups of tea/ coffee consumed by the subjects. Out of the 51.87% of subjects who consume tea/coffee every day, 45.19% and 49.03% consume <2 cups and 2-4 cups respectively whereas as 5.76% of subjects consume more than 4 cups of tea/ coffee every day.

TABLE 4.16 CONSUMPTION OF TEA/COFFEE EVERYDAY (N, %)

Consumption of coffee/ tea everyday	(N=401)	%
Yes	208	51.87
No	193	48.12

TABLE 4.17 NO. OF CUPS OF TEA/COFFEE CONSUMED EVERYDAY (N, %)

No. of cups of tea/ coffee	(N=208)	%
<2 cups	94	45.19
2-4 cups	102	49.03
More than 4 cups	12	5.76

REPLACEMENT OF DAILY MEALS WITH FAST FOODS

Replacement of meals with fast-foods

Table 4.18 shows the replacement of regular meals with fast/junk foods by the subject. About 72.56% of subjects replaced their regular meals with fast food and 27.43% did not replace their regular meal with fast foods. Table 4.19 shows meal replaced by subjects with fast foods/ junk foods. Out of the total subjects who replaced regular meals with fast foods and junk foods 50.51% and 42.26% mainly replaced their lunch and dinner respectively, whereas only 7.21% of subjects replaced their breakfast with any junk food/fast foods.

Frequency of replacement of meals

When the frequency of replacement of regular meals was looked at it was observed that 28.8% of subjects and 17.52% of subjects replaced their meals once a week and once in 15 days respectively whereas 5.84%, 0.27%, 9.96% and 10.30% replaced their meals daily,2-3 times a week, once a month and occasionally. (Table 4.20)

TABLE 4.18 PRACTICE OF REPLACING REGULAR MEALS WITH FAST FOODS/ JUNK FOODS (N, %)

Replacement of regular meals	(N=401)	%
Yes	291	72.56
No	110	27.43

TABLE 4.19 MEAL REPLACED WITH FAST FOODS/ JUNK FOODS (N, %)

Meals	(N=291)	%
Breakfast	21	7.21
Lunch	147	50.51
Dinner	123	42.26

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TABLE 4.20 FREQUENCY OF REPLACEMENT OF MEALS (N, %)

Frequency of replacing regular meals	(N=291)	%
Daily	17	5.84
2-3 times a week	80	0.27
Once a week	84	28.86
Once in 15 days	51	17.52
Once a month	29	9.96
Occasionally	30	10.30

Consumption of supplements

Table 4.21 showcases the consumption of nutrient supplements by the subjects. It was found that 86.78% of subjects did not take any supplements and only 13.21% consumed micronutrient supplements.

Out of the total subjects who consumed nutrient supplementation 66.03% consumed multivitamin, 11.3% consumed protein supplements and 30.18% of subjects consumed micronutrient supplements. (Table 4.22)

Consumption of flavored teas

Table 4.23 shows the consumption of flavored teas by the subjects. Out of the total number of subjects, 74.56% did not consume any type of flavored teas whereas 25.43% consumed flavored tea.

Table 4.24 shows the frequency of consumption of flavored teas. Out of the 25.43% subjects who consumed flavored teas 20.58% consumed it daily, 17.64% consumed it 2-3 times a week, 31.37% consumed it occasionally and 26.46% consume it either once a week, once in 15 days or once in a month respectively.

TABLE 4.21 CONSUMPTION OF SUPPLEMENTS (N, %)

Nutrient supplementation	(N=401)	%
Yes	53	13.21
No	348	86.78

TABLE 4.22 TYPE OF SUPPLEMENTS (N, %)

Supplementation	(N=53)	%
Multi-vitamin supplementation	35	66.03
Protein supplementation	6	11.32
Micronutrient supplementation	16	30.18

TABLE 4.23 CONSUMPTION OF FLAVORED TEAS (N, %)

Consumption of coffee/ tea everyday	(N=401)	%
Yes	102	25.43
No	299	74.56

TABLE 4.24 FREQUENCY OF CONSUMPTION OF FLAVORED TEAS (N, %)

Frequency of consumption of flavored teas	(N=102)	%
Daily	21	20.58
2-3 times a week	18	17.64
Once a week	9	8.82
Once in 15 days	9	8.82
Once a month	9	8.82
Occasionally	32	31.37

MEAN NUTRIENT INTAKE OF THE SUBJECTS (MEAN ± SD)

Table 4.25 shows the mean nutrient intake by the male and female subjects. In the female subjects mean energy intake was 1264 Kcal which met 76.15% of the required EAR. Mean carbohydrates intake in female subjects was 162.81g which met 160.6% of the required EAR. Mean protein intake for female subjects was 35.39g which was 96.91% of required EAR. Mean fat intake in female subjects was 50.96g which was 255.7% of the required EAR.

In the male subjects mean energy intake was 1338 Kcal which was 63.14% of the required EAR. Mean carbohydrates intake in male subjects was 178.78 g which met 178.78 % of the required EAR. Mean protein intake for male subjects was 38.29g which met 89.04 % of the required EAR. Mean fat intake in male subjects was 49.90g which was 199.6% of required EAR.

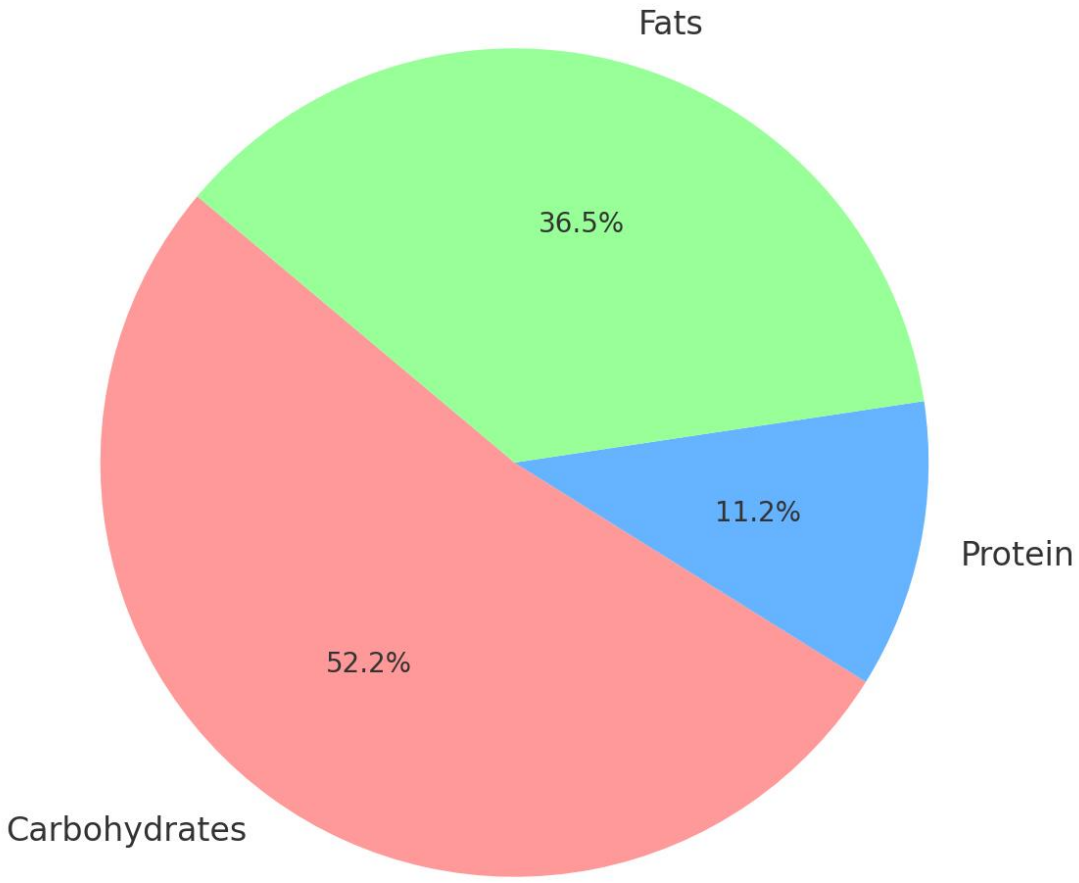
As shown in fig. 4.1 among the total subjects mean calorie contribution from carbohydrates is 52.2%, from protein it is 11.09% and from fats it is around 36.5%.

TABLE 4.25 MEAN NUTRIENT INTAKE OF THE SUBJECTS (MEAN ± SD)

Nutrient	EAR Female	Female	EAR Male	Male	Total
Energy (kcal)	1660	1264±489 (76.15)	2110	1338±622 (63.14)	1275±510
Carbohydrate (g)	100	160.66±63.10 (60.66)	100	178.78±85.23 (178.78)	162.81±67.02
Protein (g)	36	34.89±15.65 (96.91)	43	38.29±22.57 (89.04)	35.39±16.86
Fats (g)	20	51.24±24.41 (255.7)	25	49.90±26.51 (199.6)	50.96±24.70
Total dietary fiber (g)	29.7	18.50±8.93 (62.28)	35.7	20.88±11.85 (58.48)	18.85±9.44
Vitamin A (µg)	390	332.50±381.46 (82.85)	460	234.75±191.51 (51.03)	318.12±361.34
Vitamin C (mg)	55	68.80±57.07 (125.0)	65	62.16±64.22 (95.63)	67.82±58.14

Values in parentheses indicate % EAR met by the subjects

Figure 4.1 Calorie contribution from macro nutrients



PHYTOCHEMICAL INDEX

Phytochemical index across population

Table 4.26 shows the mean PI. Mean PI was 45.59. Mean calories consumed by the population was 1275 Kcal and mean calories from phytochemical rich food groups among the population was 572 Kcal.

