ASSOCIATION OF PHYSICAL ACTIVITY LEVELS WITH BODY COMPOSITION, DIETARY AND LIFESTYLE PATTERN OF YOUNG ADULTS

Dissertation submitted to

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

Affiliated to

MAHATMA GANDHI UNIVERSITY

In partial fulfilment of requirement for the

AWARD OF THE DEGREE OF MASTER OF SCIENCE IN

HOME SCIENCE (BRANCH C)

FOOD SCIENCE AND NUTRITION

By

ASWATHY V

Register No. AM23HFN003

DEPARTMENT OF HOMESCIENCE AND CENTRE FOR RESEARCH

APRIL 2025

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I hereby declare that this research work titled **"Association of physical activity levels with body composition, dietary and lifestyle pattern of young adults"** is an original research work carried out by me under the supervision and guidance of Dr. Anu Joseph, Associate Professor, Department of Home Science, St.Teresa's College (Autonomous), Ernakulam.

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I hereby certify that the dissertation entitled **"Association of physical activity levels with body composition, dietary and lifestyle pattern of young adults"** is an original research work carried out by Ms. Aswathy V under my guidance and supervision.

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ACKNOWLEDGEMENT

I would like to begin by thanking God Almighty for his constant guidance and wisdom throughout every step of this research.

My heartfelt gratitude to Dr. Vinitha CSST, Provincial Superior and Manager of the college, Sr. Emeline CSST, Director of the college, Dr. Alphonsa Vijaya Joseph, Principal St. Teresa's College, Ernakulam.

I would like to express my deep and sincere gratitude to Ms. Teresa Kuncheria, Head of the Department of Home Science, St. Teresa's College, Ernakulam for the valuable support, through out the time of my research.

I extend my profound thanks to my research guide, Dr. Anu Joseph, Associate Professor in the Home Science Department, for her unwavering support, valuable guidance, and insightful suggestions throughout the entire research process. I am equally grateful to the faculty members of the Home Science Department for their cooperation, encouragement, and guidance, which played a crucial role in the successful completion of my study.

I would also like to express my gratitude to the authorities of St. Teresa's College for providing me with the necessary resources and a conducive environment to carry out my research.

Lastly, I would like to express my profound gratitude to my family and friends for their unwavering support, encouragement, and understanding throughout this academic journey. Their belief in me has been a constant source of motivation.

Aswathy V

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CHAPTER 1
INTRODUCTION

Physical fitness is not only one of the most important keys to a healthy body, but it is also the basis of dynamic and creative intellectual activity.

- JOHN F. KENNEDY

The transition into young adulthood, typically spanning ages 18 to 30, is a pivotal period marked by significant lifestyle changes that can profoundly influence long-term health outcomes. During this phase, individuals often establish habits related to physical activity, dietary choices, and other lifestyle behaviors that can impact body composition and overall well-being.

The important role of physical activity in body composition relates to its ability to control both fat-free mass and fat mass maintenance. There has been a global decrease in physical activity levels across all age groups in recent years, making physical inactivity a growing concern worldwide. The World Health Organization (WHO) 2020 study report indicates that worldwide one third (31%) of adults fail to fulfill the recommended physical activity guidelines. This equates to 1.8 billion adults.

A sedentary lifestyle in the modern day is a major factor in the growth in obesity and associated illnesses. Reduced physical activity and increased consumption of foods high in calorie density are the main causes of the rising number of overweight people in industrialized economies. Studies show that the gradual decline in social physical activity has shifted the trajectory of public health, making sedentary behavior an independent risk factor for CVD.

Globally, approximately 34% of women and 29% of men fell short of global physical activity recommendations.The gap in gender participation rates between men and women reaches above 10 percentage points in 31% of surveyed countries.

Globally, physical inactivity tends to rise with age, with fewer adults aged 60 and above meeting the recommended levels of physical activity compared to their younger counterparts. Among men, inactivity levels show a gradual increase with age, followed by a significant surge after 60. In contrast, women generally maintain steady or slightly declining inactivity levels until the age of 60, after which a sharp increase is observed. These age-related trends in inactivity also differ across various regions and countries.

Physical inactivity levels show significant variation across WHO regions. The Eastern Mediterranean and South-East Asia Regions recorded the highest inactivity rates, both at 40%. On the other hand, the Western Pacific (28%), European (25%), and African (16%) Regions reported the lowest levels of inactivity. Among different country groupings, "high-income Asia" — which includes Japan, the Republic of Korea, and Singapore — exhibited the highest physical inactivity rate at 48%, followed by South Asia (including Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka) at 45%. The Oceania and sub-Saharan Africa regions showed the lowest inactivity levels.

Disparities in physical inactivity are also evident across and within country-income groups, based on the World Bank classification. Although previous reports indicated a trend of rising inactivity with increasing income levels, recent data highlight a sharp rise in physical inactivity in lower-middle-income countries over time. By 2022, inactivity levels in these countries reached 38%, surpassing those in high-income countries (33%) and significantly higher than in low-income countries (18%).

Globally, there has been a 5-percentage-point increase in physical inactivity — from 26% in 2010 to 31% in 2022. If this upward trend persists, inactivity levels are projected to climb to 35% by 2030 (with 38% among women and 32% among men). These findings suggest that the world is not on track to achieve the global target of a 15% relative reduction in physical inactivity by 2030.

India is currently experiencing major socioeconomic, demographic, and lifestyle transitions. Our civilization has seen tremendous transformation in the past half-century. Because of the increased level of education, global scientific and technological advancements, and the expansion of human understanding, labor today is generally more cerebral and involves less physical exertion. As a result, people's social lives and activities have changed, raising the population's weight index and, consequently, the prevalence of related disorders that pose a major public health concern going forward. Urbanization, inadequate nutrition and physical inactivity contribute to the rising morbidity and mortality from non-communicable diseases.

India, traditionally recognized for its high rates of undernutrition, is now witnessing a significant rise in overweight and obesity, which coexist within the population. If left unmanaged, obesity can contribute substantially to the burden of non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes, liver disorders, and various forms of cancer.

As highlighted by Sidenur et al. (2022), obesity has escalated to epidemic levels globally, with at least 2.8 million deaths annually attributed to complications related to overweight and obesity. In 2016 alone, more than 1.9 billion adults aged 18 and above were overweight, and among them, over 650 million were classified as obese. In the Indian urban population, 31.3% of women and 26% of men are either overweight or obese.

Wulan et al. reported that individuals from the Indian subcontinent exhibit the highest prevalence of obesity and obesity-related diseases among Asians. Notably, India sees an annual increase of approximately 1.8 million adults diagnosed with type 2 diabetes, a number that continues to grow in both native and migrant South Asian populations. Additionally, metabolic syndrome affects nearly one-third of the urban population in major Indian cities.

A cross-sectional study by Bowen et al. (2015), conducted in Hyderabad, investigated the relationship between dietary habits, physical activity, and body fat distribution in an Indian cohort. The study concluded that higher energy intake was positively correlated with increased body fat, while greater physical activity was associated with reduced total body fat. These findings emphasize the critical role of a balanced diet and regular physical activity in promoting a healthy body composition.

According to a study conducted by Anjana et al. (2014) to evaluate physical activity patterns of adults in India, it was found that 31.9% of individuals were active and 13.7% were highly active, 54.4% of persons were inactive. Compared to rural areas, subjects were less active in urban settings. Subjects spent more active time in the workplace than commuting or recreational activities. Given that less than 10% of Indians participate in recreational physical exercise, the study concludes that a sizable portion of the population is sedentary.

Kerala, a state in India renowned for its high literacy rates and commendable health indicators, is now facing rising challenges related to lifestyle diseases. Over the past two decades, the state has seen a significant surge in the incidence of non-communicable diseases (NCDs), with data indicating that 52% of total deaths occurred in the economically productive age group of 30 to 70 years due to various NCDs. A study by Aslesh et al. (2015) conducted in rural Kerala examined physical activity levels among individuals aged 16 to 65 years and found that a large portion of the population did not meet recommended physical activity levels. This underscores the urgent need for interventions aimed at encouraging more active lifestyles in the region. Additionally, several epidemiological studies have assessed physical activity patterns among South Asians, a group known to have a higher predisposition to obesity. Workers' daily physical activity tends to decline as a result of a more sedentary lifestyle brought on by increased computerization, mechanization, and convenient transportation (Huang et al., 2017). The accumulation of excess adipose tissue, especially in the visceral area, makes this scenario favorable for the early onset of several metabolic illnesses (Kopiczko and Bogucka, 2018). In South Asian populations, lower levels of physical activity have been linked to increased adiposity, while higher physical activity levels correlate with reduced waist circumference. Wulan et al. (2021) observed that South Asians with greater visceral fat engaged less in both moderate and moderate-to-vigorous physical activity. Given the elevated cardio-metabolic risk among South Asians, a critical question arises: is the current global recommendation of 150 minutes of moderate physical activity (MPA) per week sufficient for this group? Research suggests that South Asians may require approximately 266 minutes of MPA weekly to achieve a favorable cardio-metabolic risk profile.

Simultaneously, many developing nations, including those in South Asia, are undergoing significant dietary transitions. These shifts are likely to intensify the prevalence of metabolic syndrome in populations already genetically predisposed to obesity. Obesity in South Asians is marked by unfavorable body composition and reduced resting energy expenditure. This decreased metabolic rate hampers their ability to manage increased caloric (particularly fat) intake, thereby promoting positive energy balance. Furthermore, limited physical activity expenditure aggravates this imbalance, contributing to rising rates of obesity and metabolic syndrome within the region.

According to Mazurek-Kusiak et al. (2021), a global nutrition study involving 195 countries and over 130 researchers revealed that one in five deaths worldwide is linked to poor dietary habits. Nutrition and physical activity are closely interconnected, both playing vital roles in health promotion and disease prevention. A well-planned exercise routine, combined with balanced, nutrient-rich meals, can significantly reduce the risk of chronic illnesses.

Nutrition is among the most influential environmental determinants of human growth, development, and long-term health. As noted by Mazurek-Kusiak et al. and Farrow et al. (2019), eating behaviors are typically established during childhood and solidified during adolescence. Many young adults, especially those transitioning out of their family homes, often lack proper dietary habits. Factors such as a fast-paced lifestyle, academic and work commitments, financial limitations, stress, and emotional challenges contribute to a reliance on fast food. According to Trafialek J. (2020), meals eaten outside the home tend to be lower in fiber and higher in calories, saturated fats, and cholesterol, all of which negatively impact body composition. Skipping breakfast, low fruit and vegetable intake, limited dietary diversity, irregular meal timings, and frequent snacking further exacerbate nutritional imbalances, as observed by Meldrum et al. (2017).

Wulan et al. (2021) also highlight the global rise of overweight and obesity, not only in affluent nations but also in rapidly industrializing regions like Asia. It is projected that by 2030, the global prevalence of overweight and obesity will reach 1.3 billion and 573 million individuals, respectively—with Asia accounting for 43% and 21% of these cases.

Srivastav et al. (2021) emphasize that improvements in socioeconomic status and industrial development have led to widespread availability of processed food and increased sedentary behaviors. These factors have significantly contributed to rising obesity rates and the burden of lifestyle-related health issues across diverse populations.

According to the World Health Organization (WHO), regular physical activity enhances both physical and mental health across all age groups and abilities. In contrast, insufficient physical activity elevates the risk of noncommunicable diseases (NCDs), including heart disease, stroke, cancer, and diabetes—all of which are leading causes of early mortality.

It is estimated that the global prevalence of diabetes in adults aged 20–79 will rise from 6.4% in 2010 to 7.7% in 2030, affecting over 400 million people. Developing countries are expected to see a 69% increase, compared to 20% in developed nations. By 2030, about 80% of individuals with diabetes will reside in developing countries, with India and China representing the highest proportions. Unlike in Western countries, diabetes in Asia has increased three- to five-fold within three decades, often affecting younger individuals (ages 20–64) with lower BMI.

South Asians are particularly vulnerable to diabetes, experiencing earlier onset and more severe cardiovascular outcomes compared to other ethnicities. This increased risk has been linked to adverse lipid profiles, including high fasting plasma triglycerides, elevated LDL, low HDL cholesterol, and an unfavorable HDL to total cholesterol ratio.