A cross sectional study was conducted in Mumbai on 239 subjects aged 17years to 25 years. A better dietary Phytochemical Index (PI) score was evident in the older age group of subjects in the age range of 20 years or above (Khandagale et al, 2018).

Phytochemical index across gender

Table 4.27 shows PI across gender. Here mean total calories consumed by male subjects was 1338 Kcal and calories from phytochemical rich foods in male subjects was 611 Kcal. Mean PI of male subjects was 45.37. For female subjects calories from phytochemicals rich foods and mean total calories were 566 Kcal and 1264 Kcal respectively. Mean PI for female subjects was 46.85. The dietary phytochemical index score was found to be better among the female subjects as compared to the male subjects.

A cross sectional study was conducted in Mumbai on 239 subjects aged 17years to 25 years. PI score for male (17-19 years of age-group) was 45.5 and that for female (17-19 years of age-group) was 46.1. Similarly the PI score for male and female (20-25 years of age group) was 47.1 and 51.9 respectively. The dietary phytochemical index score was found to be better among the female subjects as compared to the male subjects (Khandagale et al, 2018).

Phytochemical index across BMI categories

Table 4.28 shows mean PI across BMI categories. Mean PI for underweight female subjects was 42.62, for normal BMI female subjects was 43.96, for overweight female subjects 47.5 and for obese females PI was 50.15 respectively. For underweight male subjects mean PI was 44.13, for normal BMI male subjects mean PI was 47.2 and for overweight male subjects mean PI was 49.39 and for obese male subjects it is 49 respectively.

A cross sectional study was conducted in Mumbai on 239 subjects aged 17years to 25 years. PI score for BMI categories (<18.50kg/m^2, 18.50-22.99kg/m^2,23-24.99

kg/m^2, >25kg/m^2) were 48.88,48.1,43.5 and 49.9 respectively (Khandagale et al, 2018).

A cross-sectional study was conducted to evaluate the association between the dietary phytochemical index (DPI), refelecting the phytochemical content of the diet , and general and central obesity in Iranian adults. In this cross-sectional study**,** 850 men and women, aged between 18 and 59 years, from different health care centers in five areas of Tehran, Iran were recruited. Out of the total subjects 31% were male and 69% were female. The prevalence of central obesity defined by WHtR, WHR, and WC was 81.1%, 42.2%, and 48.6%, respectively. General obesity (BMI ≥ 30 kg/m2) had a prevalence of 28.2%. The DPI score in men and women were 33.7 ± 24.7 and 36.2 ± 26.8, respectively. Women in the top quartile of the DPI (i.e DPI= 45.74-205.45) had a lower odd of central obesity by waist circumference.Men in the third quartile(i.DPI=28.93-45.7) of the DPI were at lower risk of central obesity by waist-to-hip ratio. The study concluded significant inverse association between DPI and central obesity in women (Asgari et al., 2021).

Calories from phytochemicals rich food groups

Table 4.28 shows mean calories from different PI rich food groups in male and female subjects. In both male and female subjects' cereals was the most calories contributing food group in the calculation of PI. Mean calories from cereals in male was 448 Kcal, from pulses it was 97 Kcal, and from fruits, vegetables and nuts and oilseeds it was 11 Kcal,47 Kcal and 7 Kcal respectively. In male subjects' soy and soy products and olive oil did not have any calorie contribution in calculation of PI. Mean calories from cereals in male was 370 Kcal, from pulses it was 107 Kcal, and from fruits, vegetables and nuts and oilseeds it was 13 Kcal,45 Kcal and 24 Kcal respectively. In female subjects mean calories from soy and soy products and olive oil was 5 Kcal and 1 Kcal respectively.

To study the the dietary phytochemical index (PI) in relation to 3-year change in weight, waist circumference (WC), body adiposity index (BAI) among Tehranian adults a longitudinal study was conducted in the framework of Tehran Lipid and Glucose Study, between 2006–2008 and 2009–2011, on 1938 adults, aged 19–70 years.

It was observed in the study that increased energy intakes, more than 37% of energy, from phytochemical rich foods could prevent weight gain and decrease body adiposity in

adults during 3 year follow-up. Higher intakes of whole grains and fruits appeared to benefit more than other phytochemical-rich foods in prevention of weight and body fat gain. It was also observed that higher intakes of phytochemical-rich foods and dietary PI in older; it suggesting that older participants are more likely to have healthy diets characterized by the consumption of plant foods. The results showed that dietary PI was inversely associated with change in body adiposity during the study follow-up; participants with higher dietary PI had 1.47% decrease in BAI as compared with the reference group. In addition to dietary PI, higher intake of whole grains in this study was inversely associated with 3-year changes in weight and BAI; higher intake of fruit was also related with lower weight gain. Thus, the study concluded that that increased dietary PI score as energy intake from phytochemical rich foods, especially whole grains and fruits, had favourable effects on prevention of weight gain and decrease of body adiposity during 3-year follow-up, as main factors contributing to development of chronic disease (Mirmiran et al.,2012).

Phytochemical index across FBS categories:

Table 4.29 shows mean PI across the FBS categories (Normal, Prediabetic and Diabetic). Mean PI score for female subjects from normal category was 45.20 and for mean PI score for pre-diabetic female subjects is 48.33. None of the female subjects had diabetic FBS value. Mean PI for normal male subjects were 47.29 and for prediabetic is 48.33.

To investigate the relationship between DPI and the risk of prediabetes a case- control study was conducted among 300 men and women including 150 healthy and 150 prediabetic participants from diabetes screening center in Shahreza, Iran. 150 participants with prediabetes (cases) and 150 healthy individuals with normal fasting blood glucose (FBG) (control) were recruited. The results found out that prediabetic participants consumed fewer phytochemical-rich foods from all the food groups, and subsequently, had lower DPI score than their control counterparts. The results also showed that compared to the control group, prediabetic participants had fewer daily intake of fruits, vegetables, whole grains, nuts and seeds, legumes, olive, and olive oil. Mean score of DPI in control group were significantly higher than prediabetic group (mean DPI of control= 40.6± 23.3 and mean DPI of pre-diabetic= 28.6±13.4). Thus, the study concluded that lower PI score is related to higher prediabetes (Abshirini, et al, 2018).

TABLE 4.26 MEAN PHYTOCHEMICAL INDEX ACROSS POPULATION (MEAN ± SD)

MEAN PHYTOCHEMICAL INDEX ACROSS POPULATION	(MEAN ± SD)
Mean calories from phytochemical rich foods	572±310
Mean total calories	1275±510
Mean Phytochemical index	45.59±17.02

TABLE 4.27 MEAN PHYTOCHEMICAL INDEX ACROSS GENDER (MEAN ± SD)

	Female (N=342)	Male (N=59)	Total (N=401)
Calories from PI rich foods	566±302	611±356	572±310
Mean total calories	1264±489	1338±622	1209±510
Dietary Phytochemical Index	46.85±14.68	45.37±17.41	45.59± 17.02

TABLE 4.28 MEAN PHYTOCHEMICAL INDEX ACROSS BMI CATEGORIES (MEAN ± SD)

Dietary Phytochemical Index	Female (N=342)	Male (N=59)	Total (N=401)
BMI<18.5 (Underweight)	42.62±16.64	44.13±19.40	42.89±17.05
BMI =18.5-22.9 (Normal)	43.96±15.03	47.2±11.84	44.55±14.76
BMI= 23 – 24.9 (Obese)	50.15±16.65	49.01±16.95	49.55±16.16
BMI≥ 25 (Overweight)	47.50±20.42	49.39±13.80	47.87±20.01

TABLE 4.29 MEAN- CALORIE CONTRIBUTION FROM PHYTOCHEMICAL-RICH FOOD GROUPS ACROSS POPULATION (MEAN ± SD)

Food groups	Calorie contribution from PRFs in Females (N=342)	Calorie contribution from PRFs in Males (N=59)	Total (N=402)
1. Cereals	370±213	448.41±309	376.41±231
2.Legumes and Pulses	108±116	96.80±96	99.03±114
3. Fruits	13±116	11.25±29	11.68±27
4.Vegetables	46±40	47.22±37	45.60±39
5. Nuts an Oil-seeds	24±65	7.51±21	18.41±61
6. Soy and soy products	5±35	0	4.70±32
7. Olive oil	0±9	0	0.34±9

TABLE 4.30 MEAN PHYTOCHEMICAL INDEX ACROSS FBS CATEGORIES (MEAN ± SD)

FBS CATEGORIES	Female N=342	Male N=59	Total N=401
Normal <100	45.20±17.67 (322)	47.29±15.38 (51)	45.48±17.38 (373)
Pre-diabetic 100-125	46.80±10.12 (18)	44.04±9.26 (8)	45.47±9.65 (26)
Diabetic >126	66.91±12.72 (2)	-	66.91±12.72 (2)

Values in parentheses indicate number of subjects

IDF DIABETES RISK ASSESSMENT SCORE AMONG SUBJECTS

Evaluation of diabetes risk assessment in subjects by IDF risk scorecard

Table 4.31 shows diabetes risk among male and female subjects which has been calculated by IDF diabetes risk score card. On the basis of the cut-off and criteria provided in the score card we interpret that among the female subjects 50.58% and among the male 69.3% were at low risk of diabetes. Among female subjects 35.29% and 32.20% of male subjects were at slightly elevated risk of diabetes. Among the total subjects 13.52% female and 6.77% male subjects fell under moderate risk category. Out of the total subjects 0.58% of female subjects were under high-risk category while no male subjects were under this category. Lastly, none of the subjects were in the very high-risk category of the score card.

A study conducted over 502 college students to assess the risk of diabetes among non-diabetic subjects. The assessment was done amongst non-diabetic subjects using a modified IDF diabetes risk score, 64.74% of the respondents fall in the category of low risk followed by 26.89% of respondents in the slightly elevated risk category and 6.7% were in the category of moderate risk. More females (28.26%) fall in the category of slightly elevated as compared to males (8.57%). Only 1.71% of the female respondents fall in the category of high risk (Shah and Venugopal et al., 2022).

Phytochemical index across IDF risk score card

Table 4.32 shows mean PI across the IDF risk score for male and female subjects. Mean PI for female and male subjects in <7 score category is 44.77 and 48.44 respectively. For score 7-11 the PI among female and male subjects is 46.17 and 43.93 respectively. For the score 12-14 the PI among female and male subjects is 44.73 and 46.37 respectively. None of the male subjects fall in the category of 15-20 and >20 (high risk and very high risk). Among the female subjects mean PI for 15-20 (high risk) is 41.82 and none of the female subjects fall in the very high-risk category.

TABLE 4.31 TYPE 2 DIABETES RISK IN AMONG NON-DIABETIC SUBJECTS N (%)

Categories	Cut-offs	Female N=340	Male N=59	Total N=399
Low risk	<7	172 (50.58)	36 (69.23)	208 (52.13)
Slightly elevated risk	7-11	120 (35.29)	19 (32.20)	139 (34.83)
Moderate risk	12-14	46 (13.52)	4 (6.77)	50 (12.53)
High risk	15-20	2 (0.58)	0 (0)	2 (0.58)
Very high risk	>20	0	0	0

Values in parentheses indicate percentage

TABLE 4.32 MEAN PHYTOCHEMICAL INDEX ACROSS IDF RISK SCORE CARD

Categories	Cut-offs	Female N=340	Male N=59	Total N=401
Low risk	<7	44.77±18.46 (172)	48.44±14.13 (36)	44.96±17.54 (208)
Slightly elevated risk	7-11	46.17±16.07 (120)	43.93±16.33 (19)	47.77±15.86 (139)
Moderate risk	12-14	44.73±16.99 (46)	46.37±12.35 (4)	44.86±16.57 (50)
High risk	15-20	41.82±3.08 (2)	0	41.82±3.08 (2)
Very high risk	>20	0	0	0

Values in parentheses indicate number of subjects

As shown in the table 4.33 74.81% of the subjects were indulged in low physical activity. Among the female subjects 74.85% and among the male subjects 74.57% were indulged in low physical activity. Out of the total subjects 22.19% were indulged in moderate physical activity. Among the female subjects 22.51% and among the male subjects 20.33% were indulged in moderate physical activity. Out of the total subjects only 2.99% were indulged in heavy physical activity. Out of the total number of female and male subjects 2.63% and 5.08% were indulged in heavy physical activity respectively.

TABLE 4.33 ASSESSMENT OF PHYSICAL ACTIVITY AMONG SUBJECTS BY IPAQ (N, %)

Physical activity	Female (N=342)	Male (N=59)	Total (N=401)
Low physical activity (<600 MET minutes)	256 (74.85)	44 (74.57)	300 (74.81)
Moderate physical activity (600-2999 MET minutes)	77 (22.51)	12 (20.33)	89 (22.19)
Heavy physical activity (≥3000 MET minutes)	9 (2.63)	3 (5.08)	12 (2.99)

Values in parentheses indicate percentage

ASSESSMENT OF DIETARY DIVERSITY BY FOOD FREQUENCY QUESTIONAIRE

Table 4.34 shows the frequencies of various foods from different food groups. Among the cereals food group wheat flour was consumed daily (86.78%), of the total participants 82.54% were never consuming brown rice and for those who were consuming it the frequency was rare (6.73). Rice milled was mainly consumed daily my majority of the subjects (59.10%). Majority of the subjects (61.34%) were not consuming Ragi, among those who were consuming it frequency was occasional (16.20%). Oats were not consumed by majority of the subjects (62.34%) mainly 11.47% consumed it occasionally. Barley was not consumed by majority of the subjects (72.31%) mainly 8.22% consumed it rarely. Oats were not consumed by majority of the subjects (29.42%) mainly 29.12% consumed it seasonally. Consumption of Maize was also not significant among the subjects (30.67%), among those who were consuming it majority (34.88%) were consuming it seasonally.

Among the Pulses and Legumes food group chickpea was majorly consumed once a week (47.63%), cowpea was also consumed mainly once a week (34.66%), Kidney beans and Broad beans were also consumed mainly once a week (40.39%) and 24.68% respectively. Red gram and green gram were mainly consumed 2-4 times in a week (26.18%) and (39.15%) respectively. Similarly Black gram, yellow lentil dal and red lentil dal were consumed mainly 2-4 times a week i.e 25.93%, 40.64%, and 25.93% respectively. The frequency consumption of both white and brown soyabean was rare (27.18%). Consumption of soya chunks was occasional (34.41%).

Among the green leafy vegetables cabbage was consumed mainly once a week (51.37%), lettuce was occasionally consumed (33.91%), spinach was mainly consumed once a week (38.40%). Coriander was mainly consumed 2-4 times a week (52.11%). Among majority of the subjects who were consuming cauliflower frequency of consumption was either daily or once a week. Consumption of broccoli was mainly once a week (31.93%). Majority of the subjects were consuming bell pepper once a week(28.67%). Beans were consumed mainly by (26.43%) rarely. Corn was mainly consumed seasonally by 30.17% of subjects. Cucumber was mainly consumed by 31.92% of subjects 2-3 times a week. Majority of the subjects were consuming lady finger 2-4 times a week (39.90%). Pumpkin was mainly consumed by 28.12% of the total subjects once a week. Majority of the

subjects were consuming tomato daily (31.17%). Among the total subject's majority (46.88%) were consuming green peas daily.

Among the fruits apple was consumed by 38.90% of the subjects 2-4 times a week. Those who were consuming apricot frequency of consumption was occasional (16.20%). Banana was consumed mainly 2-4 times a week by 27.18% of the subjects. Black berries, blue berries, cranberries and cheeries were not consumed by majority of the subjects. Among those who were consuming it frequency of consumption was 2-4 times a week (19.45%), occasional (12.16%), seasonal 13.46% and 13.21% respectively. Gooseberry was mainly consumed seasonally (48.87%). Both green and black grapes were majorly consumed seasonally (81.04%) and (78.80%) respectively. Fruits such as guava, mango, lemon, orange, papaya, peach and pomegranate were majorly consumed seasonally. Raspberry was not consumed by majority of the participants only 17.70% consumed it seasonally. Fruits such as watermelon and strawberry were mainly consumed seasonally (82.04%) and (72.06%).

Among roots and tubers food group only carrot and onion were consumed by majority of the participants. Among nuts and oilseeds almonds and walnuts were consumed by majority of the subjects daily, cashews and pistachio nuts were consumed rarely and flax seeds and chia seeds were consumed occasionally by majority of the subjects. Frequency consumption of peanuts was mainly once a week by 37.40% of the subjects.

Majority of the subjects were not using any of the oils as cooking oils. Also, food items such as peanut butter, tofu and dark chocolate were not consumed by majority of the subjects. Among the fresh fruits and vegetable juices most of the subjects were not consuming most of the juices. Among those who were consuming it the frequency was either occasional or seasonal.

TABLE 4.34 FOOD FREQUENCY QUESTIONAIRE

WHOLE GRAINS			
FOOD ITEM	**FREQUENCY OF CONSUMPTION**	**N**	**%**
Whole wheat flour	Daily	348	86.78
	2-4 times a week	32	7.98
	5-6 times a week	8	1.99
	Once a week	3	0.74
	Once in 15 days	6	1.49
	Once in a month	2	0.49
	Occasionally		
	Seasonally		
	Rarely		
	Never	2	0.49
Brown rice	Daily	6	1.49
	2-4 times a week	13	3.24
	5-6 times a week		
	Once a week	8	1.99
	Once in 15 days		
	Once in a month		
	Occasionally	16	3.99
	Seasonally		
	Rarely	27	6.73
	Never	331	82.54
Rice, milled	Daily	237	59.10
	2-4 times a week	71	17.70
	5-6 times a week	29	7.23
	Once a week	39	9.72
	Once in 15 days	14	3.49
	Once in a month	2	0.49
	Occasionally		
	Seasonally		
	Rarely		
	Never	9	2.24
Ragi	Daily		
	2-4 times a week		
	5-6 times a week		

	Once a week		
	Once in 15 days		
	Once in a month		
	Occasionally		
	Seasonally		
	Rarely		
	Never		
Oats	Daily	4	0.99
	2-4 times a week	17	4.23
	5-6 times a week		
	Once a week	16	3.99
	Once in 15 days	18	4.48
	Once in a month	17	4.23
	Occasionally	46	11.47
	Seasonally	5	1.24
	Rarely	28	6.98
	Never	250	62.34
Barley	Daily	-	-
	2-4 times a week	10	2.49
	5-6 times a week	2	0.49
	Once a week	16	3.99
	Once in 15 days	5	1.24
	Once in a month	14	3.49
	Occasionally	22	5.48
	Seasonally	9	2.24
	Rarely	33	8.22
	Never	290	72.31
Jowar	Daily		
	2-4 times a week	10	2.49
	5-6 times a week	6	1.49
	Once a week	20	4.98
	Once in 15 days	22	5.48
	Once in a month	23	5.73
	Occasionally	59	14.71
	Seasonally	117	29.17
	Rarely	26	6.48
	Never	118	29.42
Maize	Daily		
	2-4 times a week	4	0.99
	5-6 times a week	4	0.99

	Once a week	17	4.23
	Once in 15 days	9	2.24
	Once in a month	44	10.97
	Occasionally	35	8.72
	Seasonally	139	34.66
	Rarely	26	6.48
	Never	123	30.67