RELEVANCE OF THE STUDY

In today's fast paced world, due to the rapid transition in lifestyle environment, young adults are increasingly adopting sedentary lifestyles, improper nutrition, and irregular physical activity patterns. The risk of obesity and chronic diseases is ultimately increased by these lifestyle changes, which also greatly contribute to undesirable body composition outcomes, such as increased fat mass and decreased muscle mass. Understanding the relation between physical activity levels and key factors affecting health such as body composition, dietary habits, and overall lifestyle behaviors is crucial for early interventions and health promotions. This study is particularly relevant as it focuses on young adults—a population that forms the core of future social productivity—offering insights that can guide preventive strategies and public health policies. By identifying clear associations between these factors, the study aims to provide a base for tailored recommendations that can improve long-term health outcomes and promote a healthier future generations.

AIM AND OBJECTIVES OF THE STUDY

- To assess the physical activity levels among adult males aged 19–59 years and classify the subjects into sedentary, moderate and heavy workers based on their PAL.
- To assess and compare body composition parameters (such as BMI, fat percentage, visceral fat, and muscle mass) of sedentary, moderate and heavy workers using Omron HBF 222T Body Composition Analyzer.
- To assess the relation between dietary patterns followed by subjects with different physical activity levels.
- To examine the lifestyle habits (including sleep, consumption of alcohol, smoking habit and stress levels) of young adults based on their physical activity status.

CHAPTER 2
REVIEW OF LITERATURE

The literature pertaining to the present study entitled "Association of physical activity levels with body composition, dietary and lifestyle pattern among young adults" is reviewed under the following headings:

2.1 The impact of Physical Activity on Body Composition
2.2 Effect of Physical Activity on Health and Morbidity pattern
2.3 Interrelation of Physical Activity and Dietary Pattern
2.4 Relationship between Physical Activity and Lifestyle pattern

2.1 The impact of Physical Activity on Body Composition

The term 'physical activity' is often used interchangeably with 'exercise'. Although both share common elements, they have distinct differences. According to WHO, physical activity is any physical motion driven by skeletal muscles that demands the use of energy. It may include any movement including activities during leisure time, for transportation to get to and from locations, or as part of a person's work or household activities. Conversely, physical fitness is the ability to engage in physical exercise and it encompasses a wide range of physiological and psychological traits. Normally, there are three categories for physical activity levels: sedentary, moderate and heavy or vigorous activity.

The health benefits of physical activity are widely recognized. A lifestyle of regular moderate physical activity has been shown to have positive effects on a variety of physiological processes, including insulin sensitivity, cardiovascular function, visceral adiposity, hypertension, dyslipidemia, and others. As a result, the chance of developing non-communicable diseases is greatly reduced. It is also well recognized that regular physical activity improves mental health. Early sedentary lifestyle is thought to be an independent risk factor for a number of chronic diseases in adulthood.

According to Knight A (2012), a sedentary lifestyle is not natural to humans. In fact, the "sedentary death syndrome" is a significant risk factor for millions of preventable deaths annually as well as a number of diseases throughout the world. According to studies, long-lived animals are better at maintaining their cells than short-lived ones, which implies that improving the body's maintenance mechanisms could delay the aging process.

Interventions in unhealthy lifestyle habits may prevent damage, encourage healing, and extend life expectancy since aging is caused by the accumulation of cellular damage.

Body composition assessment plays a crucial role in both monitoring performance and training in athletes and evaluating the overall health status of the general population. Although Body Mass Index (BMI)—calculated as weight divided by height squared (BMI = weight/height^2)—is commonly used to determine weight status, it does not differentiate between the various components of body mass. As such, using BMI as an indicator of body fat and associated health risks can be misleading, particularly among physically active individuals who tend to have greater body density and higher fat-free mass (FFM) than the general population (Lorenzo et al., 2013).

On the other hand, body fat percentage (%F) has a more direct link to increased health risks, particularly for metabolic and cardiovascular conditions. Sacheck et al. (2010) noted that lower physical activity levels are associated with an elevated risk of obesity and cardiovascular disease. Regardless of dietary influences, physical activity alone has been shown to help reduce and manage body fat (May et al., 2010). Broadly speaking, engaging in regular physical activity significantly lowers various health risk factors, especially those related to cardiovascular disease and metabolic syndrome.

Abdominal obesity, as highlighted by Whitaker et al. (2017), is a well-established risk factor for both metabolic and cardiovascular diseases. Fat accumulation within the intra-abdominal area—such as visceral adipose tissue (VAT), intermuscular adipose tissue (IMAT), and liver fat—is strongly associated with heightened risks of insulin resistance, dyslipidemia, glucose intolerance, hypertension, and cardiovascular complications. In contrast, subcutaneous adipose tissue (SAT) may play a relatively smaller role in the development of chronic diseases. General adiposity can result from several factors, with physical activity level being a major determinant. As emphasized by Kay et al. (2006), the benefits of physical activity are far-reaching, contributing to reduced fat accumulation and lowering the risk of numerous chronic diseases—often independent of BMI.

Biswas et al. (2015) highlighted growing evidence connecting sedentary behaviors (such as prolonged sitting or lying down) with poor health outcomes, including cardiovascular disease, diabetes, cancer, and all-cause mortality. Some studies also suggest that even meeting physical activity guidelines may not counteract the adverse effects of high sedentary time.

One potential mechanism linking sedentary behavior with chronic disease progression is its influence on body composition, particularly concerning intra-abdominal fat accumulation.

In the South Asian population, several epidemiological studies have explored physical activity patterns and their link to obesity. Wulan et al. (2017) reported that lower levels of physical activity in South Asians correlated with greater adiposity and larger waist circumferences, while those with higher visceral fat were typically less engaged in moderate or vigorous physical activity. Given the heightened cardio-metabolic risk in this population, current recommendations of 150 minutes per week of moderate physical activity (MPA) may not be adequate. In fact, evidence suggests that South Asians may require up to 266 minutes of MPA weekly to achieve favorable cardio-metabolic health outcomes.

2.2 Effect of Physical Activity on Health and Morbidity pattern

Health is a core element of human well-being and societal stability. Maintaining regular physical activity plays a vital role in preserving health and preventing non-communicable diseases (NCDs). While physical fitness is a key indicator of health, its assessment is influenced by various factors (Bello et al., 2016). Health-related fitness (HRF), also referred to as health-related physical fitness (HRPF), is the ability to perform daily tasks with sufficient energy and resilience, and is associated with a reduced risk of chronic diseases and premature mortality (Cvejic et al., 2013). This type of fitness is strongly linked to an individual's physical activity levels (Ruiz et al., 2009) and dietary habits (Kaasalainen et al., 2013).

The World Health Organization (WHO, 2012) introduced the "Global Recommendations on Physical Activity for Health" to guide policymakers on the optimal frequency, duration, intensity, and type of activity required to reduce the risk of NCDs. These guidelines cater to various age groups—5–17, 18–64, and 65 years and older—and include physical activity in forms such as leisure, transport, occupation, household tasks, and recreational pursuits. For adults aged 18–64, at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic activity per week is recommended, ideally in bouts of 10 minutes or more. For additional health benefits, this can be increased to 300 minutes of moderate or 150 minutes of vigorous activity weekly, along with muscle-strengthening activities at least twice a week (WHO, 2010).

The global rise in overweight and obesity, especially among young adults, has become a pressing concern (Mazurek et al., 2019). Sedentary lifestyles, calorie-dense diets, and decreased physical activity contribute significantly to this trend, particularly in industrialized nations. According to WHO, weight gain is driven by a positive energy balance, whereas weight loss results from a negative energy balance.

Obesity and physical inactivity are among the most modifiable risk factors for cardiovascular diseases. Excess body weight elevates the risk of heart disease, hypertension, and type 2 diabetes. Some individuals also develop metabolic syndrome—also known as Reaven Syndrome—which heightens cardiovascular risk. The decline in routine physical activity has independently increased susceptibility to cardiovascular disease.

According to the International Diabetes Federation (2013), over 382 million individuals globally had diabetes, a number projected to rise to 592 million by 2035. A large portion of this increase is expected to occur in low- and middle-income countries, particularly China and India. This surge is largely attributed to unhealthy lifestyles, including inadequate physical activity and poor dietary practices, which are risk factors not only for type 2 diabetes but for other chronic diseases as well.

Lifestyle factors such as physical activity, diet, and daily routines also influence bone health, especially in older adults (Gabr et al., 2015). Low physical activity levels are associated with an increased risk of osteoporosis and fractures, while regular activity helps maintain bone mineral density (BMD) and lowers BMI. Research confirms that physical activity enhances BMD through mechanical loading effects.

Furthermore, a lack of physical activity contributes to muscle mass loss and declining strength, which can accelerate aging-related immune dysfunctions, including inflammation and immunosenescence (Fulop et al., 2020). This condition weakens the immune system, making individuals more vulnerable to infections and reducing the effectiveness of vaccines. Long-term physical activity, however, supports immune function, reduces infection risk, and improves both physical and cognitive health outcomes. The WHO recognizes physical inactivity as a major risk factor for global mortality, emphasizing that even minimal activity is better than none, and more is preferable for optimal health (Reardon et al., 2019; Bull et al., 2020). Moderate exercise is especially effective in lowering infection risks compared to a sedentary lifestyle (Silişteanu & Covaşă, 2015).

2.3 Interrelation of Physical Activity and Dietary Pattern

Shao et al. (2021) emphasize that proper nutrition is a crucial environmental factor influencing human growth, development, and the maintenance of health. Together with physical activity, it forms the foundation of a healthy lifestyle, promoting energy balance, enhancing bodily functions, and strengthening the immune system. Adequate nutrition can significantly extend life expectancy, whereas poor dietary habits may reduce it. Mokdad et al. further note that poor diet and physical inactivity are among the leading "actual causes of death." A concerning trend seen today is that of "overfeeding and undernutrition," which contributes to nutrient deficiencies, chronic diseases, increased body weight, and higher mortality rates.

Obesity remains a critical public health issue in both developed and developing nations, closely associated with lifestyle factors such as diet and physical activity (Schneider et al., 2017). Unhealthy eating patterns—including meal skipping and low intake of fruits, vegetables, and dairy products—necessitate urgent lifestyle modifications to prevent disease onset (Yahia et al., 2016). As Mazurek et al. (2019) point out, eating habits are established during childhood and solidified during adolescence. Young adults, often living independently for the first time, tend to lack healthy eating routines. A hectic lifestyle, academic and professional responsibilities, limited time, financial constraints, and psychological stress contribute to a reliance on fast food. Eating out frequently is linked to meals that are low in fiber and high in calories, saturated fats, and cholesterol, which can negatively affect body composition. Common dietary issues include breakfast skipping, low vegetable and fruit consumption, and irregular or insufficient meals, often accompanied by unhealthy snacking (Meldrum et al., 2017).

In the South Asian context, Wulan et al. (2017) observed that traditional diets are often rich in carbohydrates (60–67%) and unhealthy fats—particularly saturated and trans fats derived from ghee, coconut oil, and palm oil—while being low in dietary fiber and omega-3 fatty acids. This results in a low omega-3/omega-6 fatty acid ratio, which has been associated with metabolic issues such as fasting hyperinsulinemia and subclinical inflammation. A multi-country study highlighted that South Asians have a particularly high prevalence of low HDL cholesterol—63% in non-diabetics and 67% in diabetics—reflecting a metabolic vulnerability. High carbohydrate intake has been linked to low HDL levels, while saturated and trans fats are associated with elevated LDL cholesterol, together heightening the risk for cardiovascular diseases. These findings underscore the need for dietary reform in this demographic.

Energy balance, the relationship between food intake and energy expenditure, is a dynamic and complex process. Good nutrition is not merely about consuming food but involves the proper absorption and utilization of nutrients to maintain balance. An ideal diet provides adequate energy and essential nutrients without resulting in excessive caloric intake. Nutritional needs vary depending on factors such as sex, activity level, and basal metabolic rate (BMR). Studies show that resting metabolic rate (RMR) influences caloric needs, while physical activity affects appetite regulation and satiety. Exercise modulates the secretion of hormones like leptin, insulin, ghrelin, cholecystokinin (CCK), and glucagon-like peptide-1 (GLP-1), all of which play key roles in hunger and metabolism. Sedentary lifestyles are linked to appetite dysregulation and overeating, thereby increasing the risk of obesity.

According to Wulan et al. (2017), the rapid dietary transitions occurring in developing countries are likely to worsen the incidence of metabolic syndrome in South Asians, who are already genetically predisposed to obesity. This population tends to have an unfavorable body composition with lower resting energy expenditure, making them more susceptible to positive energy balance and fat accumulation. Reduced energy expenditure due to low physical activity levels may further contribute to the rising prevalence of obesity and metabolic syndrome in this group.