PULSES AND LEGUMES			
FOOD ITEM	**FREQUENCY OF CONSUMPTION**	**N**	**%**
Chickpeas	Daily		
	2-4 times a week	44	10.97
	5-6 times a week	8	1.99
	Once a week	191	47.63
	Once in 15 days	38	9.47
	Once in a month	61	15.21
	Occasionally	43	10.72
	Seasonally	3	0.74
	Rarely		
	Never	13	3.24
Cowpea	Daily		
	2-4 times a week	23	5.73
	5-6 times a week	5	1.24
	Once a week	139	34.66
	Once in 15 days	19	4.73
	Once in a month	37	9.22
	Occasionally	33	8.22
	Seasonally	12	2.99
	Rarely	16	3.99
	Never	117	29.17
Kidney beans	Daily		
	2-4 times a week	11	2.74
	5-6 times a week	7	1.74
	Once a week	162	40.39
	Once in 15 days	32	7.98
	Once in a month	56	13.96
	Occasionally	47	11.72
	Seasonally		

	Rarely	5	1.24
	Never	81	20.19
Broad beans	Daily		
	2-4 times a week	3	0.74
	5-6 times a week	3	0.74
	Once a week	99	24.68
	Once in 15 days	19	4.73
	Once in a month	42	10.47
	Occasionally	48	11.97
	Seasonally	3	0.74
	Rarely	32	7.98
	Never	152	37.90
Red gram	Daily	28	6.98
	2-4 times a week	105	26.18
	5-6 times a week	17	4.23
	Once a week	39	9.72
	Once in 15 days	25	6.23
	Once in a month	16	3.99
	Occasionally	36	8.97
	Seasonally	2	0.49
	Rarely	13	3.24
	Never	120	29.92
Green gram	Daily	3	0.74
	2-4 times a week	157	39.15
	5-6 times a week	20	4.98
	Once a week	101	25.18
	Once in 15 days	37	9.22
	Once in a month	25	6.23
	Occasionally	27	6.73
	Seasonally		
	Rarely	2	0.49
	Never	29	7.23
Black gram	Daily	10	2.49
	2-4 times a week	104	25.93
	5-6 times a week	15	3.74
	Once a week	69	17.20
	Once in 15 days	27	14.21
	Once in a month	51	12.71
	Occasionally	60	14.96
	Seasonally	2	0.49

	Rarely	5	1.24
	Never	10	6.98
Yellow lentil	Daily	9	2.24
	2-4 times a week	163	40.64
	5-6 times a week	22	5.48
	Once a week	67	16.70
	Once in 15 days	57	14.21
	Once in a month	18	4.48
	Occasionally	31	77.30
	Seasonally	5	1.24
	Rarely	2	0.49
	Never	27	6.73
Red lentil	Daily		
	2-4 times a week	104	25.93
	5-6 times a week	3	0.74
	Once a week	69	17.2
	Once in 15 days	42	10.47
	Once in a month	38	9.47
	Occasionally	33	8.22
	Seasonally	8	1.99
	Rarely	15	3.74
	Never	89	22.19
Soyabean (white)	Daily		
	2-4 times a week	9	2.24
	5-6 times a week	4	0.99
	Once a week	5	1.24
	Once in 15 days	14	1.24
	Once in a month	16	3.49
	Occasionally	28	10.22
	Seasonally	15	2.49
	Rarely	109	27.18
	Never	205	50.87
Soyabean (brown)	Daily	2	0.49
	2-4 times a week	2	0.49
	5-6 times a week	2	0.49
	Once a week	8	1.99
	Once in 15 days	14	3.49
	Once in a month	16	3.99
	Occasionally	28	6.98
	Seasonally	15	3.74

	Rarely	109	27.18
	Never	205	51.12
Soya chunks	Daily		
	2-4 times a week	5	1.24
	5-6 times a week	2	0.49
	Once a week	14	3.49
	Once in 15 days	26	6.48
	Once in a month	30	7.48
	Occasionally	138	34.41
	Seasonally		
	Rarely	20	4.98
	Never	166	41.39

VEGETABLES			
FOOD ITEM	**FREQUENCY OF CONSUMPTION**	**N**	**%**
Cabbage, green	Daily	17	4.23
	2-4 times a week	64	15.96
	5-6 times a week	2	5.48
	Once a week	206	51.37
	Once in 15 days	36	8.97
	Once in a month	9	2.24
	Occasionally	15	3.74
	Seasonally	17	4.23
	Rarely	6	1.49
	Never	9	2.24
Lettuce	Daily	4	0.99
	2-4 times a week	6	1.49
	5-6 times a week		
	Once a week	39	9.72
	Once in 15 days	6	1.49
	Once in a month	29	7.23
	Occasionally	136	33.91
	Seasonally	17	4.23
	Rarely	19	4.73
	Never	145	36.15
Spinach	Daily	2	0.49
	2-4 times a week	39	9.72

	5-6 times a week	11	2.74
	Once a week	154	38.40
	Once in 15 days	23	5.73
	Once in a month	34	8.47
	Occasionally	7	8.22
	Seasonally	60	14.96
	Rarely	5	1.24
	Never	40	9.97
Coriander	Daily	57	14.21
	2-4 times a week	209	52.11
	5-6 times a week	84	20.94
	Once a week	36	8.97
	Once in 15 days		
	Once in a month	6	1.49
	Occasionally		
	Seasonally		
	Rarely		
	Never	9	2.24
Cauliflower	Daily	138	34.41
	2-4 times a week	56	13.96
	5-6 times a week	18	4.48
	Once a week	131	32.66
	Once in 15 days	16	3.99
	Once in a month		
	Occasionally	11	2.74
	Seasonally		
	Rarely	4	0.99
	Never	10	6.73
Broccoli	Daily	2	0.49
	2-4 times a week	37	9.22
	5-6 times a week	24	5.98
	Once a week	128	31.92
	Once in 15 days	16	3.99
	Once in a month	13	3.24
	Occasionally	21	5.23
	Seasonally	5	1.24
	Rarely	99	24.68
	Never	56	13.96
Bell pepper	Daily		
	2-4 times a week	7	1.74

	5-6 times a week		
	Once a week	115	28.67
	Once in 15 days	19	4.73
	Once in a month	33	8.22
	Occasionally	69	17.20
	Seasonally	20	4.98
	Rarely	19	4.73
	Never	119	29.67
Beans	Daily	13	3.24
	2-4 times a week	49	12.21
	5-6 times a week	17	4.23
	Once a week	38	9.47
	Once in 15 days	34	8.47
	Once in a month	40	9.97
	Occasionally	30	7.48
	Seasonally	18	4.48
	Rarely	106	26.43
	Never	56	13.96
Corn	Daily		
	2-4 times a week	11	2.74
	5-6 times a week	14	3.49
	Once a week	54	13.46
	Once in 15 days	19	4.73
	Once in a month	40	9.97
	Occasionally	42	10.47
	Seasonally	121	30.17
	Rarely	19	4.73
	Never	81	20.19
Cucumber	Daily	10	2.49
	2-4 times a week	128	31.92
	5-6 times a week	3	0.74
	Once a week	38	9.47
	Once in 15 days	36	8.97
	Once in a month	29	7.23
	Occasionally	58	14.46
	Seasonally	50	12.46
	Rarely	4	0.99
	Never	45	11.22
Ladies finger	Daily	28	6.98
	2-4 times a week	160	39.90

	5-6 times a week	24	5.98
	Once a week	58	14.46
	Once in 15 days	37	9.22
	Once in a month	22	5.48
	Occasionally	20	4.98
	Seasonally	9	2.24
	Rarely	9	2.24
	Never	34	8.47
Pumpkin	Daily		
	2-4 times a week	56	13.6
	5-6 times a week	8	1.99
	Once a week	114	28.42
	Once in 15 days	27	6.73
	Once in a month	9	2.24
	Occasionally	13	3.24
	Seasonally	9	2.24
	Rarely	10	2.49
	Never	155	38.65
Tomato	Daily	125	31.7
	2-4 times a week	6	1.49
	5-6 times a week	6	1.49
	Once a week	29	7.23
	Once in 15 days	28	6.98
	Once in a month	5	1.24
	Occasionally	34	8.47
	Seasonally	16	3.99
	Rarely	7	1.74
	Never	145	36.15
Green peas	Daily	188	46.88
	2-4 times a week	53	13.21
	5-6 times a week	106	26.43
	Once a week	19	4.73
	Once in 15 days	12	2.99
	Once in a month	12	2.9
	Occasionally	3	0.74
	Seasonally	2	0.49
	Rarely	6	
	Never		1.49

FRUITS			
FOOD ITEM	**FREQUENCY OF CONSUMPTION**	**N**	**%**
Apple	Daily	16	3.99
	2-4 times a week	156	38.90
	5-6 times a week	19	4.73
	Once a week	73	18.20
	Once in 15 days	22	5.48
	Once in a month	9	2.24
	Occasionally	42	4.73
	Seasonally	10	10.47
	Rarely	19	2.49
	Never	35	8.72
Apricot	Daily	7	1.74
	2-4 times a week	30	7.48
	5-6 times a week	8	1.99
	Once a week	49	12.21
	Once in 15 days	28	6.98
	Once in a month	9	2.24
	Occasionally	65	16.20
	Seasonally	41	10.22
	Rarely	21	5.23
	Never	143	35.66
Banana	Daily	12	
	2-4 times a week	109	
	5-6 times a week	4	
	Once a week	28	
	Once in 15 days	2	
	Once in a month	3	
	Occasionally	41	
	Seasonally	25	
	Rarely	20	
	Never	157	
Black-berries	Daily	12	3.24
	2-4 times a week	109	19.45
	5-6 times a week	4	3.24
	Once a week	28	13.96
	Once in 15 days	2	4.73
	Once in a month	3	5.23
	Occasionally	41	3.74
	Seasonally	25	5.23