2.4 Relationship between Physical Activity and a Healthy Lifestyle

A significant portion of the global population remains physically inactive, and this widespread inactivity is now recognized as a public health concern rather than just an individual issue (Kljajevic et al., 2021).

Fayad F (2022) highlights that lifestyle choices—such as levels of physical activity, dietary habits, and stress management—can shape the health outcomes of individuals, families, and entire societies. A healthy lifestyle promotes well-being and longevity, while an unhealthy one can lead to illness and increased morbidity (Saffari et al., 2013; El Baz, 2004). In fact, lifestyle-related factors contribute to nearly two-thirds of the major causes of death globally.

Krause and Mahan (2020) emphasize that inadequate sleep disrupts the hormonal regulation of hunger and satiety. This imbalance activates appetite-related hormones, potentially leading to excessive caloric intake. Over time, chronic sleep deprivation can alter eating patterns—both in quality and quantity—and is believed to be a contributing factor in the rising rates of obesity. Additionally, insufficient sleep, disrupted circadian rhythms, genetic predispositions, and stress are closely linked to the development of metabolic syndrome.

Stress plays a critical role in influencing appetite. The hormone cortisol, released during stressful situations, stimulates insulin release to maintain glucose levels for the "fight-or-flight" response, which in turn increases appetite. Prolonged stress and consistently elevated cortisol levels may result in persistent changes in eating behavior. Typically, cortisol levels peak in the morning and are lowest at night. However, individuals with night-eating syndrome (NES) often experience delayed meal timing, possibly due to neuroendocrine imbalances and altered cortisol secretion patterns (Stunkard & Lu, 2010).

In developing nations, unhealthy lifestyle patterns are largely driven by urbanization, globalization, and dietary transitions. These rapid changes in living environments and behaviors expose populations to a higher risk of noncommunicable diseases and premature death. Economic progress has led to reduced physical activity, shortened sleep duration, and elevated stress levels.

In contrast, maintaining an active lifestyle is shown to enhance health and delay its decline, especially among young adults. This underlines the need to adopt healthier habits—including regular exercise—as a preventive strategy. Therefore, it is essential for the younger generation to integrate physical activity into their daily routines to support both physical and mental well-being (Taruna et al., 2021).

CHAPTER 3
METHODOLOGY

The methodology adopted for the study on "Association between different physical activity levels with body composition, dietary pattern and lifestyle habits among young adults" is given under the following headings:

3.1 Selection of the Area
3.2 Selection of the Subjects
3.3 Selection of Tool
3.4 Conduct of the Study
3.5 Statistical Analysis
3.6 Research design

3.1 Selection of the Area

The area selected for the study was Ernakulam District.

3.2 Selection of the Subjects

For the present study 119 subjects in the age group of 19 to 59 years were selected for the study. Inclusion criteria were male subjects, ranging from age 19-59 years, and the participant's consent to participate in the study. Females and subjects of age less than 18 years and above 59 years were excluded from the study.

All subjects were classified into sedentary, moderate and heavy based on their PAL calculated using a 24 hour physical activity pattern. Subsample of the population were selected for the comparative study, comprising 90 subjects (30 from each category) of age ranging from 19 to 39, as majority of subjects engaging in sedentary and heavy activity were observed in this age group.

3.3 Selection of Tool

For all participants, a structured questionnaire was administered to obtain data on socio-demographic parameters and behavioural aspects including physical activity, dietary pattern and lifestyle habits. The study instrument was divided into six sections:

(a) <u>General profile-</u> in which data regarding education, occupation, family income, religion and marital status were collected from participants. SES was determined by using the revised

Kuppuswamy's scale of socio-economic status (2024) classification based on occupation, education and family income per month (in Rupees) as parameters. Individuals were classified as belonging to upper SES if the total score was 26–29, upper middle SES if the total score was 16–25, lower middle SES if the total score was 11–15, upper lower SES if the total score was 5-10 and lower SES if the total score was <5.

(b) Physical Activity Level- The average PAL of healthy, well-nourished people is a primary driver of their total energy requirement. PAL can be measured or calculated from the average 24-hour TEE and BMR (i.e., PAL = TEE/BMR), as growth does not contribute to energy needs in adulthood.

Classification of physical activity levels: Energy needs correlate strongly with regular physical activity. The 1981 FAO/WHO/UNU consultation categorized physical activity into three levels (WHO, 1985), but later revisions assigned a range of PAL values instead of a mean. The various degrees of activity linked to a population's lifestyle are represented by the categories in table 2.1. Over time, these categories show the type of physical activity that the majority of people in the population engage in most frequently. The duration of the period can be stated as one month or more, but there is no physiological foundation for doing so.

Since some groups of people with light or sedentary occupations regularly engage in vigorous discretionary activities, the term "lifestyle" was preferred over "occupational work," as used in the 1985 report. As a result, their lifestyles are more appropriately classified as "active" or "vigorously active." Additionally, it should be remembered that certain people experience cyclical shifts in their lifestyles, such as those associated with the agricultural cycle in traditional rural civilizations or the seasons, when cold winters alternate with hot or warm summers. These populations' energy needs will vary according to the energy demands of their cyclical lifestyles.

Table 3.1: Classification of Physical activity level

Category	PAL Value
Sedentary or light active lifestyle	1.40 - 1.69
Active or moderately active lifestyle	1.70 - 1.99
Heavy or vigorously active lifestyle	2.00 - 2.40

Source: Human energy requirements. FAO.org

a. *Sedentary or light activity lifestyles*: Refers to individuals whose occupation require minimal physical activity, typically relies on cars for transportation, do not engage in regular exercise or sports, and spend most of their free time sitting or engaging in passive activities such as talking, reading, watching television, listening to the radio, using computers etc. Male metropolitan office workers who rarely partake in physically demanding activities during or after work hours are one example. Rural women who live in communities with piped water, electricity, and paved roads nearby are another example. They spend most of their time selling vegetables at home or in the marketplace, performing light housework, and taking care of their children in and around their homes.A sedentary person in one who expends less than 10% of their daily energy expenditure on physical activities.

b. *Active or moderately active lifestyles*: Although the energy demands of these people's jobs are not very high, they do require more energy than those associated with sedentary lifestyles. Alternatively, sedentary workers may engage in moderate-to-intense physical activity as part of their daily routine, either voluntarily or involuntary. For instance, a person's average PAL can increase from 1.55 (which corresponds to the sedentary category) to 1.75 (which corresponds to the moderately active category) by engaging in one hour (either continuously or in multiple bouts throughout the day) of moderate to vigorous exercise, such as jogging/running, cycling, aerobic dancing, or other sports. Examples of moderately active occupations include masons, construction workers, and rural women in less developed traditional communities who engage in agricultural tasks or travel great distances to obtain fuelwood and water.

c. *Vigorous or vigorously active lifestyles*: These individuals frequently devote several hours to demanding jobs or demanding recreational activities. Examples are non-sedentary women who spend two hours a day swimming or dancing, or non-mechanized agricultural workers who spend several hours a day using a machete, hoe, or axe and walking great distances over difficult terrain while frequently carrying large loads.

A 24 hour physical activity pattern record was used to observe the time spent on different activities on an average day. The daily activities were classified into light, moderate and heavy activities according to Human Energy Requirements by FAO/WHO/UNU (1981). The questionnaire has questions to assess frequency of different activities at work, home and leisure activities. The major advantage of this is that it can assess physical activity in each domain separately in addition to the total physical activity.

The lifestyle of the subjects was determined on the basis of PAL values. The subjects of different age groups were classified into three following lifestyle categories: 1) Sedentary or light activity lifestyle 1.40 - 1.69; 2) Active or moderately active lifestyle 1.70 - 1.99; 3) Vigorous or vigorously active lifestyle 2.00 - 2.40.

Basal and resting energy expenditure- basal metabolic rate (BMR), is the minimum amount of energy expended that is compatible with life. An individual's BMR reflects the amount of energy used for 24 hours while physically and mentally at rest in a thermoneutral environment that prevents the activation of heat- generating processes, such as shivering. Resting metabolic rate (RMR), is the energy expended in the activities necessary to sustain normal body functions and homeostasis. These activities include respiration and circulation, the synthesis of organic compounds, and the pumping of ions across membranes. RMR includes the energy required by the central nervous system and for the maintenance of body temperature (Krause and Mahan, 2020).

Total energy expenditure (TEE) is the total amount of energy expended by an individual in a day. TEE was calculated by using the following formula:

$$\text{Total energy expenditure (TEE)} = \text{Mean PAL} \times \text{BMR}$$

(c) Anthropometric Assessment- Anthropometric measures such as height and weight of the participants were analysed. Stature height (cm) was measured using a measuring tape. Body weight (kg) was measured using a calibrated electronic OMRON HBF-222T the Body Composition Analyzer.

(d) Body Composition- Body composition is a critical component of nutrition assessment and medical status. It is used concurrently with other assessment factors to differentiate the estimated proportions of fat mass, soft tissue body mass, and bone mass (Krause and Mahan, 2020). BMI, body fat %, visceral fat level, skeletal muscle % and RMR was measured using Omron HBF-222T Body Composition Analyzer.

Body mass index- The Quetelet index or the body mass index (BMI) [weight (kg) / height squared (m2)] is used to determine whether an adult's weight is appropriate for height and can indicate overnutrition or undernutrition (Krause and Mahan, 2020). BMI accounts for differences in body composition by defining the level of adiposity and relating it to height, thus eliminating dependence on frame size (Stensland and Margolis, 1990). Subjects were classified into different categories according to WHO classification of BMI, (i.e., < 18.5 – underweight, 18.5 to 24.9 – normal weight, 25 to 29.9 – overweight and > 30 – obese).

Body fat percentage- The fat from all body sources including the brain, skeleton, intramuscular fat, and adipose tissue. Total body fat is the combination of "essential" and "storage" fats, usually expressed as a percentage of total body weight that is associated with optimum health. Muscle and even skeletal mass adjust to some extent to support the burden of excess adipose tissue (Krause and Mahan, 2020). Subjects are classified into low (<8.0%), normal (8-19.9%), high (20.0-24.9%) and very high (≧25.0%) based on the classification of OMRON Body Composition Analyzer.

Visceral fat- is the fat stored around the internal organs such as stomach, liver, intestine etc. in the abdominal cavity. Increased deposition of visceral fat is linked to increased risk for metabolic disorders such as cardiovascular diseases, type 2 diabetes, hypertension etc. Subjects are classified into normal (1-9), high (10-14) and very high (15-30) based on the classification of OMRON Body Composition Analyzer.

Skeletal muscle mass- is the amount of muscle present within the body and is relatively constant from person to person. Higher the muscle mass better the fitness and metabolism. Subjects are classified into low (<33.3%), normal (33.3-39.3%), high (39.4-44.0%) and very high (≧44.1%) based on the classification of OMRON Body Composition Analyzer.

(e) <u>Health profile</u>- to assess the morbidity pattern of the subjects, intake of medicines and/or supplements.

(f) <u>Dietary Pattern</u>- Energy requirements are defined as the dietary energy intake that is required for growth or maintenance in a person of a defined age, gender, weight, height, and level of physical activity. Body weight is one indicator of energy adequacy or inadequacy. The body has the unique ability to shift the fuel mixture of carbohydrates, proteins, and fats to accommodate energy needs (Krause and Mahan, 2020). However, consuming too much or too little energy over time results in body weight changes. Thus body weight reflects adequacy of energy intake, but it is not a reliable indicator of macronutrient or micronutrient adequacy. In addition, because body weight is affected by body composition, a person with a higher lean mass to body fat mass or body fat mass to lean mass may require different energy intakes compared with the norm or "average" person. Obese individuals have higher energy needs because of an increase in body fat mass and lean body mass (Kee et al, 2012).

A “24 Hour Recall” method is used to collect the information regarding food intake. It provided both quantitative and qualitative insights into the participants’ daily food consumption, contributing significantly to the understanding of the impact of dietary choices on BC and physical activity levels. The questionnaire also included questions on food frequency, meal skipping, snacking pattern, stress eating and worksite eating habits.

Energy balance was calculated from the recorded food intake and activities carried out for an average day. It is the value obtained by reducing energy intake from total energy expenditure. A negative energy balance depicts improper food intake, whereas a positive energy balance depicts increased food intake then required.

(g) Lifestyle habits- There is a relationship between lifestyle habits such as inadequate sleep, disrupted circadian rhythm, genes, and the development of metabolic syndrome. Stress is another factor that leads to increased appetite (Krause and Mahan, 2020).