	Rarely	20	3.24
	Never	157	37.90
Blue-berries	Daily		
	2-4 times a week		
	5-6 times a week		
	Once a week		0.74
	Once in 15 days		
	Once in a month	6	0.49
	Occasionally	49	12.21
	Seasonally	56	13.96
	Rarely	37	9.22
	Never	254	63.34
Blue-berries	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	 6 49 56 37 254	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week-0.74 5. Once in 15 days- 6. Once in a month-0.49 7. Occasionally-12.21 8. Seasonally-13.96 9. Rarely- 9.22 10. Never-63.34
Cran-berries	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	 2 53 54 42 250	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month-0.49 7. Occasionally-13.21 8. Seasonally-13.46 9. Rarely- 10.47 10. Never-62.34

Cherries	Daily- 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	3 10 25 53 51 259	1. Daily- 2. 2-4 times a week-0.74 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month-2.49 7. Occasionally-6.23 8. Seasonally-13.21 9. Rarely- 12.71 10. Never- 64.58
Gooseberry	Daily- 4 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	4 7 10 40 196 28 116	1. Daily-0.99 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 1.74 6. Once in a month-2.49 7. Occasionally-9.97 8. Seasonally-48.87 9. Rarely- 6.98 10. Never-28.92
Grapes (Green)	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	8 6 2 2 11 325 17 30	1. Daily- 1.99 2. 2-4 times a week-1.49 3. 5-6 times a week- 4. Once a week-0.49 5. Once in 15 days- 6. Once in a month-0.49 7. Occasionally-2.74 8. Seasonally-81.04 9. Rarely- 4.23 10. Never-7.48
Grapes	Daily-		1. Daily-

(Black)	2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	8 9 8 6 31 316 4 19	2. 2-4 times a week-1.99 3. 5-6 times a week- 4. Once a week-2.24 5. Once in 15 days- 1.99 6. Once in a month-1.49 7. Occasionally-7.73 8. Seasonally-78.80 9. Rarely- 0.99 10. Never-4.73
Guava (Pink flesh)	Daily- 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Nevers	 4 7 10 2 11 31 299 4 33	1. Daily- 2. 2-4 times a week-0.99 3. 5-6 times a week-1.74 4. Once a week-2.49 5. Once in 15 days- 0.49 6. Once in a month-2.74 7. Occasionally-7.73 8. Seasonally-74.56 9. Rarely- 0.99 10. Never-8.22
Lemon	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never-	16 97 6 26 12 10 47 133 7 47	1. Daily- 3.99 2. 2-4 times a week-24.18 3. 5-6 times a week-1.49 4. Once a week-6.48 5. Once in 15 days- 2.99 6. Once in a month-2.49 7. Occasionally-11.7 8. Seasonally-33.16 9. Rarely- 1.74 10. Never-11.72

Mango	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally- Seasonally Rarely Never	 32 351 9 14	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-7.98 8. Seasonally-87.53 9. Rarely- 0.99 10. Never-3.49
Orange	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	6 2 4 3 6 6 8 346 2 14	1. Daily- 1.49 2. 2-4 times a week- 1.49 3. 5-6 times a week-0.99 4. Once a week-0.74 5. Once in 15 days- 1.49 6. Once in a month-1.49 7. Occasionally-1.99 8. Seasonally-86.28 9. Rarely- 0.49 10. Never-3.49
Papaya	Daily- 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally- Seasonally- Rarely- Never-	 25 6 30 5 19 26 245 6 39	1. Daily- 2. 2-4 times a week-6.23 3. 5-6 times a week-1.49 4. Once a week-7.48 5. Once in 15 days- 1.24 6. Once in a month-4.73 7. Occasionally-6.48 8. Seasonally-61.09 9. Rarely- 1.49 10. Never-9.72

Peach	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionallyw Seasonally Rarely Never	 50 273 8 70	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-12.46 8. Seasonally-68.07 9. Rarely- 1.99 10. Never- 17.45
Pomegranate	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	2 4 9 12 5 15 308 11 35	1. Daily- 0.49 2. 2-4 times a week-0.99 3. 5-6 times a week- 4. Once a week-2.24 5. Once in 15 days- 2.99 6. Once in a month-1.24 7. Occasionally-3.74 8. Seasonally-76.80 9. Rarely- 2.74 10. Never-8.72
Raspberry	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally Seasonally Rarely Never	 15 71 28 287	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-3.74 8. Seasonally-17.70 9. Rarely- 6.98 10. Never-71.57
Strawberry	Daily	3	1. Daily- 0.74

	2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	8 3 3 2 19 289 20 54	2. 2-4 times a week-1.99 3. 5-6 times a week- 4. Once a week-0.74 5. Once in 15 days- 0.74 6. Once in a month-0.49 7. Occasionally-4.73 8. Seasonally-72.06 9. Rarely- 4.98 10. Never-13.46
Watermelon	Daily 2-4 times a week 5-6 times a week Once a week Once in 15 days Once in a month Occasionally Seasonally Rarely Never	2 4 4 8 13 329 4 37	1. Daily- 0.49 2. 2-4 times a week-0.99 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 0.99 6. Once in a month-1.99 7. Occasionally-3.24 8. Seasonally-82.04 9. Rarely- 0.99 10. Never-9.22

ROOTS AND TUBERS		
FOOD ITEM	**N**	**%**

Carrot	Daily- 31 2-4 times a week-137 5-6 times a week-17 Once a week-54 Once in 15 days-30 Once in a month-11 Occasionally-6 Seasonally-99 Rarely-2 Never-14	1. Daily- 7.73 2. 2-4 times a week-34.16 3. 5-6 times a week-4.23 4. Once a week-13.46 5. Once in 15 days- 7.48 6. Once in a month-2.74 7. Occasionally-1.49 8. Seasonally-24.68 9. Rarely- 0.49 10. Never-3.49
Sweet Potato	Daily- 2-4 times a week-2 5-6 times a week-6 Once a week-12 Once in 15 days-13 Once in a month-25 Occasionally-109 Seasonally-109 Rarely-113 Never-70	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-27.18 8. Seasonally-27.18 9. Rarely- 28.17 10. Never-17.45
Mushroom	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month-27 Occasionally-53 Seasonally-9 Rarely-34 Never-278	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-19.95 8. Seasonally-2.24 9. Rarely- 8.47 10. Never-69.32
Onion	Daily- 329 2-4 times a week-35 5-6 times a week-6 Once a week-17 Once in 15 days-3 Once in a month-3 Occasionally-6 Seasonally- Rarely- Never-2	1. Daily- 82.04 2. 2-4 times a week-8.72 3. 5-6 times a week-1.49 4. Once a week-4.23 5. Once in 15 days- 0.74 6. Once in a month-0.74 7. Occasionally-1.49 8. Seasonally- 9. Rarely- 10. Never-0.49

NUTS AND OILSEEDS

FOOD ITEM	N	%
Almonds	Daily- 211 2-4 times a week-62 5-6 times a week-11 Once a week-32 Once in 15 days-22 Once in a month-9 Occasionally-39 Seasonally-0 Rarely-10 Never-5	1. Daily- 52.61 2. 2-4 times a week-15.46 3. 5-6 times a week-2.74 4. Once a week-7.98 5. Once in 15 days- 5.48 6. Once in a month-2.24 7. Occasionally-9.72 8. Seasonally- 9. Rarely- 2.49 10. Never-1.24
Cashew nuts	Daily- 70 2-4 times a week-60 5-6 times a week-12 Once a week-31 Once in 15 days-33 Once in a month-18 Occasionally-45 Seasonally-3 Rarely-105 Never-24	1. Daily- 17.45 2. 2-4 times a week-14.96 3. 5-6 times a week-2.99 4. Once a week-7.73 5. Once in 15 days- 8.22 6. Once in a month-4.48 7. Occasionally-11.22 8. Seasonally-0.74 9. Rarely- 26.18 10. Never-5.98
Pistachio nuts	Daily- 33 2-4 times a week-35 5-6 times a week- Once a week-33 Once in 15 days-12 Once in a month-14 Occasionally-73 Seasonally-13 Rarely-113 Never-75	1. Daily- 8.22 2. 2-4 times a week-8.72 3. 5-6 times a week- 4. Once a week-8.22 5. Once in 15 days- 2.99 6. Once in a month-3.49 7. Occasionally-18.20 8. Seasonally-3.24 9. Rarely- 28.17 10. Never-18.70
Walnuts	Daily- 147 2-4 times a week-35 5-6 times a week-17 Once a week-33 Once in 15 days-16 Once in a month-21 Occasionally-44 Seasonally-10 Rarely-20 Never-58	1. Daily- 36.65 2. 2-4 times a week-8.72 3. 5-6 times a week-4.23 4. Once a week-8.22 5. Once in 15 days- 3.99 6. Once in a month-5.23 7. Occasionally-10.97 8. Seasonally-2.49 9. Rarely- 4.98 10. Never-14.46
Flax seeds	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-142 Seasonally-3 Rarely-44	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-35.51 8. Seasonally-0.74 9. Rarely- 10.97

	Never-212	10. Never-52.86
Chia seeds	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-141 Seasonally-3 Rarely-42 Never-215	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-35.16 8. Seasonally-0.74 9. Rarely- 10.47 10. Never-53.61
Peanuts	Daily- 31 2-4 times a week-34 5-6 times a week-6 Once a week-150 Once in 15 days-30 Once in a month-16 Occasionally-56 Seasonally-7 Rarely-16 Never-55	1. Daily- 7.73 2. 2-4 times a week-8.47 3. 5-6 times a week-1.49 4. Once a week-37.40 5. Once in 15 days- 7.48 6. Once in a month-3.99 7. Occasionally-13.96 8. Seasonally-1.74 9. Rarely- 3.99 10. Never-13.71