Lifestyle habits such as duration of sleep, stress, alcohol consumption, smoking habits and its frequency were also analysed using the questionnaire.

3.4 Conduct of the Study

Information was collected through a structured interview method. Data collection took place in two stages; initial anthropometric measurements and body composition were measured using OMRON HBF-22T Body Composition Analyzer. General data and data regarding physical activity, dietary pattern and lifestyle habits were collected using the pre-structured questionnaire.

3.5 Statistical Analysis

Data was analysed using the Software Statistical Package for Social Sciences (SPSS) version 20.0. Descriptive statistics for mean, standard deviation and range were employed to summarise the data. A two - way analysis of variance (ANOVA) was performed to examine the effect of physical activity, dietary pattern and lifestyle habits on each category and their interaction on anthropometric and body composition measurement.

3.6 Research Design

A cross sectional design was adopted to accomplish the research objectives. The samples were selected using purposive sampling method.

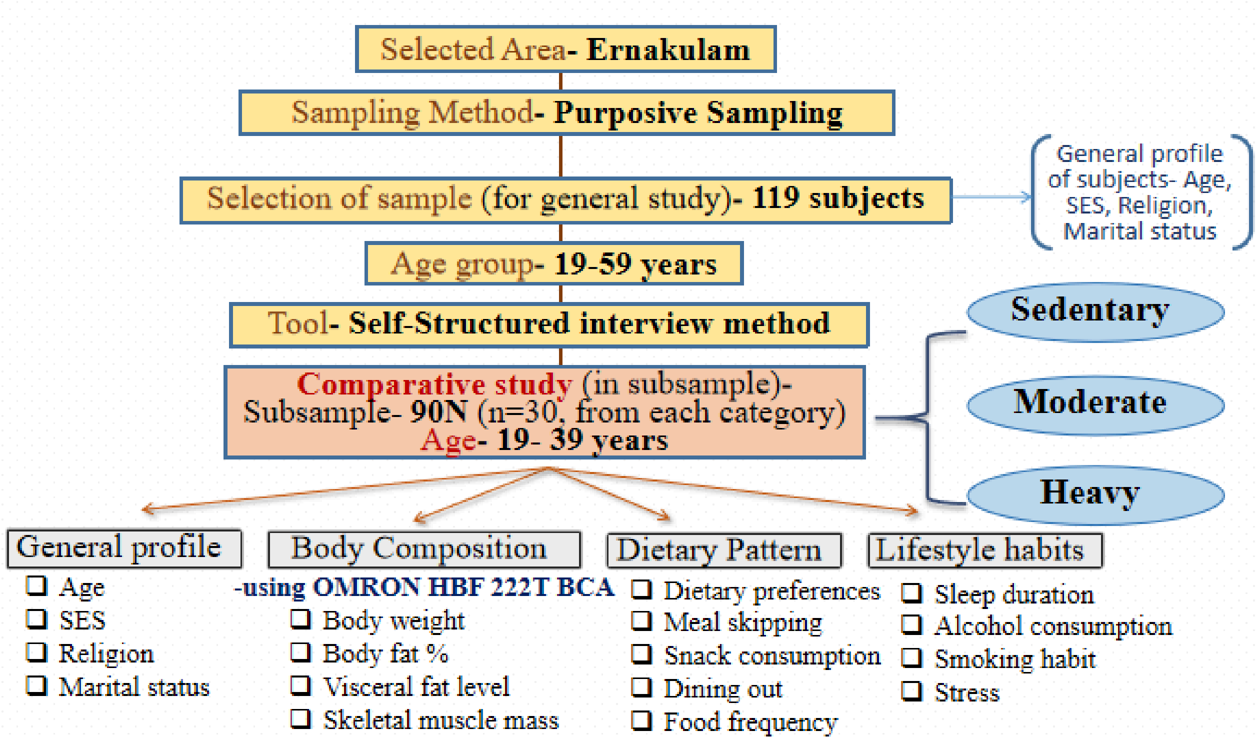

Fig. 3.1 Research design

CHAPTER 4

RESULTS AND DISCUSSION

The results and discussion pertaining the study titled "Association of physical activity levels with body composition, dietary and lifestyle pattern among young adults" are discussed under the following headings:

A. General profile of the subjects
B. Distribution of subjects based on BMI
C. Body composition of subjects based on physical activity level
D. Morbidity pattern of subjects based on physical activity level
E. Dietary habits of subjects based on physical activity level
F. Lifestyle habits of subjects based on physical activity level
G. Statistical analysis

A. General profile of the subjects

Distribution of subjects according to age, socio-economic status, religion and marital status is given in the table below:

Table 1: General profile and Socio-economic status of the subjects (N=119)

Variable	Category	Sedentary	Moderate	Heavy	Total (%)
Age (years)	19-39	30	30	30	**90** (76)
	40-59	7	9	13	29 (24)
SEC*	Upper class	0	1	0	1 (1)
	Upper middle class	**23**	**20**	9	**52** (44)
	Lower middle class	9	4	8	21 (17)
	Upper lower class	5	14	**26**	45 (38)
	Lower class	0	0	0	0
Religion	Hindu	18	24	26	**68** (57)
	Christian	12	8	6	26 (22)
	Muslim	7	7	11	25 (21)
Marital status	Married	18	26	12	56 (47)
	Unmarried	19	13	31	**63** (53)

*Classification by revised Kuppuswamy scale of socio-economic status (2024)

Table 1 shows the distribution of subjects by general profile and socio-economic status.
A total of 119 subjects participated in the study. According to their PAL values, the subjects were classified as sedentary, moderate or heavy activity. From the table it can be seen that the majority (76%) of the subjects belong to the age group 19-39 years.
Majority (44%) of the subjects belonged to upper middle class, followed by upper lower class (38%), lower middle class (17%) and upper class (1%). None of the participants belonged to the lower class.
Majority of the subjects were hindus (57%), followed by christians (26%) and muslims (25%). Among the participants, 63% of the subjects were unmarried whereas, 56% of the subjects were married.

B. Distribution of subjects based on BMI

The study comprised 119 male subjects of age ranging from 19 to 59 years. The comparative study has been carried out on a subsample of the population comprising 90 subjects (30 from each category) of age ranging from 19 to 39 years, and the data regarding the association between different physical activity levels with body composition, dietary pattern and lifestyle habits of the subjects were collected and is discussed below

Classification of subjects according to BMI

From the weight and height data of the subjects, BMI was calculated and the distribution of subjects is given below:

Table 2: Distribution of Subjects based on BMI (N=90)

<table>
<tr><th colspan="2">BMI Category*</th><th>Sedentary (%)
n=30</th><th>Moderate (%)
n=30</th><th>Heavy (%)
n=30</th><th>Total (%)
N=90</th></tr>
<tr><td colspan="2">Underweight (<18.5)</td><td>1 (3)</td><td>3 (10)</td><td>1 (3)</td><td>5 (6)</td></tr>
<tr><td colspan="2">Normal weight (18.5-24.9)</td><td>17 (57)</td><td>21 (70)</td><td>12 (40)</td><td>50 (55)</td></tr>
<tr><td colspan="2">Overweight (25-29.9)</td><td>10 (33)</td><td>4 (13)</td><td>16 (54)</td><td>30 (33)</td></tr>
<tr><td rowspan="3">Obese
(≥30)</td><td>Class 1 Obese
(30-34.9)</td><td>2 (7)</td><td>2 (7)</td><td>1(3)</td><td>5 (6)</td></tr>
<tr><td>Class 2 Obese
(35-39.9)</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Class 3 Obese
(≥40)</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="2">Total</td><td>30</td><td>30</td><td>30</td><td>90</td></tr>
</table>

*Classification by WHO (2022)

According to BMI classification by WHO (2022), the study indicated that the majority (55%) of study participants had a normal BMI, whereas 33% were overweight and 6% had Class 1 Obesity. No participants were observed to be in Class 2 and class 3 Obesity.
When comparing the subjects across physical activity levels, it was observed that, the majority of the sedentary (57%) and moderately (33%) active subjects had a normal BMI ranging within 18.5 to 24.9. The heavy activity participants have the most marked distribution with 54% of subjects falling within the overweight category.

The findings of the present study suggest that there is no significant association between BMI and physical activity patterns. However, this contrasts with the results of a study conducted by Anjana et al. (2014), which reported that individuals who were physically active exhibited lower BMI values compared to their inactive counterparts, who demonstrated relatively higher BMI levels.

Body composition of subjects based on physical activity

Classification of data on body composition parameters of subjects based on different physical activity levels is given below:

a. **Body fat percentage vs Physical activity**

Distribution of subjects across different physical activity levels based on body fat percentage data is given in the table below:

Table 3: Body fat percentage of subjects based on physical activity

Body Fat %	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Low (8.0%)	0	0	0	0
Normal (8-19.9%)	8 (26)	12 **(40)**	7 (23)	27 (30)
High (20.0-24.9%)	11 (37)	10 (33)	13 **(44)**	34 **(37)**
Very high (≥25.0%)	11 **(37)**	8 (27)	10 (33)	29 (32)
Total	30	30	30	90

From table 3, it was observed that the majority (37%) of the participants had a high body fat percentage. Significant differences are seen between sedentary, moderately and heavy active subjects.

The percentage of body fat was observed to be high for sedentary and heavy active groups whereas, the majority of moderate active was having a normal range of body fat percentage. The fact that just 26% of sedentary subjects kept their body fat percentage within normal limits shows the link between increased fat buildup and physical inactivity. Of the moderately active people, 40% were in the normal range, which made them the most balanced group in terms of body fat percentage. Higher body fat percentages were most prevalent in the group that engaged in heavy activities. Despite their high levels of physical activity, 44% of these people had high body fat, and 33% had very high body fat. This suggests that they may still have trouble losing fat. This might be brought on by their physical activity level, metabolic variables, or food habits.

The findings of the present study indicate that body fat percentage does not exhibit a significant association with physical activity levels. However, this contrasts with the results reported by Patel et al. (2020), who observed that individuals engaged in higher levels of occupational physical activity had significantly lower body fat percentages compared to office workers with predominantly sedentary lifestyles.

b. Visceral fat level vs Physical activity

Distribution of subjects across different physical activity levels based on visceral fat level data is given in the table below:

Table 4: Visceral fat levels of subjects based on physical activity

Visceral Fat Level	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Normal (1-9)	20 (67)	23 **(77)**	17 (57)	60 **(67)**
High (10-14)	7 (23)	5 (17)	13 **(43)**	25 (28)
Very high (15-30)	3 **(10)**	2 (6)	0 (0)	5 (5)
Total	30	30	30	90

Table 4 shows the data on visceral fat levels in various physical activity groups. It was observed that the majority of the subjects of each category had a normal visceral fat level.

Among sedentary individuals, 67% had normal visceral fat levels, while the remaining 33% exhibited high or extremely high levels, possibly due to reduced energy expenditure and unhealthy eating habits. In the moderate activity group, 77% maintained normal visceral fat, highlighting the positive impact of regular physical activity on fat distribution. Surprisingly, only 57% of the heavily active group had normal visceral fat, and 43% had elevated levels, despite their higher activity. This suggests that visceral fat accumulation may also be influenced by other factors such as dietary patterns, stress, and metabolic differences, even in highly active individuals.

c. Skeletal muscle percentage vs Physical activity

Distribution of subjects across different physical activity levels based on skeletal muscle percentage data is given in the table below:

Table 5: Skeletal muscle percentage of the subjects based on physical activity

Skeletal Muscle %	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Low (33.3%)	11 (37)	9 (30)	17 **(57)**	37 (41)
Normal (33.3-39.3%)	16 (53)	17 **(57)**	12 (40)	45 **(50)**
High (39.4-44.0%)	3 (10)	4 **(13)**	1 (3)	(9)
Total	30	30	30	90

From table 5, it was observed that, majority (50%) of the subjects had a normal skeletal muscle percentage. Among various physical activity groups, a considerable number of sedentary subjects (37%) have less muscle mass, which could be explained by a decrease in physical activity. Low levels of skeletal muscle percentage was also observed to be more in the heavy active group (57%) compared to sedentary group, which may be a sign of additional factors affecting muscle retention, such as the kind of exercise engaged in, the amount of food consumed or the amount of time spent muscle recovery.

Compared to the sedentary and heavy active group, a slightly higher percentage (13%) had a high skeletal muscle percentage. This implies that muscle mass is maintained or marginally improved by moderate activity and that high levels of physical activity do not always correspond with higher muscle percentage.