COOKING OILS		
FOOD ITEM	**N**	**%**
Sunflower oil	Daily- 188 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-45 Seasonally-7 Rarely-4 Never-157	1. Daily- 46.88 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-11.22 8. Seasonally-1.74 9. Rarely- 0.99 10. Never-39.15
Rice-bran oil	Daily- 12 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-28 Seasonally-5 Rarely-10 Never-346	1. Daily- 2.99 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-6.98 8. Seasonally-1.24 9. Rarely- 2.49 10. Never-86.28
Soyabean oil	Daily- 2-4 times a week- 5-6 times a week-	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week-

	Once a week- Once in 15 days- Once in a month- Occasionally-28 Seasonally-8 Rarely-15 Never-356	4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-6.98 8. Seasonally-0.49 9. Rarely- 3.74 10. Never-88.77
Olive oil	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-40 Seasonally-8 Rarely-15 Never-338	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-9.97 8. Seasonally-1.99 9. Rarely- 3.74 10. Never-84.28

MISCELLENEOUS		
FOOD ITEM	**N**	**%**
Dark chocolate	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month-24 Occasionally-126 Seasonally- Rarely-103 Never-85	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month-5.98 7. Occasionally-31.42 8. Seasonally- 9. Rarely- 25.68 10. Never-21.19
Tofu	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-33 Seasonally- Rarely-21 Never-284	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-8.22 8. Seasonally- 9. Rarely- 5.23 10. Never-70.82
Peanut butter	Daily- 3 2-4 times a week- 5-6 times a week- Once a week-18 Once in 15 days- Once in a month- Occasionally-29 Seasonally-	1. Daily- 0.74 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week-4.48 5. Once in 15 days- 6. Once in a month- 7. Occasionally-7.23 8. Seasonally-

	Rarely-118 Never-170	9. Rarely- 29.42 10. Never-42.39

FRESH FRUITS AND VEGETABLE JUICES		
FOOD ITEM	**N**	**%**
Apple juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-51 Seasonall-15 Rarely-28 Never-307	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-12.71 8. Seasonally-3.74 9. Rarely- 6.98 10. Never-76.55
Cranberry juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-45 Seasonally-13 Rarely-16 Never-327	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-11.22 8. Seasonally-3.24 9. Rarely-3.99 10. Never-81.54
Pomegranate juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-84 Seasonally-41 Rarely-108 Never-168	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-20.94 8. Seasonally-10.22 9. Rarely- 26.93 10. Never-41.89
Pineapple juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days-	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days-

	Once in a month- Occasionally-115 Seasonally-41 Rarely-106 Never-139	6. Once in a month- 7. Occasionally-28.67 8. Seasonally-10.22 9. Rarely- 26.43 10. Never-34.66
Mango juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-20 Seasonally-274 Rarely-10 Never-97	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-4.98 8. Seasonally-68.32 9. Rarely- 2.49 10. Never- 24.18
Watermelon juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-21 Seasonally-250 Rarely-14 Never-116	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-5.23 8. Seasonally-62.34 9. Rarely- 3.49 10. Never-28.92
Orange juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally- Seasonally- Rarely- Never	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally- 8. Seasonally- 9. Rarely- 10. Never-
Lime juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days-	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days-

	Once in a month- Occasionally- Seasonally- Rarely- Never	6. Once in a month- 7. Occasionally- 8. Seasonally- 9. Rarely- 10. Never-
Gooseberry juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-30 Seasonally-142 Rarely-14 Never-202	1. Daily- 3.24 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-7.48 8. Seasonally-35.41 9. Rarely- 3.49 10. Never-50.37
Grape juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally- Seasonally-51 Rarely-16 Never-334	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally- 8. Seasonally-12.71 9. Rarely- 3.99 10. Never-83.29
Beetroot juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-86 Seasonally-23 Rarely-14 Never-271	1. Daily- 1.74 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-21.44 8. Seasonally-5.73 9. Rarely- 3.49 10. Never-67.58
Carrot juice	Daily- 7 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days-	1. Daily- 1.74 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days-

	Once in a month- Occasionally-82 Seasonally-27 Rarely-15 Never-297	6. Once in a month- 7. Occasionally-13.71 8. Seasonally-67.33 9. Rarely- 3.74 10. Never-74.06
Spinach juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-27 Seasonally-9 Rarely-13 Never-355	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-5.98 8. Seasonally-2.24 9. Rarely- 3.24 10. Never-88.52
Coriander juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-24 Seasonally-7 Rarely-20 Never-350	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-5.98 8. Seasonally-1.74 9. Rarely- 4.98 10. Never-87.28
Tomato juice	Daily- 2-4 times a week- 5-6 times a week- Once a week- Once in 15 days- Once in a month- Occasionally-46 Seasonally-17 Rarely-7 Never-331	1. Daily- 2. 2-4 times a week- 3. 5-6 times a week- 4. Once a week- 5. Once in 15 days- 6. Once in a month- 7. Occasionally-11.47 8. Seasonally-4.23 9. Rarely- 1.74 10. Never-82.54

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSIONS

Non-communicable diseases (NCDs) such as diabetes, hypertension, and cardiovascular diseases (CVDs) as leading causes of global mortality, particularly emphasizing the origins of risk factors like poor diet, smoking, sedentary behaviour, and obesity early in life. These behaviours, established during adolescence, significantly affect health throughout an individual's life course. The study highlights how unhealthy diets, particularly high in sugar-sweetened beverages and saturated fats, contribute significantly to the increased risk of CVD globally.

Non-communicable diseases (NCDs) among youth in India are influenced by several modifiable risk factors, exacerbating their prevalence and impact (MoHFW report, 2020).

One of the primary risk factors is an unhealthy diet, characterized by the consumption of processed foods, sugary beverages, and fast food. This dietary pattern contributes significantly to the development of NCDs such as obesity, diabetes, and cardiovascular diseases.

Additionally, sedentary lifestyles prevalent among youth further compound the risk, as physical inactivity is strongly associated with NCD incidence.

Phytochemicals are plant components having discrete bio-activities with a variety of health benefits and are sometimes referred to as functional ingredients/ nutraceutical compounds and are identified as carotenoids, vitamins, minerals, fibers, fatty acids, peptides, proteins and secondary plant metabolites. Whereas, phenolics, terpenoids, glucosinolates, pollyacetylene, phytosterols & phytostanols and non-digestible carbohydrates and are present in in a good amount in fruits, vegetables, nuts, cereals and legumes.

Phytochemicals derived from diverse foods presumably can interact additively and (possibly) synergistically; thus, the total dietary load of phytochemicals may have important implications for health. As a means of very roughly quantifying this load, a “phytochemical index” (PI) is proposed, defined as the percent of dietary calories derived from foods rich in phytochemicals. Calories derived from fruits, vegetables (excluding potatoes), legumes, whole grains, nuts, seeds, fruit/vegetable juices, soy products, wine, beer, and cider – and foods compounded therefrom – would be counted in this index. PI would provide only a very rough approximation of the quantity or quality of phytochemical nutrition diets high in phytochemical-rich plant foods could help improve the phytochemical nutrition (McCarty, 2004). Thus, assessing the

phytochemical index would help to know the quality of diet and later would help to make the right corrections in the diet.

BROAD OBJECTIVE: To assess Phytochemical Index in the Diets of University Students.

SPECIFIC OBJECTIVES:

1. To assess dietary pattern and nutrient intake of the university students.
2. To assess physical activity levels among university students.
3. To assess diabetes risk among university students
4. To investigate the association between dietary phytochemical (PI) and anthropometric measurements, blood pressure, diabetes risk, fasting blood sugar(FBS).

THE RESULTS OF THE STUDY ARE DISCUSSED IN THE FOLLOWING SECTIONS:

1. Socio-demographic information, anthropometric data, medical and family history, physical activity pattern, and the dietary pattern of the subjects.
2. Evaluation of phytochemical index from the diet of students.
3. Association of phytochemical index with overweight-obesity, abdominal obesity and IDF risk assessment score.

BACKGROUND INFORMATION

- From the total 14.71% subjects were male and 85.28% of the subjects were female. From the total number of subjects 47.13% were <20years of age whereas 52.86% were ≥20 years of age.
- The mean age of the subjects was 20.2 years. Mean age of the male subjects was 19.6 years and that of female subjects was 20.3 years
- From the total, highest number of subjects were undergraduate students (75.09%) and 22.19% and 2.74% were post-graduate students and PhD scholars respectively.
- Majority of the students (61.34%) belonged to nuclear families.

SOCIO-ECONOMIC STATUS

- According to Kuppuswamy SES classification. Around 12.96%, 68.34%, 13.46% and 4.76% of the subjects fell in the upper, upper middle, lower middle and upper lower classes respectively.

ANTHROPOMETRIC MEASUREMENTS

- The mean height, weight and BMI of the subjects is 160.1cm, 56.7 Kgs and 22.1Kg/m² respectively.
- The mean BMI values for male subjects was 21.1Kg/m² and that for the female subjects was 22.3Kg/m² respectively.
- Mean stature ratio for females was 0.5 and that for male subjects was 0.45 respectively.

PREVALENCE OF OVERWEIGHT AND OBESITY

- Based on the Asia-pacific classification of BMI, majority of the male (47.75%) and female (37.42%) subjects belonged to the normal BMI category.
- Among the male subjects 28.81% belonged to the underweight category and 5.08% and 18.64% belonged to the overweight and obese categories respectively, whereas among the female subjects 23.09% belonged to the underweight category and 13.15% and 26.31% belonged to the overweight and obese category respectively.

ABDOMINAL OBESITY

- Out of the total male subjects 11.86% had waist circumference ≥90 cm to identify the prevalence of abdominal obesity Waist circumference and Waist-hip ratio was considered.
- Similarly, among the female subjects 36.54% had waist circumference ≥80cm. Also, 35.59% of male subjects had ≥0.90 waist-hip ratio and 29.23% of female participants had ≥0.85 of waist hip ratio.

BLOOD PRESSURE

- Mean systolic and diastolic blood pressure for females was 105.6 mmHg and 71.9 mmHg respectively, while for male subjects it was 115.42mmHg and 77.54mmHg respectively.

FASTING BLOOD GLUCOSE

- Mean FBS for female subjects was 87.8 mg/dl and that for the male subjects was 91.13mg/dl.

DIETARY PATTERN

- Out of the total number of subjects 58.35% were vegetarians, 32.41% were non-vegetarians and 9.22% were ovo-vegetarians.

FREQUENCY OF CONSUMPTION OF FAST FOODS, JUNK FOODS AND ORDERING ONLINE

- Majority of the subjects (i.e. 33.66%) consumed fast foods 2-3 times a week.
- Majority of the subjects (28.67%) consumed cold drinks and beverages occasionally.
- Consumption frequency of junk and packaged foods daily, once a week, once in 15 days, once a month, occasionally and never by students was 10.47%,19.20%,15.46%,5.23%, 11.22% and 2.24% respectively.
- Majority of subjects that is 21.94% ordered/ takeaway food once a week.

NUTRIENT INTAKE s SUBJECTS

- Mean calorie contribution from carbohydrates is 51.49%, from protein it is 18.86% and from fats it is 24.94%.

PHYTOCHEMICAL INDEX

- Mean PI was 45.59.
- Mean PI of male subjects was 45.37.
- Mean PI for female subjects was 46.85.
- Mean PI for underweight female subjects was 42.62, for normal BMI female subjects was 43.96, for overweight female subjects 47.5 and for obese females PI was 50.15 respectively.
- For underweight male subjects mean PI was 44.13, for normal BMI male subjects mean PI was 47.2 and for overweight male subjects mean PI was 49.39 and for obese male subjects it is 49 respectively.
- Mean calories from cereals in male was 448 Kcal, from pulses it was 97 Kcal, and from fruits, vegetables and nuts and oilseeds it was 11 Kcal,47 Kcal and 7 Kcal respectively. In male subjects' soy and soy products and olive oil did not have any calorie contribution in calculation of PI. Mean calories from cereals in female was 370 Kcal, from pulses it was 107 Kcal, and from fruits, vegetables and nuts

and oilseeds it was 13 Kcal,45 Kcal and 24 Kcal respectively. In female subjects mean calories from soy and soy products and olive oil was 5 Kcal and 1 Kcal respectively.

- On the basis of the cut-off and criteria provided in the score card we interpret that among the female subjects 50.58% and among the male 69.3% were at low risk of diabetes.
- Among female subjects 35.29% and 32.20% of male subjects were at slightly elevated risk of diabetes.
- Among the total subjects 13.52% female and 6.77% male subjects fell under moderate risk category.
- Out of the total subjects 0.58% of female subjects were under high-risk category while no male subjects were under this category.

PHYSICAL ACTIVITY:

On assessment of physical activity via IPAQ it was found that majority of the students were inactive and were living a sedentary lifestyle.

CONCLUSION:

- In the present study, calorie consumption from CHO and fats was double then the requirement in both female and male subjects.
- The phytochemical index obtained by the assessment of diet of the students was almost half of the considered best phytochemical index score.
- Among the phytochemical rich food groups cereals, pulses and vegetables were the main calorie contributor in the index.

By IDF diabetes risk score card assessment it was found that considerable number of subjects among the total subjects were at slightly elevated risk and moderate risk of diabetes.

RECOMMENDATIONS:

- According to the proposal literature of dietary phytochemical index the best phytochemical score is considered to be 100 and the least score is considered to be 20.

- In the present study the phytochemical index obtained was 45.59 which is even less than half of the best score.
- Hence, to improve the phytochemical index and quality of diet the daily nutrient requirements should be met. Excess of calories coming from carbohydrates and fats should be cut down.
- Higher consumption of foods such as soy and soy products, whole grains, nuts and oilseeds, fruits, vegetables, and legumes is recommended as a valuable strategy to increase the dietary phytochemicals and phytochemical index of the diet.
- Along with commonly consumed phytochemical rich food groups (cereals, pulses and vegetables) other phytochemicals rich food groups such as fruits, nuts and oil seeds, soy and soy products and olive oil should also be inculcated to enhance the phytochemical index as well as quality of diet.

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APPENDICES

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 2024-2025

This is to certify Ms. Maitri Kulkarni study titled; "Assessment of Phytochemical Index in Diets of University Students." from Department of Foods and Nutrition has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number IECHR/FCSc/M.Sc./10/2024/49.

Komal

Prof. Komal Chauhan
Member Secretary
IECHR

Prof. Mini Sheth
Chairperson
IECHR

Chair Person
IECHR
Faculty of Family & Community Sciences
The Maharaja Sayajirao University of Baroda

QUESTIONNAIRE:

Socio-demographic data

1. Name:
2. Age:
3. DOB:
4. Gender:

☐ Male ☐ Female ☐ Other

5. Religion:

a. Hindu b. Muslim c. Christian d. Buddhist e. Sikh f. Parsi g. Jain

6. Department:

a. Clothing and Textile (CT) b. Family and Community Resource Management (FCRM)

c. Foods and Nutrition (FN) d. Extension and Communication (EC)

e. Human Development and Family Studies (HDFS) f. General Level Program (GLP)

g. Institute of Fashion Technology (IFT)

7. Subject major: _____
8. Education level:

a. Under-graduate student b. P.G. Diploma student c. Post-graduate student d. PhD Scholar

9. Contact details:
10. Place of residence: ☐ On campus accommodation ☐ Off campus accommodation/ PG ☐ At home with family
11. Residential address:

12. Family type: ☐ Nuclear ☐ Joint ☐ Extended
13. How many family members do you have in your family? _____
14. Socio-economic status:

(i) Education of head of the family:	
(a) Profession or honors	
(b) Graduate	
(c) Intermediate or diploma	
(d) High school certificate	
(e) Middle school certificate	

(f) Primary school certificate	
(g) Illiterate	
(ii) Occupation of head of the family:	
a) Legislators, senior officials and managers	
b) Professionals	
c) Technicians and associate professionals	
d) Clerks	
e) Skilled workers and shop and market sales workers	
f) Skilled agricultural and fishery workers	
g) Craft and related trade workers	
h) Plant and machine operators and assemblers	
i) Elementary occupation	
j) Unemployed	

(iii) Family income (Monthly):	
a) 2,13,814 and above	
b) 1,06,850-2,13,813	
c) 80,110-1,06,849	
d) 53,361-80,109	
e) 31,978-53,360	
f) 10,703-31,977	
g) <10,702	

15. Father's education:

a. Profession or honor b. Graduate c. Intermediate or diploma d. High school certificate

e. Middle school certificate f. Primary school certificate g. Illiterate

16. Father's occupation: a. Business b. Service c. Professional d. Retired

17. Mother's education:

a. Profession or honor b. Graduate c. Intermediate or diploma d. High school certificate

e. Middle school certificate f. Primary school certificate g. Illiterate

18. Mother's Occupation: a. Homemaker b. Business/ Self-employed c. Service d. Professional e. Retired

19. Do you have any of the following habits? If yes please specify the frequency:

Habit	Yes/No	If yes, frequency
Smoking		
Chewing tobacco		
Drinking alcohol		
Any other(specify)		

20. Do you have any of the following medical conditions?

a. Diabetes: ☐ Yes No ☐
b. Hypothyroidism: ☐ Yes No ☐
c. Hypertension: ☐ Yes No ☐
d. Dyslipidemia (High TG/LDL/ Total Cholesterol, Low HDL): ☐ Yes ☐ No
e. Any other (such as PCOD/PCOS): _____

21. Family history of any of the following non-communicable disease:

Non-Communicable disease	Immediate (Father/ Mother/ Sibling/ Own child)	Distant (Grandparent from either side/ Uncle/ Aunt/ First cousin)
1.Diabetes (Type-1or Type-2)		
2. Hypertension		
3. Chronic obstructive pulmonary disease (COPD)		
4. Dyslipidemia		
5. Cancer		
6. Other (Please specify)		

22. How many hours do you sleep everyday on an average? _____

Anthropometric measurements:

23.

Height(cm)	
Weight(kg)	
Waist circumference(cm)	
Hip circumference(cm)	
BMI (kg/m^2)	
Waist-hip ratio (WHR)	
Waist- height ratio (WHtR)	

24. Is there any sudden weight gain/loss in recent months? If yes, then what and how much please specify? _____

25. Blood pressure measurements:

Systolic:(mmHg)	
Diastolic:(mmHg)	

26. Fasting blood sugar (FBG): _____

Dietary pattern:

27. Type of diet consumed:

a. Vegetarian b. Non-vegetarian c. Ovo-vegetarian

28. Any clinically diagnosed food allergies?

a. Yes, please specify: _____ b. No

29. Are you following any specific type of diet, for eg. Keto diet, Gluten free diet, Vegan diet, Intermittent fasting?

a. Yes, please specify: _____ b. No

30. How frequently do you eat fast foods (i.e Pizza, Pasta, Burger, Momos, Frankie, Samosa, Vadapav, Dabeli, Sandwich, Chinese etc.)?

a. Daily b. 2-3 times a week c. Once in a week d. Once in 15 days e. Once in a month

f. Occasionally g. Never

31. How frequently do you eat packaged/junk foods (i.e Chips, Biscuits, Cookies, Namkeen, Pastry, Donuts, Brownies, Puff, Nankhatai, Rusk etc)?