The findings of the present study indicate that skeletal muscle percentage does not exhibit a significant association with physical activity levels. However, this contrasts with the results reported by Patel et al. (2020), who observed that individuals engaged in higher levels of occupational physical activity had significantly higher skeletal muscle percentages compared to office workers with predominantly sedentary lifestyles.

C. <u>Morbidity pattern of subjects based on physical activity level</u>

From the data obtained on the morbidity pattern of subjects across all activity levels, it was observed that the majority (80%) of subjects did not report having a history of non-communicable diseases.

Among the three categories, heavy workers reported least (33%) having lifestyle related disease. Among sedentary group the prevalence of NCD was higher for hypertension followed by dyslipidemia, grade 1 fatty liver, breathing difficulty and allergy respectively, which was considerably lower among moderate and heavy active group. This implies that individuals indulging in moderate to vigorous activity have have lower likelihood of developing NCDs.

These findings indicate that physical activity plays a significant role in influencing morbidity patterns. A study by Whitaker et al. (2017) reported a positive association between sedentary behavior and hepatic fat accumulation, highlighting the adverse metabolic consequences of physical inactivity. Similarly, research conducted by Anjana et al. (2014) demonstrated a higher prevalence of dyslipidemia among physically inactive individuals compared to their active counterparts, further emphasizing the protective role of regular physical activity in preventing metabolic disorders.

D. Dietary habits of subjects

a. Dietary preference of subjects

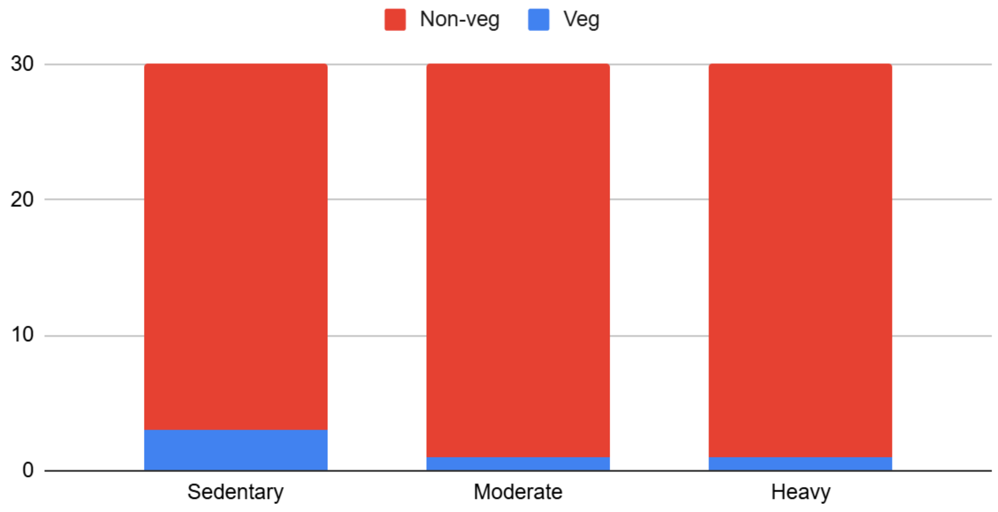

Fig.1: Veg or Non-Veg

Figure 1 depicts that the majority (94%) of the study participants were non vegetarian and only 6% were pure vegetarians. Vegetarian diets were mainly observed among sedentary subjects (10%) than among moderate and heavy active subjects. The higher consumption of non-vegetarian food sources across all levels of physical activity may be attributed to a prevalent preference for such diets, potentially driven by the perception that non-vegetarian foods offer superior protein quality and are more effective in supporting muscle development.

b. Special dietary pattern followed by subjects

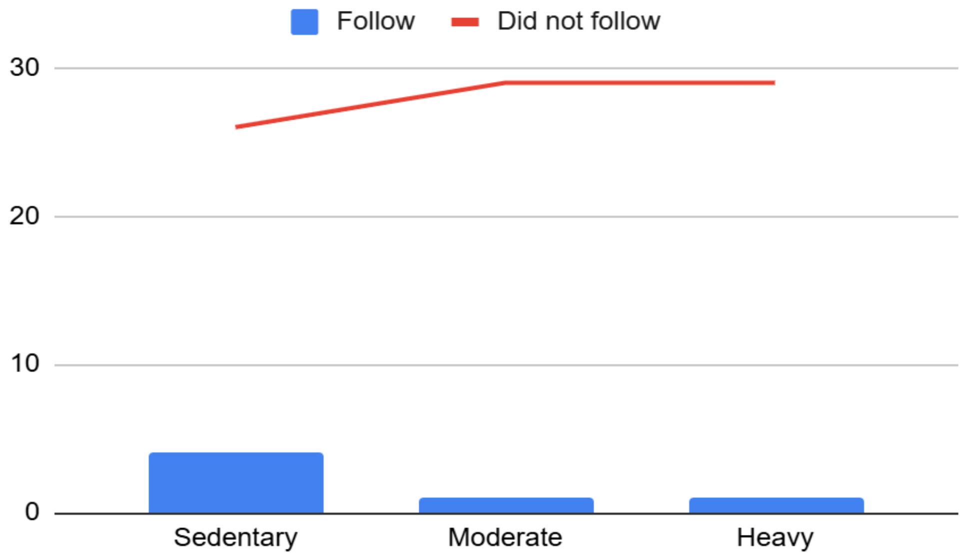

Fig. 2: Special dietary pattern followed by subjects

Figure 2 shows that 93% of subjects did not follow dietary modifications or restriction, whereas only 7% followed a specific dietary pattern across all activity levels. Dietary restriction was mainly observed among sedentary subjects (13%). Dietary modification or restriction followed by the subjects were mainly a low carbohydrate-low sugar diet, followed by a high protein diet, intake of less processed and junk foods, a low fat diet respectively. A lack of awareness, difficulty maintaining consistency, or a sense that dietary control is not necessary for preserving body composition and general health are some of the reasons why people do not follow their diets.

c. Meal frequency among the subjects

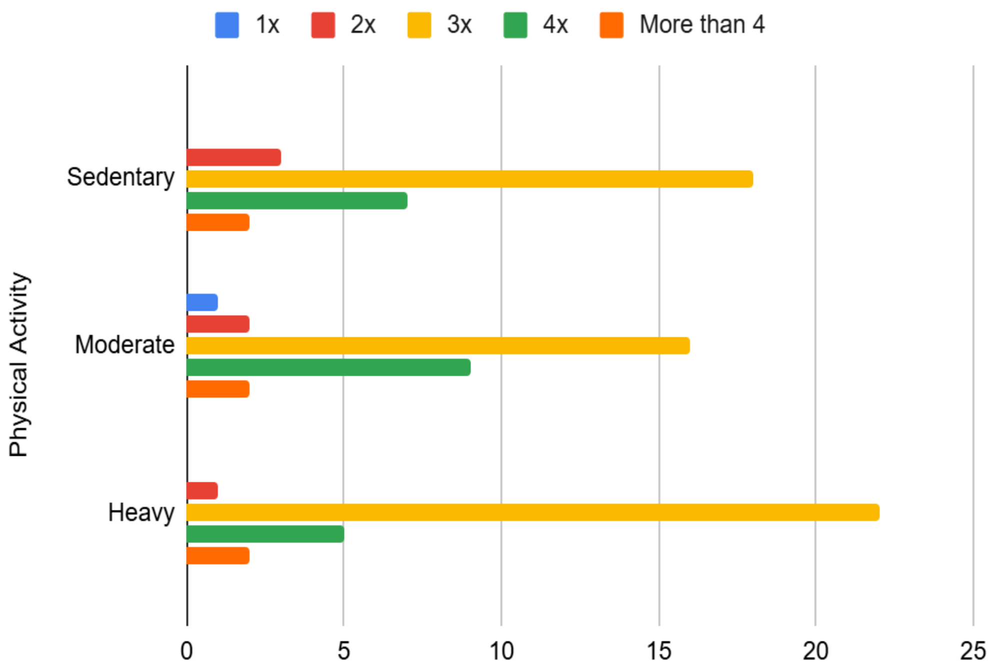

Fig. 3: Frequency of intake of meal in a day

Figure 3 depicts that the majority (62%) of subjects across all activity groups consumed three meals per day, followed by 23% consuming four meals per day, 7% each consuming two meals and more than four meals per day respectively, and only 1% consuming one meal per day.

d. Main meal preferred by subjects

Distribution of subjects across different physical activity levels based on the data on main meal preferred by the subjects is given in the table below:

Table 6: Main meal preferred by subjects

Main meal preferred	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Breakfast	17 (57)	20 **(67)**	11 (37)	48 **(53)**
Lunch	12 (40)	10 (33)	19 **(63)**	41 (46)
Dinner	1 **(3)**	0 (0)	0 (0)	1 (1)
Total	30	30	30	90

From table 3, it was noted that the majority (53%) of subjects preferred breakfast as their main meal, followed by 46% choosing lunch and only 1% for dinner. Preference for breakfast as the main meal was mainly observed among sedentary and moderately active subjects. Whereas, the majority of heavy active subjects (63%) preferred lunch as their main meal.

This change would suggest that those who exercise vigorously choose to consume more calories in the middle of the day in order to maintain their energy levels while working on their activities.

e. Frequency of Dine out

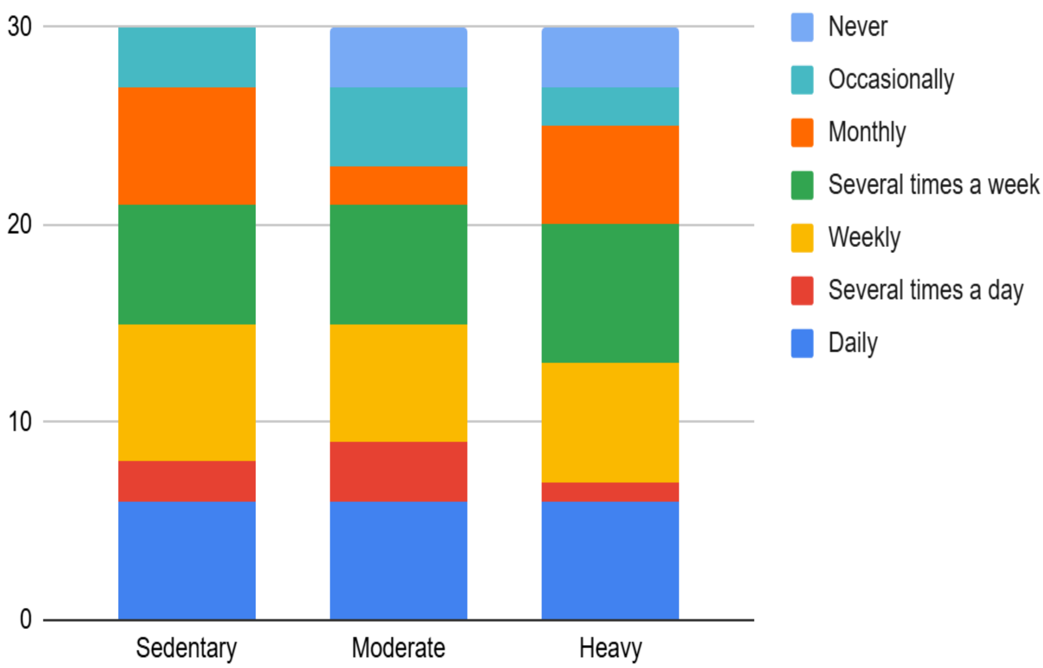

Fig. 4: Frequency of dining out

From figure 4 it shows that among all activity levels, 20% of participants reported eating out every day, indicating a pattern of eating out frequently. Only 7% of participants dine out multiple times a day, with heavy workers being the least likely to do so (3%).

Eating out once a week was more prevalent, as reported by 21% of the participants, and was most observed among sedentary subjects (23%). Dining out multiple times a week showed a similar pattern, with heavy workers having a slightly greater percentage (23%) than sedentary and moderate activity groups (20%).

14% of people reported eating out once a month, with moderate workers reporting the least frequency (7%), and heavy activity workers reporting the least frequency (17%). With heavy workers reporting the lowest frequency (17%) and moderate workers reporting the lowest frequency (7%), 14% of respondents reported dining out monthly. 10% of participants reported eating out occasionally, with minor differences between the groups.

Remarkably, 7% of subjects never dined out, with moderate and heavy workers accounting for the same percentage (10%), and no sedentary subject reported they never dined out at all. This may suggest that moderate and heavy activity workers rely more on home-cooked meals, whereas sedentary subjects may occasionally choose to dine out for convenience or work-related reasons.

f. Skipping of meals vs Physical activity

Distribution of subjects across different physical activity levels based on meal skipping pattern of the subjects is given in the table below:

Table 7: Pattern of skipping meals among various physical activity levels

Pattern of skipping meal	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	15 **(50)**	10 (33)	14 (47)	39 (43)
No	15 (50)	20 **(67)**	16 (53)	51 **(57)**
Total	30	30	30	90

Data from table 7 reveals that the majority of participants (57%) refrained from skipping meals and meal skipping pattern was observed in only 43% of subjects.

Meal skipping was observed to be equally prevalent among sedentary people, with 50% reporting skipping meals and 50% refraining from it. They rarely skipped meals, mainly lunch followed by breakfast.

A significant portion of the moderate activity group (67%) reported never skipping meals, reflecting a generally consistent eating routine. Similarly, in the heavy activity group, 53% of participants indicated they did not skip meals, while 47% acknowledged doing so. Among those who skipped meals, breakfast emerged as the most frequently missed, particularly in the moderate and heavily active groups. Despite their increased energy requirements, the occasional skipping of breakfast among these individuals may be attributed to factors such as work-related time constraints or irregular daily schedules.

g. Consumption of snacks between main meals

Distribution of subjects across different physical activity levels based on the data on consumption of snacks between main meal is given in the table below:

Table 8: Consumption of snacks between main meals

Habit of snack consumption	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	22 (73)	27 (90)	29 **(97)**	78 **(87)**
No	8 **(27)**	3 (10)	1 (3)	12 (13)
Total	30	30	30	90

From table 8, it was observed that the majority (87%) of the study participants consumed snacks between main meals compared to 13% who did not. Consumption of snacks was observed slightly higher among heavy active subjects followed by moderate active subjects. This implies that snacking is a typical eating pattern, especially for people who are more physically active , most likely as a result of their higher energy needs as well as the ease in access of food at or nearby workspace.

The snacks consumed across all three categories were mainly fried snacks, followed by nuts, fruits, junk foods, chips, biscuits and vegetables. The consumption of fried snacks, junk foods and chips was observed higher among heavy active group. Whereas, biscuits, fruits and nuts were mainly consumed by moderate active group.

h. Avoidance of food due to health reasons

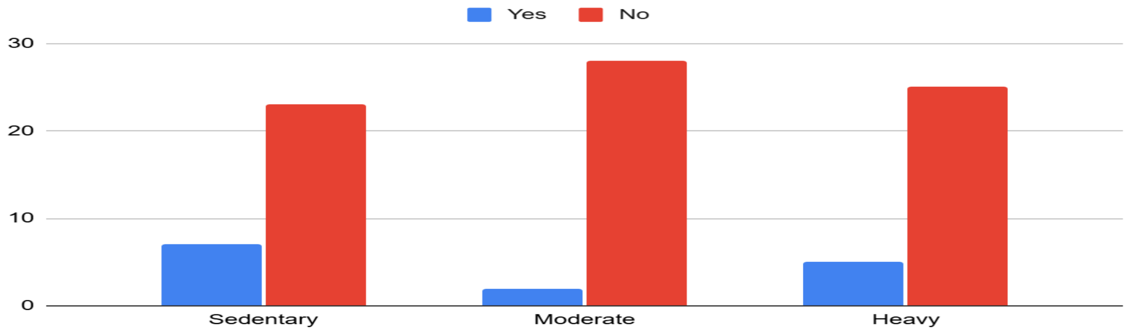

Fig. 6: Avoidance of food among subjects due to various health reasons

Figure 6 depicts that a significant number (84%) of the subjects did not report avoiding foods due to any health reasons, compared to just 16% who did. Avoidance of food was mainly observed in sedentary subjects compared to moderate and heavy active groups. These dietary restrictions could be because of dietary choices or pre-existing medical issues.

i. Food craving of subjects

Distribution of subjects across different physical activity levels based food cravings is given in the table below:

Table 9: Food craving vs Physical activity

Frequency of food craving	Sedentary **(%) n=30**	Moderate **(%) n=30**	Heavy **(%) n=30**	Total **(%) N=90**
Often	3 (10)	5 **(17)**	0 (0)	8 (9)
Sometimes	14 (47)	8 (27)	14 (47)	36 (40)
No	13 (43)	17 **(57)**	16 (53)	46 **(51)**
Total	30	30	30	90

From table 9 it can be seen that only 3% of the study participants reported food craving while the majority (51%) feel satiated. Food cravings were reported occasionally by 47%, each from sedentary and heavy active groups. Overall, sedentary and moderately active people reported food cravings more frequently than heavy workers, who reported them the least frequently. This implies that even if physical activity raises energy demands, those who engage in high levels of activity might have better control over their hunger signals. This difference across the three categories may be attributed to variations in energy balance across activity levels, meal time, and metabolic rates.

Subjects reported craving for foods like fried snacks, processed chips, sweets, chocolate, non-veg fast foods etc. Only 4% of subjects craved freshly-prepared home made foods.

Among the subjects who reported having food cravings, the majority (81%) of subjects consumed the food whereas, 19% did not have or refrained from it. Subjects of heavy category were able to control the desire for the food rather than sedentary and moderate active subjects who consumed the desired food.

j. Worksite eating habits

Distribution of subjects across different physical activity levels based on the worksite eating habits of subjects is given in the table below:

Table 10: Provision of food at worksite of subjects based on physical activity

Provision of food at worksite	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	14 **(47)**	13 (43)	10 (33)	37 (41)
No	16 (53)	17 (57)	20 **(67)**	53 **(59)**
Total	30	30	30	90

Table 11 shows that most of the work space did not provide food, whereas, 41% of subjects had food provided at their workplace. The provision of food was mainly observed for sedentary (47%) subjects followed by moderate (33%) and heavy (33%) subjects. The foods mainly provided at the workspace were tea or coffee (59%), followed by snacks (57%), meals (46%), fast foods and sweetened beverages, 3% each respectively.

Table 11: Worksites encouraging healthy eating practices of subjects

Worksite encouraging healthy eating practices	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	6 (20)	1 (3)	10 (33)	17 (19)
No	24 (80)	29 **(97)**	20 (67)	73 **(81)**
Total	30	30	30	90

From table 12, it was observed that the majority (81%) of the workplace did not offer healthy eating habits of subjects. Whereas, only 19% of subjects had a workplace encouraging healthy eating habits with heavy active subjects reporting 33%, followed by sedentary 20% and least reported by moderately (3%) active subjects.

k. Food frequency of subjects

Distribution of subjects across different physical activity levels based on the data food frequency pattern of the subjects is given in the table below:

Table 12: Food frequency pattern of subjects based on physical activity level

Food item	Frequency	Sedentary n=30 (%)	Moderate n=30 (%)	Heavy n=30 (%)	Total N=90 (%)
Cereals	Daily	30 (100)	30 (100)	30 (100)	90 **(100)**
Pulses	Daily	3 **(10)**	2 (7)	1 (3)	6 (7)
	Several times a week	22 (73)	21 (70)	24 **(80)**	67 **(74)**
Dal	Several times a week	19 (63)	20 (67)	22 **(73)**	61 **(68)**
	Once a week	5 (17)	4 (13)	5 (17)	14 (16)
Sprouts	Occasionally	3 (10)	6 (20)	6 (20)	15 (17)
	Never	23 **(77)**	19 (63)	17 (57)	59 **(66)**
Green leafy vegs.	Several times a week	10 (33)	14 **(47)**	9 (30)	33 **(37)**
	Once a week	8 (27)	7 (23)	8 (27)	23 (26)
Roots and tubers	Daily	5 (17)	4 (13)	9 (30)	18 (20)
	Several times a week	15 (50)	22 **(73)**	15 (50)	52 **(58)**
Other vegs.	Daily	7 (23)	8 (27)	4 (13)	19 (21)
	Several times a week	9 (30)	15 (50)	20 **(67)**	44 **(49)**
Fruits	Daily	7 (23)	12 **(40)**	7 (23)	26 **(29)**
	Several times a week	4 (13)	8 (27)	12 (40)	24 (27)
Milk	Daily	17 (57)	19 **(63)**	17 (57)	53 **(59)**
	Never	6 (20)	5 (17)	10 **(33)**	21 (23)
Paneer	Occasionally	9 (30)	10 (33)	4 (13)	23 (26)
	Never	12 (40)	10 (33)	15 **(50)**	37 **(41)**
Cheese	Once a month	10 (33)	5 (17)	6 (20)	21 (23)
	Never	12 (40)	12 (40)	12 (40)	36 **(40)**
Curd	Daily	4 (13)	2 (7)	1 (3)	7 (8)
	Several times a week	10 (33)	12 (40)	18 **(60)**	40 **(44)**
	Once a week	3 (10)	8 (27)	4 (13)	15 (17)

Ghee	Daily	1 (3)	2 (7)	0 (0)	3 (3)
	Once a month	8 (27)	7 (23)	6 (20)	21 (23)
	Never	7 (23)	7 (23)	10 **(33)**	24 **(27)**
Red meat	Several times a week	12 **(40)**	10 (33)	9 (30)	31 **(34)**
	Once a week	6 (20)	8 (27)	11 (37)	25 (28)
	Never	2 (7)	5 (17)	6 (20)	13 (14)
Fish	Daily	9 (30)	2 (7)	10 (33)	21 (23)
	Several times a week	13 (43)	13 (43)	17 **(57)**	43 **(48)**
Shellfish /crab	Several times a week	1 (3)	6 (20)	5 (17)	12 (13)
	Occasionally	4 (13)	6 (20)	8 **(27)**	18 **(20)**
	Never	9 (30)	1 (3)	6 (20)	16 (18)
Poultry	Daily	7 (23)	4 (13)	1 (3)	12 (13)
	Several times a week	12 (40)	14 (47)	17 **(57)**	43 **(48)**
	Once a week	5 (17)	8 (27)	8 (27)	21 (23)
Egg	Daily	13 (43)	14 (47)	7 (23)	34 (38)
	Several times a week	12 (40)	12 (40)	19 **(63)**	43 **(48)**
Coconut	Daily	7 (23)	5 (17)	19 (63)	31 (34)
	Several times a week	15 (50)	14 (47)	16 **(53)**	45 **(50)**
Nuts and dry fruits	Daily	5 (17)	4 (13)	5 (17)	14 (16)
	Several times a week	7 (23)	7 (23)	1 (3)	15 (17)
	Once a week	4 (13)	6 (20)	8 (27)	18 (20)
Oil	Daily	27 (90)	27 (90)	28 **(93)**	82 **(91)**
Sugar and sweets	Daily	8 (27)	8 (27)	2 (7)	18 (20)
	Several times a week	11 **(37)**	6 (20)	5 (17)	22 **(24)**
	Never	2 (7)	3 (10)	4 (13)	9 (10)
Fast foods	Daily	5 (17)	6 **(20)**	4 (13)	15 (17)
	Several times a week	10 (33)	10 (33)	8 (27)	28 **(31)**
	Once a month	7 (23)	5 (17)	6 (20)	18 (20)
Fried foods	Daily	9 (30)	9 (30)	7 (23)	25 (28)
	Several times a week	12 (40)	13 **(43)**	11 (37)	36 **(40)**

Table 12 provides the details on the food frequency pattern of participants, based on their physical activity levels.

From the table it can be observed that all participants consumed cereals on a daily basis. Whereas, pulses were consumed on several times a week basis, with the majority reported by a heavy active group (80%). Only a small fraction (7%), mainly sedentary (10%) group, reported consuming pulses daily. Similar pattern was observed in consumption of dal, where the majority (68%) of the subjects reported consuming several times a week, with the majority of heavy workers (73%) consuming dal. Sprouts were unconsumed by the majority (66%) of subjects.

Consumption of green leafy vegetables was reported several times a week by the majority (37%) of the participants. Similar patterns were observed in the consumption of roots and tubers, and other vegetables as well. The consumption of green leafy vegetables was observed to be higher among sedentary (33%) and moderate workers (47%) compared to heavy workers (30%). Similarly, moderate and sedentary workers were more likely to consume roots, tubers, and other vegetables than heavy workers.

40% of moderate workers reported consuming fruit every day, which is marginally greater than the 23% of sedentary and heavy workers, indicating that moderately active people consume more fruit. Most people in all groups consumed milk on a daily basis while the percentage was slightly lower for heavy workers. Consumption of paneer and cheese was uncommon in all categories, with a greater percentage of participants never eating these foods.

Over 90% of all subjects consumed eggs daily or multiple times per week, indicating consistent intake across groups among animal-based meals. About 31% to 43% of participants reported consuming fish and red meat multiple times each week, with heavy workers consuming these foods slightly more frequently. All groups consumed relatively little poultry.

Data revealed that coconut together with nuts and dry fruits and oil received extensive use since more than 50% of participants utilized them daily. Local nutritional traditions seem to be the reason behind this finding. The sedentary participants reported consuming sugar and sweets as well as fried foods daily or frequently to a rate of 30–43% while these foods were less common among moderate and heavy workers. The data indicates that inactive citizens exhibit higher rates of eating high-energy processed foods.

F. Lifestyle habits of subjects

a. Sleep duration of subjects

Analysis of sleep duration across different physical activity levels revealed that the majority of sedentary and moderately active participants reported sleeping for 8–10 hours. Conversely, most individuals in the heavily active group reported shorter sleep durations, primarily within the 5–7 hour range. This pattern may indicate a potential association between higher levels of physical activity and reduced sleep duration, which could be attributed to more rigorous schedules or limited rest time due to increased daily demands.

b. Consumption of alcohol among subjects

Distribution of subjects across different physical activity levels based on alcohol consumption is given in the table below:

Table 13: Consumption of Alcohol among subjects based on physical activity

Alcohol consumption	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	20 **(67)**	19 (63)	17 (57)	56 **(62)**
No	10 (33)	11 (37)	13 **(43)**	34 (38)
Total	30	30	30	90

Table 13 reveals that the majority (62%) of study participants consumed alcohol, while 34% refrained from it. Alcohol consumption was observed to be highest among sedentary (67%) and moderate (63%) activity individuals, whereas, among heavy workers, the alcohol consumption was comparatively at lower rates (57%). As the use of alcohol is common among all activity levels, the frequency patterns imply that alcohol consumption is not primarily impacted by activity level alone, but rather is more common in social and lifestyle behaviours.

a. Habit of smoking among subjects

Distribution of subjects across different physical activity levels based on smoking habits of subjects is given in the table below:

Table 14: Habit of smoking among subjects based on physical activity

Habit of smoking	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	14 **(47)**	11 (37)	8 (27)	33 (37)
No	16 (53)	19 (63)	22 **(73)**	57 **(63)**
Total	30	30	30	90

From table 14 it was noted that the majority (63%) of subjects were non-smokers, whereas, 37% of the subjects had a habit of smoking. Among the different activity groups, smoking prevalence was highest in the sedentary group (47%), followed by moderate workers (37%), and lowest among heavy workers (27%). The majority of heavy workers (73%) were non-smokers, indicating that smoking was less common in this group compared to sedentary and moderate workers.

b. Stress vs physical activity

Distribution of subjects across different physical activity levels based on stress level is given in the table below:

Table 15: Stress among subjects based on physical activity

Stress	Sedentary **(%)** **n=30**	Moderate **(%)** **n=30**	Heavy **(%)** **n=30**	Total **(%)** **N=90**
Yes	18 (60)	21 **(70)**	17 (57)	56 **(62)**
No	12 (40)	9 (30)	13 **(43)**	34 (38)
Total	30	30	30	90

From table 15, it can be noted that the majority (62%) reported experiencing stress. Moderate workers had the highest percentage of reported stress (70%), followed by sedentary workers (60%) and heavy workers (57%). Conversely, 38% of the total participants reported no stress, with the highest percentage among heavy workers (43%), followed by sedentary workers (40%) and moderate workers (30%). This suggests that while stress is prevalent across all work categories, its perception and connection to work differ.

Connection of Stress and Eating habits

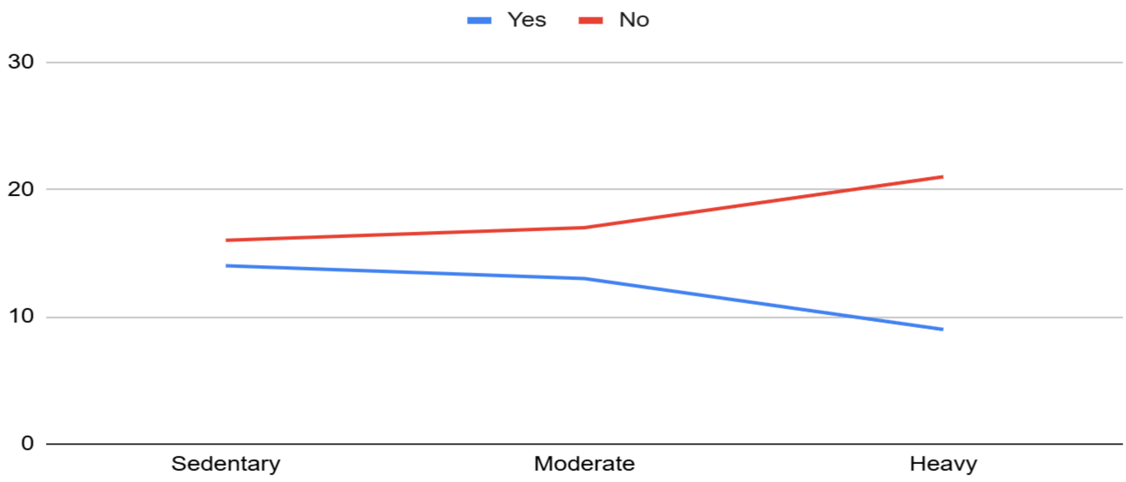

Fig. 7: Connection of stress with eating habits among subjects based on physical activity

Figure 7 depicts that the majority (60%) of the study participants did not observe a connection between stress and eating while 40% of subjects noticed a connection between stress and eating pattern, most observed among sedentary (47%) subjects followed by moderate (43%) and least by heavy (30%) active subjects.

Table 16: Connection between stress and eating habits

Connection between stress and eating	Sedentary **(%) n=30**	Moderate **(%) n=30**	Heavy **(%) n=30**	Total **(%) N=90**
More	7 (23)	4 (13)	1 (3)	12 (13)
Less	7 (23)	9 (30)	8 (27)	24 (27)
Nil	16 (53)	17 (57)	21 (70)	54 (60)
Total	30	30	30	90

From table 16 it was observed that among the study participants who observed a connection between stress and eating habits reported reduced intake of food when stressed, mainly by moderate (30%), followed by heavy (27%) and sedentary (23%) subjects. Only small proportion of subjects (13%) reported increased consumption of food when stressed, reported mainly by sedentary (23%) followed by moderate (13%) and heavy (3%) active subjects

G. **Statistical analysis**

Table 17: Statistical analysis of data

Variable	**Category**	**N**	**Mean ± SD**	**Significance**
BMI	Sedentary	30	24.483 ± 4.06	.075
	Moderate	30	22.907 ± 3.64	
	Heavy	30	24.870 ± 2.59	
	Total	90	24.087 ± 3.55	
Body Fat %	Sedentary	30	22.803 ± 4.95	.262
	Moderate	30	20.920 ± 5.73	
	Heavy	30	22.683 ± 4.00	
	Total	90	22.136 ± 4.97	
Visceral Fat Level	Sedentary	30	8.93 ± 5.56	.112
	Moderate	30	7.00 ± 4.14	
	Heavy	30	9.22 ± 3.180	
	Total	90	8.38 ± 4.46	
Skeletal Muscle %	Sedentary	30	34.570 ± 3.35	.222
	Moderate	30	35.200 ± 3.52	
	Heavy	30	33.740 ± 2.79	
	Total	90	34.503 ± 3.25	
RMR	Sedentary	30	1640.17 ± 177.18	**.044**
	Moderate	30	1565.03 ± 174.87	
	Heavy	30	1676.67 ± 168.05	
	Total	90	1627.29 ± 177.71	
BMR	Sedentary	30	1687.67 ± 179.88	**.020**
	Moderate	30	1614.53 ± 177.85	
	Heavy	30	1743.00 ± 166.68	
	Total	90	1681.73 ± 180.84	
TEE	Sedentary	30	2468.27 ± 378.94	**.000**

	Moderate	30	2843.27 ± 376.30	
	Heavy	30	3827.73 ± 531.07	
	Total	90	3046.42 ± 719.15	
Energy Intake	Sedentary	30	1959.27 ± 519.52	.227
	Moderate	30	1754.73 ± 415.95	
	Heavy	30	1809.50 ± 476.12	
	Total	90	1841.17 ± 475.12	
Energy Balance	Sedentary	30	509.00 ± 451.52	.000
	Moderate	30	1088.53 ± 527.85	
	Heavy	30	2018.23 ± 780.07	
	Total	90	1205.26 ± 863.87	
Sleep duration	Sedentary	30	7.75 ± 1.35	.280
	Moderate	30	7.69 ± 1.26	
	Heavy	30	7.28 ± 1.04	
	Total	90	7.57 ± 1.23	

Table 17 depicts the statistical analysis of the data.

ANOVA analysis demonstrated that there were statistically significant differences among the sedentary, moderately active, and heavily active groups for several variables. Parameters such as Resting Metabolic Rate (RMR), Basal Metabolic Rate (BMR), Total Energy Expenditure (TEE), and Energy Balance varied significantly across different physical activity levels ($p < 0.05$), suggesting that physical activity has a notable influence on these metabolic and energy-related indicators.

Notably, individuals with higher activity levels exhibited elevated RMR and BMR, reflecting increased metabolic demands associated with greater physical exertion. These findings are consistent with existing literature that links increased physical activity to enhanced metabolic function.

The most pronounced variation was observed in Total Energy Expenditure (TEE) ($p = 0.000$), which is expected as energy expenditure rises proportionally with activity levels. Similarly, Energy Balance (EB) also displayed a highly significant difference ($p = 0.000$), indicating that participants with higher activity levels may achieve a more favorable energy balance due to greater caloric output.

Conversely, parameters including Energy Intake (EI), Body Mass Index (BMI), Body Fat Percentage, Visceral Fat, Skeletal Muscle Percentage, and Sleep Duration did not reveal statistically significant differences across the activity groups ($p > 0.05$). Although variations may be present, they were not sufficient to confirm a meaningful association with activity levels in the present sample.

Overall, these results emphasize the substantial impact of physical activity on energy metabolism, while also suggesting that other factors such as dietary habits, muscle composition, and sleep are likely influenced by a multifaceted interaction of lifestyle components beyond physical activity alone.

CHAPTER 5
SUMMARY AND CONCLUSION

In recent times, increasing awareness about health and wellness has brought greater attention to physical activity, lifestyle changes, and dietary improvements as essential components of overall well-being. Despite this, many individuals still lack a clear understanding of how these factors interconnect especially in relation to body composition. This gap often results in inconsistent health behaviors, poor dietary choices, or overdependence on specific routines without fully grasping their impact on health.

The research study titled *"Association between different physical activity levels with body composition, dietary pattern and lifestyle habits among young adults"* aimed to explore how varying physical activity levels influence key health indicators such as body composition, dietary habits, and lifestyle behaviors. Conducted in Ernakulam, the study focused on young adults aged 19–39, drawn from a total sample of 119 participants aged 19–59 years using purposive sampling. A comparative analysis was done on the 19–39 age group, with equal representation across sedentary, moderately active, and highly active individuals. Data was collected through structured interviews, and body composition was assessed using the Omron HBF 222T analyzer.

- ★ The main findings of the study are summarized below:
- ★ Most participants (76%) were between 19 and 39 years.
- ★ Majority of the sedentary (23%) and moderate subjects (20%) were from the upper middle class, whereas, majority of heavy active (26%) subjects were from upper lower class
- ★ Most participants were Hindus (57%), and the majority (63%) were unmarried.
- ★ Majority of the moderate active subjects had a normal BMI. Whereas, the majority of heavy active subjects fell within the overweight category.
- ★ The majority of sedentary subjects had very high body fat percentages, heavy active subjects mostly fell within the high range, while moderate active subjects were primarily within the normal range.
- ★ The majority of moderate active subjects had normal visceral fat levels, while heavy active subjects mostly fell within the high range, and sedentary subjects were primarily in the very high range.

- ★ The majority of heavy active subjects had low skeletal muscle percentage, while most sedentary and moderate active subjects were within the normal range, with moderate active subjects showing higher skeletal muscle percentage.
- ★ Lifestyle-related conditions like hypertension, dyslipidemia, and fatty liver were more frequent among sedentary individuals, while heavy workers reported the fewest health issues.
- ★ The majority of subjects (94%) were non-vegetarians. Dietary modifications were minimal, seen in only 7%—mostly sedentary individuals.
- ★ Majority of subjects had three meals per day, with breakfast as the primary meal for sedentary and moderate subjects, while 63% of heavy workers preferred lunch as their main meal.
- ★ Majority of sedentary subjects dined out weekly, while the majority of heavy workers dined out multiple times a week.
- ★ Majority of subjects refrained from skipping meals. Skipping meals, mainly lunch was observed in sedentary subjects. Moderately and heavily active individuals had more stable eating habits with least of them skipping breakfast.
- ★ Snacking was prevalent among heavy active subjects, who primarily consumed fried snacks and chips, while the moderate group favored fruits and nuts.
- ★ Most subjects did not restrict foods for health reasons, with food avoidance primarily observed in sedentary individuals.
- ★ Food cravings were often reported by sedentary and moderately active individuals mainly for fried snacks and fast foods.
- ★ Most workplaces did not provide food, though tea/coffee, snacks and meals were commonly available at the workplaces of sedentary subjects.
- ★ All participants consumed cereals daily.
- ★ Pulses and dal were more frequent among heavy workers, while leafy greens and fruits were more common among sedentary and moderate groups.
- ★ Eggs were a common source of protein. Heavy activity individuals consumed more red meat and fish. Poultry intake was generally low.
- ★ Sedentary participants had a higher intake of fried and sweet items, reflecting a less healthy dietary pattern.
- ★ Sedentary and moderate groups averaged 8–10 hours of sleep per night. Heavy workers slept less (5–7 hours), indicating potential sleep deprivation.

- ★ Alcohol consumption was reported by 62%, with the highest prevalence among sedentary and moderately active groups.
- ★ Majority of subjects were non-smokers and habit of smoking was observed among sedentary subjects.
- ★ The majority of subjects reported no stress. Among those experiencing stress, sedentary individuals exhibited increased food intake, while moderately active individuals showed decreased food intake.
- ★ ANOVA analysis showed statistically significant differences among sedentary, moderately active, and heavily active groups for RMR, BMR, TEE, and Energy Balance ($p < 0.05$).
- ★ Higher physical activity levels were associated with elevated Resting Metabolic Rate (RMR) and Basal Metabolic Rate (BMR), indicating increased metabolic demands.
- ★ TEE showed the most significant variation ($p = 0.000$), increasing proportionally with physical activity levels.
- ★ Highly significant differences were also observed in Energy Balance ($p = 0.000$), suggesting better caloric regulation in more active individuals.
- ★ No statistically significant differences were found for Energy Intake (EI), Body Mass Index (BMI), Body Fat Percentage, Visceral Fat, Skeletal Muscle Percentage, and Sleep Duration ($p > 0.05$).
- ★ Physical activity significantly impacts energy metabolism, but other factors like diet, body composition, and sleep are likely influenced by a broader range of lifestyle components.

CONCLUSION

This study highlights the significant impact of physical activity on body composition, dietary habits, and lifestyle behaviors among young adults. Moderate physical activity, particularly when combined with regular structured exercise, was associated with healthier fat-to-muscle ratios, better dietary practices, and more stable lifestyles. In contrast, sedentary individuals exhibited poor dietary habits, higher body fat percentages, and a greater prevalence of lifestyle diseases.

Importantly, the findings indicate that high levels of occupational physical activity, as observed in the heavily active group, do not necessarily translate to improved health outcomes. Contributing factors likely include irregular engagement in structured exercise, inadequate dietary regulation, elevated energy intake, frequent consumption of snacks, and insufficient sleep duration. In contrast, the moderately active group, which combined occupational activity with regular, structured physical exercise such as gym workouts and strength training, demonstrated superior health indicators.

These results underscore that the nature, consistency, and quality of physical activity, alongside supportive dietary and lifestyle practices, are critical determinants of overall health. Mere occupational exertion without structured exercise and proper lifestyle management is insufficient to achieve optimal health outcomes. Therefore, public health strategies should emphasize the promotion of regular exercise, balanced nutrition, and adequate rest to enhance the well-being of young adults and prevent the onset of lifestyle-related disorders.

Limitations of the study:

- The study involved 119 participants, which may not be large enough to represent a broader population. Additionally, the focus on male participants aged 19-59 years may limit the applicability of the findings to other age groups or females.
- Since the study was cross-sectional, it captures data at one point in time, limiting the ability to establish causal relationships between physical activity, dietary habits, and body composition.
- Many of the lifestyle and dietary habits were based on self-reports, which could lead to recall bias or inaccuracies in the data.
- The absence of a follow-up period means the study cannot assess how changes in physical activity or diet impact body composition and health outcomes over time.
- The study did not include detailed analysis of nutrient intake, which could provide more insight into how specific nutrients affect body composition and overall health.

Recommendations of the study:

- Future studies should include a larger and more diverse sample, encompassing different genders and a wider age range to enhance the generalizability of the findings.
- Long-term studies would be beneficial to observe how physical activity, diet, and lifestyle changes affect body composition and health outcomes over time.

- Utilizing objective tools to measure dietary intake (e.g., food diaries, biomarkers) and physical activity (e.g., accelerometers) could reduce reliance on self-reporting and improve data accuracy.
- Future research should focus on assessing specific nutrients, such as proteins, fats, and carbohydrates, to better understand their role in body composition changes.
- Conducting intervention studies, where participants adjust their physical activity or dietary habits, would help determine the direct effects of these changes on body composition and health.

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APPENDIX

QUESTIONNAIRE TO ASSESS ASSOCIATION OF PHYSICAL ACTIVITY LEVELS WITH BODY COMPOSITION, DIETARY AND LIFESTYLE PATTERN OF YOUNG ADULTS

I. GENERAL PROFILE

a. Name:...
b. Gender- M / F
c. Age in years- / /
d. Phone No……………………………….
e. Religion: Hindu / Christian / Muslim
f. Education qualification:
   - ☐ Profession or honours
   - ☐ Graduate
   - ☐ Intermediate or diploma
   - ☐ High school certificate
   - ☐ Middle school certificate
   - ☐ Primary school certificate
   - ☐ Illiterate
g. Occupation
   - ☐ Legislators, senior officials and managers
   - ☐ Professionals
   - ☐ Technicians and associate professionals
   - ☐ Clerks
   - ☐ Skilled workers and shop and market sales workers
   - ☐ Skilled agricultural and fishery workers
   - ☐ Craft and related trade workers
   - ☐ Plant and machine operators and assemblers
   - ☐ Elementary occupation
   - ☐ Unemployed
h. Marital status- Single / Married / Divorced
i. Monthly income
   - ☐ Less than 10,702
   - ☐ 10,703 - 31,977
   - ☐ 31,978 - 53,360
   - ☐ 53,361 - 80,109
   - ☐ 80,110 - 1,06,849
   - ☐ 1,06,850 - 2,13,815
   - ☐ 2,13,814 & above

II. ANTHROPOMETRIC ASSESSMENT & BODY COMPOSITION

Height- cm	Body fat %-	Skeletal Muscle %-
Weight- kg	Visceral fat level-	BMI-
Body Age-	Body water-	RMR-

III. PHYSICAL ACTIVITY

Ⅳ.24 HOUR ACTIVITY PATTERN

Time	Main Activity

V. HEALTH PROFILE

1. How often do you get routine biochemical tests done?
   - ☐ Daily
   - ☐ Weekly
   - ☐ Monthly
   - ☐ Annually
   - ☐ Any other

2. Do you have any of the following diseases/disorders? If yes, mention the results of the latest biochemical test and since when?

Disease/Disorder	Blood Value	Onset
Diabetes Fasting blood sugar Random blood sugar		
Hypertension		
Dyslipidemia Total cholesterol HDL LDL Triglycerides		
Liver function test SGOT SGPT Total protein Serum albumin Serum globulin		
Kidney disease Urea Creatinine Uric acid BUN		
Osteoporosis Vitamin D Bone density		
Anemia Hb		
Hormonal imbalances (PCOD, fibroid, Thyroid)		
Breathing difficulty		
Gastrointestinal disorders (peptic ulcer, IBS, GERD)		
Any other….....................(specify)		

3. Do you regularly take any medications or supplements to manage biochemical parameters?

   ☐ Yes ☐ No

VI. DIETARY PATTERN

1. Are you Vegetarian or Non-Vegetarian

☐ Veg ☐ non-Veg

2. Are you currently following any diet plans or any dietary modifications? (eg. low-carb, low-salt, vegan, keto diet, high-protein, low-fat, gluten-free, lactose-free etc.)

☐ Yes ☐ No

If YES, what diet are you on?.. (Specify reason)

3. How many meals do you eat per day?

☐ 1x
☐ 2x
☐ 3x
☐ 4x
☐ More than 4

4. What meal would you consider to be your main meal of the day?

☐ Breakfast
☐ Lunch
☐ Dinner
☐ Other………(specify)

5. How often do you normally dine out (in restaurants / cafeterias)?

☐ Daily
☐ Several times a day
☐ Weekly
☐ Several times a week
☐ Monthly
☐ Never

6. Do you skip any meals?

☐ Yes ☐ No

If YES, which one?

☐ Breakfast
☐ Lunch
☐ Snack
☐ Dinner

7. How often do you skip meals or purposely go a long time without eating?

☐ Almost always
☐ Sometimes
☐ Often
☐ Rarely
☐ Never

8. Do you eat snacks between main meals?

☐ Yes ☐ No

If YES, what do you most often choose as snacks?........

☐ Biscuits
☐ Chips
☐ Fruits
☐ Nuts
☐ Veg-salad
☐ Fried-items
☐ Junk foods
☐ Other…………. (specify)

9. Have you been avoiding some foods for health reasons?

☐ Yes ☐ No

If YES,............ (specify)

10. List any vitamins or dietary supplements you take and how often? (reason?)

………………..

VII. HUNGER CUES AND APPETITE

11. Do you feel like you have trouble controlling your appetite / hunger?

☐ Often
☐ Sometimes
☐ Seldom
☐ Never

12. Do you normally struggle with food cravings?

☐ Often ☐ Sometimes ☐ No

If yes or sometimes, what do you normally crave?... (specify)

13. What do you normally do when you have cravings?

….. (specify)

14. Do you consume alcohol?

☐ Yes ☐ No

If YES, how often?

☐ Daily
☐ Several times a week
☐ Once a week
☐ Several times a month
☐ Once a month
☐ Never

15. Do you smoke?

☐ Yes ☐ No

If YES, how often?

☐ Daily
☐ Several times a week
☐ Once a week
☐ Several times a month
☐ Once a month
☐ Never

VIII. FOOD FREQUENCY QUESTIONNAIRE

16. How often do you eat the following?

	Daily	Several times a week	Once a week	Several times a month	Once a month	Never
Cereals & Cereal products (rice, wheat, oats etc)						
Whole pulses (Bengal gram, chickpeas, green gram)						
Dals						
Sprouts						
Green leafy vegetables						
Roots and tubers						
Other vegetables						
Fruits						
Milk						
Paneer						
Cheese						
Curd						
Ghee						
Red Meat						
Fish						
Shellfish/ crab						
Poultry						
Egg						
Coconut						
Nuts and dry fruits						
Oil						
Sugar and sweet foods						
Fast foods						
Fried foods						

IX. STRESS AND EATING

1. Do you often feel stressed out?

☐ Yes ☐ No

2. Have you ever noticed any connection between stress and your eating habits?

☐ Yes ☐ No

If YES, what happens? (e.g., When I'm stressed I eat more / less)
…..(specify)

3. How often have you seen yourself eating uncontrollably, with an unusually large amount of food?

☐ Always
☐ Often
☐ Sometimes
☐ Rarely
☐ Never

X. WORKSITE EATING HABITS

1. Does your worksite provide food?

☐ Yes ☐ No

If YES, what kind of foods?

☐ Snacks
☐ Meals
☐ Fast foods
☐ Tea/Coffee
☐ Sweetened carbonated beverages (eg. Cola, Pepsi, Sprite, Soda etc.)

2. Does your worksite encourage healthy eating practices?

☐ Yes ☐ No

3. Are there any measures taken by your company to ensure healthy eating of employees?

☐ Provide healthy food options
☐ Provide healthy foods at subsidised rate
☐ Educate employees about nutrition
☐ Encourage physical activity by offering fitness classes / promoting active breaks during the workday
☐ Create a healthy work environment by designating smoke-free areas and encourage regular breaks / promoting stress management techniques
☐ Recognize and reward healthy choices

XI. 24 HOUR RECALL

Time	FOOD ITEM	Qty (no / cup / ml)	Ingredients (g/ml)
Early morning			
Breakfast			
Midmorning			
Lunch			
Evening snack			
Dinner			
Miscellaneous			