a. Daily b. 2-3 times a week c. Once in a week d. Once in 15 days e. Once in a month

f. Occasionally g. Never

32. How frequently do you drink sugar sweetened beverages (cold drinks, readymade juices, packaged drinks etc.)?

a. Daily b. 2-3 times a week c. Once in a week d. Once in 15 days e. Once in a month

f. Occasionally g. Never

33. How frequently do you eat outside, takeaway or order your meals online?

a. Daily b. 2-3 times a week c. Once in a week d. Once in 15 days e. Once in a month

f. Occasionally g. Never

34. How many glasses of water do you drink in a day? _____

35. How many meals do you consume in a day? _____

36. Do you skip breakfast?

a. Yes, why? _____ b. No

37. Do you skip lunch?

a. Yes, why? _____ b. No

38. Do you skip dinner?

a. Yes, why? _____ b. No

39. Do you have long time intervals in between your meals?

a. Yes, please specify the time interval: _____ b. No

40. Do you consume tea or coffee daily?

a. Yes, please specify no. of cups consumed in a day: _____ b. No

41. Do you replace your regular meals (i.e Breakfast, Lunch, Dinner) with fast foods or junk foods (such as Maggi, Pasta, French fries, Noodles etc.)? a. Yes b. No

42. If yes, which regular meals are replaced with fast-foods? a. Breakfast b. Lunch c. Dinner

43. How frequently do you replace your regular meals (i.e Breakfast, Lunch, Dinner) with fast foods or junk foods (such as Maggi, Pasta, French fries, Noodles etc.)?

a. Daily b. 2-3 times a week c. Once in a week d. Once in 15 days e. Once in a month

f. Occasionally g. Never

44. Do you take any micronutrient supplementation? (For eg. Vitamin supplements, Omega-3-supplements? a. Yes b. No

45. Do you drink green tea, black tea, yellow tea, chamomile tea, cinnamon tea, hibiscus tea, herbal tea? a. Yes b. No

46. How often do you drink green tea, black tea, yellow tea, chamomile tea, cinnamon tea, hibiscus tea, herbal tea?

a. Daily b. 2-3 times a week c. Once in a week d. Once in 15 days e. Once in a month

f. Occasionally g. Never

****

SR NO.	MEAL TIME	INGREDIENTS	RAW WEIGHT(g)	COOKED VOLUME
1.	**BREAKFAST:** **NAME OF THE FOOD STUFF**			
2.	**MID-MORNING SNACK:** **NAME OF THE FOOD STUFF**			
3.	**LUNCH:** **NAME OF THE FOOD STUFF**			

4.	**EVENING SNACK:** **NAME OF THE FOOD STUFF**			
5.	**DINNER:** **NAME OF THE FOOD STUFF**			
6.	**LATE NIGHT SNACK/DRINK:** **NAME OF THE FOOD STUFF**			

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. 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. Please 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 that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____days per week

☐ No vigorous physical activities → Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days? _ hours per day_____minutes per day

☐ Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
_____days per week

☐ No moderate physical activities → Skip to question 5

4. How much time did you usually spend doing moderate physical activities on one of those days?_____hours per day

_____minutes per day

☐ Don't know/Not sure

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.

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

_____days per week

☐ No walking → Skip to question 7

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

_____hours per day

_____minutes per day

☐ Don't know/Not sure

The last question is about the time you spent sitting on weekdays 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.

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

_____hours per day

_____minutes per day

☐ Don't know/Not sure

IDF diabetic risk assessment score:

1. Age:
   a. Under 45 years
   b.45-54 years
   c. 55-64 years
   d. Over 64 years
2. BMI:
   a. <18.5- Underweight b. 18.5-22.9- Normal c. 23-24.9- Overweight d. >25 Obese
3. Waist circumference: Men- a. <102 cm b. >102 cm
   Women- a. <88 cm b. >88cm
4. Do you do at least 30 minutes of physical activity during work or leisure time?
   a. Yes b. No
5. How often do you consume fruits and vegetables or berries?
   a. Everyday b. Not everyday
6. Have you ever taken medication for high blood pressure on regular basis.
   a. Yes b. No
7. Have you ever been found to have high blood glucose level (during medical examination, illness or pregnancy)?
   a. Yes b. No
8. Have you or any other members of your immediate family or other relatives been diagnosed with diabetes? (Type-1 or Type-2)
   a. No
   b. Yes- Grandparent, uncle, aunt or first cousin
   c. Yes- Parent, brother, sister or own child

Food Item	Daily	2-4 times a week	5-6 times a week	Once a week	Once in 11-15 days	Once a month	Occasionally	Seasonally	Rarely	Never
(i) Cereals										
1. Whole wheat flour										
2. Rice, brown										
3. Rice, milled										
4. Ragi (Finger millet)										
5. Oats										
6. Barley- Jav										
7. Sorghum- Jowar										
8. Maize-Makai										
(ii) Legumes and Lentils										
1. Chickpeas- Chole chana										
2. Cowpea- Chawli										
3. Kidney beans- Rajmah										
4. Broad beans- Val										
5. Red gram- Toor										
6. Green gram- Moong										
7. Black gram- Urad dal										
8. Yellow lentil – Moong dal										
9. Red lentil- Masoor dal										
10. Soya bean-white										
11. Soya bean- brown										
12. Soya chunks										
(iii) Green leafy vegetables										
1. Cabbage, green										
2. Lettuce										

Food Item	Daily	2-4 times a week	5-6 times a week	Once a week	Once in 11-15 days	Once a month	Occasionally	Seasonally	Rarely	Never
3. Spinach										
4. Coriander										
5. Cauliflower										
(iv) Other Vegetables										
1. Broccoli										
2. Bell pepper (Capsicum-red, green, yellow)										
3. Beans- fansi										
4. Corn										
5. Cucumber										
6. Ladies finger										
7. Pumpkin										
8. Tomato										
9. Green peas										
(v) Fruits										
1. Apple										
2. Apricot										
3. Banana										
4. Black berries										
5. Blue berries										
6. Cranberries										
7. Cherries										
8. Gooseberry										
9. Grapes (green)										

Food Item	Daily	2-4 times a week	5-6 times a week	Once a week	Once in 11-15 days	Once a month	Occasionally	Seasonally	Rarely	Never
10. Grapes (black)										
11. Guava, pink flesh										
12. Lemon										
13. Mango										
14. Orange										
15. Papaya										
16. Peach										
17. Pear										
18. Pomegranate										
19. Raspberry										
20. Strawberry										
21. Watermelon										
(vi) Roots and Tubers										
1. Carrot										
2. Sweet Potato										
3. Mushroom										
4. Onion										
(vii) Nuts and Oil seeds										
1. Almonds										
2. Cashew nuts										
3. Pistachio nuts										
4. Walnuts										
5. Flax seeds										
6. Chia seeds										
7. Peanuts										

Food Item	Daily	2-4 times a week	5-6 times a week	Once a week	Once in 11-15 days	Once a month	Occasionally	Seasonally	Rarely	Never
(viii) Cooking oils										
1. Sunflower oil										
2. Ricebran oil										
3. Soyabean Oil										
4. Olive oil										
(ix) Others										
1. Dark Chocolate										
2. Tofu										
3. Peanut butter										
(x) Fresh fruit and vegetable juices										
1. Apple juice										
2. Cranberry juice										
3. Pomegranate juice										
4. Pineapple juice										
5. Mango juice										
6. Watermelon juice										
7. Orange juice										
8. Lime juice										
9. Gooseberry juice										
10. Grape juice										
11. Beetroot juice										
12. Carrot juice										
13. Spinach juice										
14. Coriander juice										
15. Tomato juice										

CONSENT FORM:

STUDY TITLE: Assessment of Phytochemical Index in the Diets of University Students: A Cross-sectional Study

INVESTIGATORS

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PURPOSE OF THE STUDY:

Phytochemicals refers to the variety and concentration of bioactive compounds found in plant-based foods, which are known to contribute to health and well-being. With rising concerns about diet-related health issues among young adults, particularly university students, assessing the phytochemical index of their diets is crucial for understanding its potential impact on their health. Assessing the phytochemical index among university students is not just an academic exercise; it is a necessary step toward improving health outcomes in a population that is often at risk for poor dietary choices. By understanding their phytochemical intake, we can better support students in achieving optimal health and academic success.

Phytochemicals are associated with various health benefits, including antioxidant, anti-inflammatory, and anticancer properties.

PROTOCOL OF THE STUDY

If you decide to join this study, data will be collected using semi-structured pre-tested questionnaires from you. Information regarding anthropometric measurements, dietary pattern and nutrient intake, physical activity levels, diabetes risk, blood pressure, and FBS levels shall be collected.

COSTS

This study requires only your time and co-operation. All the costs included will be borne by the researcher and there is no financial compensation for your participation in this research.

POSSIBLE BENEFITS AND RISKS

- The study will help in understanding dietary pattern and nutrient intake of the university students, physical activity levels of university students, diabetes risk among university students.

- The study will also help in understanding the association between phytochemical index and physical activity, blood pressure, anthropometric measurements and diabetes risk.

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

VOLUNTARY PARTICIPATION
Your cooperation is important for the success of this study. Unless many volunteers like you participate in this study it will be not possible.

RIGHT TO WITHDRAW:

Your decision to join this study is voluntary. You can quit the study 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 a correct conclusion.

AVAILABILITY OF RESULTS:

At the end of the study, relevant information will be shared with you.

CONTACT:

If you have any questions regarding this study, you can contact the investigators.

CERTIFICATE OF CONSENT
I have read this information (or had the information read to me) and understood the description of the study, I agree to take part in the research being carried out by Dr. Shonima Venugopal and her student, Ms. Maitri Kulkarni, on 'Assessment of Phytochemical Index in the Diets of University Students'. I understand that the study requires participants to complete a questionnaire with details such as 24-hour dietary recall, food frequency questionnaire, anthropometric measurements and physical activity questionnaire. Also, I am aware that blood pressure will be checked and blood sample will be taken as well to check the fasting blood sugar levels by a digital glucometer. I understand that I may ask questions about the study at any time. I am also aware of my right to opt-out of the study anytime.

_____

Name of the student and signature: Date: