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A Descriptive Cross-sectional Study to Assess the Dietary Diversity and Weight Status among Secondary School-Going Adolescents in Urban Pune.

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ABSTRACT

Background- The Individual Dietary Diversity Score (IDDS) represents the quality of the diet of the individual and it is a proxy measure of micro and macro nutrient adequacy of the diet. Weight status is an important indicator of malnutrition. The aim of this study is to assess the dietary diversity status and weight status of secondary school going adolescents from Urban Pune.

Methods- We analysed collected data among adolescents to assess the Individual Dietary Diversity Score (IDDS) and weight status. Dietary Diversity score was calculated using 9 food groups categories as per Food and Agricultural Organisation-WDDS and weight status was assessed using BMI value.

Results- The prevalence of Low, Medium and High Dietary Diversity was 45%,50% and 5% respectively. The mean Dietary Diversity Score was 3.68±1.06 with starchy staples being (100%) consumed food group. The prevalence of underweight, overweight, and normal weight was 80%, 3% and 17% respectively.

Conclusion- Adolescents diets were low in diversity and monotonous in nature, which can be a risk factor for poor nutrient adequacy and health outcome of adolescents. Majority of the participants are underweight reflect undernourishment which are due to inadequate intake of energy -dense foods as per the requirements. Policies and programs should be designed and implemented to enhance the quality of diets to ensure improved diet diversity and nutrient adequacy and thereby improving the nutritional status.

Introduction

India is dealing with a triple burden of malnutrition—undernutrition, micronutrient deficiency, and overnutrition—which is a public health problem. (Kumar et al, 2021). Overweight and obesity have also become major public health concerns that contribute to non-communicable diseases (NCDs), along with undernutrition (Pandey & Mahendra Dev, 2022). About 63% of deaths in India in 2017 were attributed to NCDs (WHO, 2018). To ensure a healthy and nutritious diet, the consumption of different food groups, or "dietary diversity", is a generally accepted concept. (Gonete et al., 2020). Even though we have access to a huge variety of edible foods, our diets are getting less diversified.(Bhargava et al., 2020). Most of the developing countries follow a monotonous diet mostly with starchy staples and lack diversity in the diet. (Diet Diversification Is Need of The Hour, Experts, n.d.). Unhealthy dietary patterns are linked to altered metabolisms and a key modifiable risk factor for higher risk of non-communicable diseases (NCDs) (TY & M, 2016).

Dietary diversity helps to determine nutritional adequacy and dietary quality. As per FAO definition, "Dietary diversity is a qualitative measure that reflects household access to a variety of foods and is also a proxy for nutritional adequacy of the diet of the individuals." (*FAO - Dietary Diversity Questionnaire.Pdf*, n.d.). Consuming a variety of foods will increase the probability to get different vitamins, minerals, nutrients, and phytochemicals which will be of great help to prevent nutrient deficiencies and chronic diseases. (Kojima et al., 2020). A balanced and diversified -diet comprises the appropriate amount of protein, carbs, vitamins, and minerals through diets, among other food items, cereals, legumes, nuts, meat, fish, eggs, fruits, and vegetables, to ensure enough nutrient intake.(Kumar et al., 2021). Numerous studies have emphasized the advantages of a diversified diet, especially one rich in fruits and vegetables, in extending life expectancy, lowering the prevalence of chronic degenerative diseases, and enhancing the nutritional quality and child development in developing countries.(Isabirye et al., 2020). The WHO recommends preventing chronic malnutrition through the consumption of a diverse range of nutrients -dense and locally available foods. (WHO,2008). Indian Council of Medical Research (ICMR) and the National Institute of Nutrition (NIN) have recommended a daily plate for Indians which ensures diet diversity, in which 45% has been allotted to cereals, 17% to pulses, eggs, and flesh foods, 12% for fats and oils, 10% for milk and curd, 8% for nuts and seeds, and merely 8% is given for fruits and vegetables. (Dietay Guidelines for Indians-A Manual, n.d.).

Source: Fig 1.1: Food Guide Pyramid for Adolescents

Dietary diversity is determined by Dietary Diversity Score which is calculated at household levels and individual levels. (Isabirye et al., 2020). The Individual Dietary Diversity Score (IDDS) represents the probability of nutritional adequacy of the diet of the individual and it is a proxy measure of micro and macro nutrient adequacy of the diet.(Isabirye et al., 2020) The DDS assessment tool- Dietary Diversity Questionnaire is a low-cost, easily administered and rapidly used, and user-friendly tool that can be modifiable as per the need of the study with regards to sex/gender, age, and the context of the study participants.(Heidari-Beni et al., 2022).

The nutritional status assessment is suggested to gain information on the prevalence and geographical distribution of nutritional consequences within a community or specific population. (Shrivastava et al., 2014) Additionally, it can be utilized to evaluate high-risk populations and evaluate the contribution of various epidemiological factors to nutritional deficiencies.(Shrivastava et al., 2014). Anthropometric indices- can suggest patterns of growth and development of an individual. (Loukrakpam et al., 2020) . Weight status is an important indicator of malnutrition. Weight status is classified as thinness, severe thinness, normal, overweight and obesity. Thinness and severe thinness reflect undernourishment which are due to inadequate intake of energy - dense foods as per the requirements whereas the overweight and obesity reflects over -nourishment which is unbalanced between energy intake and expenditure which results in excess energy storage. Dietary quality might influence the weight status of the children.(Devindran et al., 2022) .

Although there is no unified definition of the adolescent age group, the United Nations Population Fund (UNFPA) and the Government of India in its decadal Census statistics agreed upon adolescents to include persons aged 10−19 years. Adolescents make up roughly 20% of the total world population. (Ganpule-Rao et al, 2021) In developing countries like India, adolescents have an even higher demographic weight- India has the largest adolescent population in the world. According to India's 2011 census, India is home to more than 250 million adolescents.

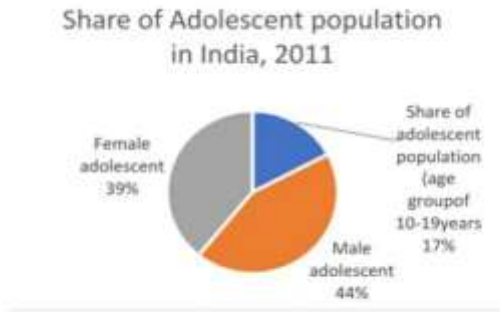


Fig: 1.2 Adolescence Population in India as per Census 2011

This period of the age is characterized by a growth spurt with rapid physical, emotional, social, sexual, and psychological development and maturation.(Isabirye et al., 2020). The adolescent period is a critical age and transient phase of life in which nutritional requirements are very high and require special nutritional care. (Dr Hélène Delisle, Professor, 2005) . Especially those of adolescent girls, since females will become future mothers, and their health will have an impact on future generations. (Nithya & Bhavani, 2018). These features make adolescents more susceptible to a variety of nutrition-related issues. (Mirmiran et al., 2004). At the same time, this period provides an important window of opportunity for interventions that promote the principles of a healthy lifestyle – with the potential to radically change the chronic disease landscape among adults across the world (Rah et al., 2017)

It is very essential to take into account adolescent nutrition which will help to raise the economic productivity of the country, better pregnancy outcomes, and mitigate adverse chronic disease outcomes. (Jikamo & Samuel, 2019). Therefore, exceptional consideration must be given to adolescent dietary intake and pattern, which is a key factor in improving adolescent health and productivity. (Ukegbu et al., n.d.). It is important from a public health perspective to understand the role of dietary diversity and assess the nutritional status of an individual, family, and community.

Pune is the second-largest city in the state of Maharashtra, the ninth most populous city in India, and one of the cities in the Asia-Pacific region that is fastest growing. (Mukherjee & Chaturvedi, 2017). Pune is experiencing a dramatic level of economic and demographic growth marked by rapid urbanization and trends in food consumption patterns. (Mukherjee & Chaturvedi, 2017).The present study tried to assess the dietary diversity and weight status among adolescents from schools located in Urban Pune, a city of Maharashtra state which is the most economically developed and most populous state in the country.

The study was framed to find out two research questions- 1) What is the food consumption pattern among adolescents? Do they eat balanced and diversified diet? 2) What is the prevalence of underweight, overweight and obesity in this population? The aims and objectives of the study is to estimate dietary diversity using Individual Dietary Diversity Score (IDDS) and to assess the weight status in terms of Anthropometric indices among 12–16 years schoolchildren of urban Pune. Thus, the current study demonstrates the quantification of food group diversification in the dietary habits that results in dietary inadequacies and shed light on anthropometric indices to get insights into the growth and development patterns among adolescents of Urban Pune.

Literature Review

For this research topic, a thorough review of the body of existing literature was conducted. PubMed, Google Scholar were used to access the literature on the subject. Several studies on the literature related to the topic were reviewed. This chapter's primary objective was to examine the prevalence of malnutrition in adolescent children, children's diet quality, dietary intake pattern, and dietary habits among schoolchildren, and currently available diet quality and nutrition indices evaluation tools for children.

Endalifer et al (2021) in their article titled “Factors associated with dietary diversity among adolescents in Woldia, Northeast Ethiopia” stated that adolescents must consume a diversified diet throughout this time to develop an active and healthy mind for their later years. This cross-sectional type of study was conducted among school-going adolescents in Woldia town. In this study dietary diversity was computed by summing the number of food groups consumed by the individual. The study concluded that sex, maternal level of education, knowledge of nutrition, and family size are key determinants of dietary diversity. Also, recommended to enhance the consumption of a variety of foods in adolescents, it is preferable to create a nutrition intervention program that focuses on nutrition education.

Kumar et al (2021) in their research study titled “Prevalence and factors associated with the triple burden of malnutrition among mother-child pairs in India: a study based on National Family Health Survey 2015–16”. Concluded that developing country like India is facing a major public health challenge in terms of the triple burden of malnutrition among children. In this study, the authors used the data driven from NFHS 4. Recommendations were made on public health programs to create awareness and effective implementation of targeted nutritional programs among children.

Isabirye et al (2020) in their research article titled Dietary diversity and associated factors among adolescents in eastern Uganda: a cross-sectional study concluded that adolescents’ diet was characterized by foods that are high in fats and oils but lack in micronutrient rich food and diversified diet. As adolescents are going through a transformation in physiological and social processes, this age group requires an adequate diet. Adolescents constitute 16% of the population globally. Also, they noticed staying with a single parent or guardian, low socio-economic class, and dependency on home meals was related to low dietary diversity. Recommended interventions to target the associated factors to address the low dietary diversity.

Jikamo & Samuel (2019) in the research study titled Does dietary diversity predict the nutritional status of adolescents in Jimma Zone, Southwest Ethiopia? Was conducted among the adolescents of age group 13-17 years old by analysing the secondary data to assess the association between dietary diversity and nutritional status among adolescents. The study concluded that dietary diversity is an independent predictor in having a significant prevalence of underweight and stunting among adolescents. So adequate nutrition for adolescents should be recommended by the programmers.

Agrawal et al (2019) in the research article titled Socio-economic patterning of food consumption and dietary diversity among Indian children: evidence from NFHS-4 concluded that given India's present nutritional transformation, education, and exposure to knowledge about diet and nutrients may be crucial. Given the high prevalence of inadequate dietary diversity overall (77%) and the sparse differences by SES, interventions must be focused to promote food consumption and a diverse dietary intake among Indian children.

Ganpule-Rao et al (2021) in their research study titled Dietary diversity scores, nutrient intakes, and biomarkers vitamin B12, folate and Haemoglobin in rural youth from the Pune Maternal Nutrition Study concluded that we require more population-specific studies because there is a wide variety of food available, as well as geographical, cultural, sex, and socioeconomic constraints that influence the variation in dietary patterns and diversity. These studies

are essential so that DDS can be measured objectively and separately instead of being compared to intakes estimated using the same questionnaire. The authors recommended conducting more studies that will be useful to check the suitability of the DDS measuring tools as mentioned in FAO guidelines in different age and physiological groups so that we could inform and evaluate the effectiveness of changes in policy and implementation

Mukherjee & Chaturvedi (2017) in their qualitative diet survey research study titled A study of the dietary habits of school children in Pune city, Maharashtra, India noticed that children preferred Snacks, fast food, and processed food over other food groups. The study proposed the need for data on the nutritional intake of school children to guide public health policymakers to design nutritional interventions and nutritionists and family physicians to advise parents and caretakers on the nutritional inadequacies of the diet. Recommendations were made on educating the parents regarding the importance of inculcating correct dietary habits to ensure that as adults they can live a healthy and productive life.

Pathania & Biswas (2021) in their research article titled Assessment of the nutritional status of adolescent school-going boys of Himachal Pradesh. The study reports the nutritional status of Himachali adolescent boys of age 15-17 years in comparison to the majority of Indian boys of similar age, Himachali boys appeared to be taller. In comparison to other Indian research on adolescent boys, the prevalence of the various categories of overnutrition and undernutrition was also lower. The occurrence of overweight and obese individuals suggests the issue of the double burden of malnutrition.

Rah et al (2017) in their study titled Adolescent Health and Nutrition stated that the currently available evidence indicates the significantly considerable prevalence of undernutrition, overweight, and micronutrient deficiencies among adolescents. In this study, the researchers mentioned the factors that make the nutritional requirements of adolescents different from other states of life. The authors concluded that Program implementation gaps still exist despite evidence of efficient strategies and delivery platforms, such as school-, community-, and health-based platforms. A range of effective, comprehensive, complementary nutrition-specific, and nutrition-sensitive interventions are needed to accelerate progress in addressing adolescent nutrition.

Nithya & Bhavani (2018) in the research study titled Dietary Diversity and its

Relationship with Nutritional Status among Adolescents and Adults in Rural India conducted at Wardha and Koratpur. The study concluded that dietary diversity plays a major role in determining the nutritional status of adolescents and adults. It was observed that diets mainly consist of starchy staples. Lack of diversity in the diet with less consumption of nutrient-rich food is an important issue in developing countries. Recommendations were made to emphasize dietary diversity by including a variety of foods and food groups to ensure nutrient adequacy. Furthermore, considering the need for a diversified diet, sustainable innovative strategies that combine agriculture and nutrition programs with interventions to improve education, health, sanitation, and household infrastructure, as well as the care and feeding practices of adolescent girls and women of reproductive age, are essential.

Shrivastava et al (2014) in the research article titled Assessment of Nutritional Status in the Community and Clinical Settings concluded that a nutritional status assessment helps determine the prevalence of nutritional disorders, design corrective actions, and simultaneously analyse the effectiveness of the implemented measures.

TY & M (2016) in their analytical type of literature review stated that Dietary diversity score as a conventional indicator of nutritional adequacy is hindered by the variability in nutrient concentration within food groups and the complex influence of sociodemographic, economic, environmental, and technological variables. Also noticed that there are some favourable and contrasting conditions to use dietary diversity as an indicator of nutrient adequacy, so it is recommended to use this score as a measure of healthy diet with ecological benefit.

Chandrasekhar et al (2017) in their research article titled Household food insecurity and children's dietary diversity and nutrition in India. Evidence from the comprehensive nutrition survey in Maharashtra argued by analysing the data from the 2012 Comprehensive Nutrition Survey in the State of Maharashtra, India, that the other literature has discussed whether dietary diversity reflects food security or dietary quality. However, there has not been much discussion on this topic in context to India. The lack of information and there is critical data gap that needs to be filled the CNSM shows that doing so is both feasible and effective. They also found evidence that in what extent food insecurity affects diet diversity and how these both factors affect the nutritional status of the children, though they did not able to provide causal relationship. Taking all this in consideration, the authors stated that this analysis will help Government of Maharashtra's and India's National Nutrition Mission in formulating appropriate policies and programs to address the children's malnutrition.

Loukrakpam et al., (2020) in the research study titled Dietary adequacy and nutritional status of Meitei community of Manipur, Northeast India concluded that evidence obtained from the study indicate the higher prevalence of malnutrition in younger children and WRA in the community. The researchers used single day 24-hour recall period to examine the food consumption pattern. The authors recommended on Long-term investments to strengthen the role of women through education, economic empowerment, social advancement, and political participation are need of the hour in order to promote mother and child nutrition. Additionally, authors emphasise It is crucial to raise awareness of the importance of maternal and child nutrition and to stimulate a cultural shift in favour of a well-balanced, healthy diet composed of high-quality, easily accessible local foods. These actions together will improve the health of the community.

Aurino et al., (2017) in the research article titled the nutrition transition and adolescents' diets in low- and middle-income countries: A cross-cohort comparison stated that their study shed light on dietary patterns of adolescents in developing counties like India, Vietnam, Ethiopia and Peru. They also observed the disparities in food consumption pattern in rural and urban areas of this countries. The findings indicate that Ethiopia (earlier stage), India (intermediate stage), Vietnam (intermediate stage), and Peru(later stage) could be positioned along the continuum of the nutrition transition). This evaluation can assist in the development of strategies and policies to mitigate the detrimental effects of the nutrition transition.

(Abizari et al., 2017) **i**n the research article titled Seasonality affects dietary diversity of school-age children in northern Ghana concluded that seasonality has an impact on the dietary diversity and food consumption patterns of school-age children in rural Northern Ghana. Although seasonal variations in dietary adequacy were not evaluated in the current study, DDS is a proxy indicator of micronutrient intake, so seasonal variations in DDS may affect the micronutrient intake of school-age children between season.

Bhargava et al (2020) in the research study titled Nutritional status of Indian adolescents (15-19 years) from National Family Health Surveys 3and 4: Revised estimates using WHO 2007 Growth reference stated By reanalysing the data on nutritional status of adolescents by using the WHO growth reference which is age and sex specific, that there is significantly overestimated level of thinness in Indian adolescents between the ages of 15 and 19. Stunting, a sign of poor long-term nutrition, is also extremely prevalent in them. The authors recommended in future editions of DHS and NFHS to consider the adolescents age group as a separate age group for nutritional assessment to better understand the nutritional transition in the population.

Gonete et al (2020) in the research study titled Dietary diversity practice and associated factors among adolescent girls in Dembia district, northwest Ethiopia,2017 illustrated that only 1/3rd of adolescent girls has adequate diet diversity. The low level of dietary variety highlights the need to intensify efforts aimed at enhancing adolescents' healthy dietary practises by paying proper attention to underprivileged families and malnourished adolescents.

Hooshmand & Udipi (2013) in the research article titled Dietary Diversity and Nutritional Status of Urban Primary School Children from Iran and India, concluded that the scores for pulses, dairy products, and non-vegetarian food items were positively correlated with height for age z-scores in both nations. According to the statistics, a varied diet that includes fruits, vegetables, beverages, sweets, fatty foods, cereals, and mixed cuisines is linked to a higher body mass index. The authors suggested to prevent childhood undernutrition as well as overweight and obesity, more studies with a detailed evaluation of the association between dietary diversity and child nutritional status is required.

Shinde et al (2021) in their study titled Association of iron supplementation and dietary diversity with nutritional status and learning outcomes among adolescents: Results from a longitudinal study in Uttar Pradesh and Bihar, India stated that diversified diet intake was positively corelated with the haemoglobin, math ability, height-for-age z-score, and a lower chance of dropping out of school in adolescents. Recommendations were made by the authors to address the nutritional needs of adolescents and enhance educational outcomes, integrated nutritional and health interventions and enhancing the current nutrition supplements programme are essential.

Mirmiran et al. (2004) in their research study titled Dietary diversity score in adolescents - a good indicator of the nutritional adequacy of diets: Tehran lipid and glucose study concluded that DDS might be an appropriate tool for anthropometric assessments in the adolescents of age group 16-18 years of age. Additionally, they claimed that while individual nutrients are important, but in terms of complex dietary pattern they work more effectively when they are in balance and are obtained from a variety of healthy foods. To evaluate nutrient intake adequacy, computing DDS is an appropriate method. More research is advised to better understand the association between nutrition and health by assessing dietary patterns.

Sié et al (2018) in research study titled Dietary diversity and nutritional status among children in rural Burkina Faso. Concluded that to reduce the burden of stunting and chronic malnutrition among young children dietary diversity should be increased. Suggested interventions to address the low dietary diversity like cash transfers, education and promotion of nutrition practices and efforts to reduce the burden of infectious diseases.

The article titled *Nutrition in Adolescence-Issues and Challenges for the Health Sector Issues in Adolescent Health and Development*, 2005)- The document represents the WHO recommendations for prevention of nutritional disorders, their early detection, diagnosis and management. Following a brief Introduction (PART 1) to the features of adolescence and to the opportunities it provides, the three specific objectives of the document are dealt with in part 2,3 and 4.

Research Methodology

Purpose of the Study-

The current study's purposes are quantification of food groups to estimate the dietary diversity score at individual level and dietary habits of adolescents and to evaluate their weight status using anthropometric indicator-BMI value. The study is concerned with finding out the quality of the diet in terms of food group consumption and also concerned to find out the growth and development pattern among individuals. Therefore, the study investigates height, weight, and BMI in addition to determining the IDDS.

Statement of the Problem-

The eating habit of adolescents was influenced by multiple factors such as lifestyle, food marketing, media, socioeconomic, and cultural factors. (Endalifer et al., 2021).

On the Global platform, it is considered that adolescents are comparatively period of good health and they are less prone to infectious and chronic diseases and life-threatening conditions than children and the elderly. (Dr Hélène Delisle, Professor, 2005). There is no consensus over the precise adolescent age group, and because of accelerated growth and development, it is challenging to accurately quantify or measure the nutritional status. (Jikamo & Samuel, 2019). The demands of adolescents are not prioritized, and the majority of nutrition interventions target mothers and children. (Loukrakpam et al., 2020). Being in a transition phase, adolescents did not receive the benefits from love and care that children get nor they received adulthood protection. (Agrawal et al., 2019).

Nutrition-dependent health of adolescents has not received public health attention and there were limited published studies regarding this. (Jikamo & Samuel, 2019). The research studies conducted in other developing nations like Bangladesh and the Philippines show a positive relationship between DDS and the nutritional status of children. (Gupta et al., n.d.). Limited evidence is available in the Indian context, where DDS has been used to evaluate the nutritional status of adolescents.(Loukrakpam et al., 2020) . A study conducted by Chandrashekhar et al shows evidence that higher dietary diversity is associated with a lesser probability of stunting and wasting in children.(Chandrasekhar et al., 2017). Menon et al found evidence that shows a positive relationship between dietary diversity scores and anthropometric indices. (Menon et al., 2015). In India data on the nutritional status of school-age children have not been routinely collected, despite the evidence, that nutritional problems adversely affect school attendance, performance, and learning. (Hooshmand & Udipi, 2013).

Questions like what is the quality of food consumption pattern of adolescents? Are they having balanced and diversified food? and what is the weight status of adolescents? and so on needs to be answered.

Research Questions and Objectives-

Research Questions

RQ1: What is the food groups consumption pattern among adolescents? Do they eat balanced and diversified diet?

RQ 2: What is the prevalence of underweight, overweight/ obese and normal weight conditions in this population?

Research Objectives

RO1: To assess the Dietary Diversity of the population of Adolescents' food groups consumption by calculating IDDS

RO2: To assess the weight status by evaluating physical growth standards in terms of height, weight, and BMI and to estimate the prevalence of underweight, overweight and normal among adolescents.

Research Design-

The current study Design is Descriptive Cross-sectional with Quantitative Approach.

In the present study, the data on Anthropometric Indices and Dietary intake on the previous day was collected in the sample Secondary school-going adolescents of age 12-16 years from the selected schools of Urban Pune.

Sampling Design-

Population- All Adolescents (12 -16 years of age) in Urban Pune.

Target Population-(Universe) The entire set of secondary-school students, aged 12 to 16, from classes 7 to 10, attending various schools in urban Pune

Accessible Population (Study Population) - Secondary school-going Adolescents from 7-10 std. of age 12-16 years from selected schools.

Inclusion Criteria-

1) The adolescents in the age group of 12-16 years are included
2) The students who are present on the day of study
3) Who are willing to participate

Exclusion Criteria-

1) The adolescents who are less than 12 years and more than 16 years of age

2) The students who are absent on the day of study.

Sample – Samples were secondary school-going adolescents from std 7-10 who were studying in selected schools of urban Pune.

Sampling Techniques- A list of schools was obtained from the data portal of PMC – Education Dept. https://www.pmc.gov.in/en/education-department. Pune city is a block in the Pune district of Maharashtra which is having 10 clusters in it. The schools are categorised under different clusters as per geographical location within PMC limits as per the block of Pune city. There is a total of 10 Clusters under the Pune city Block in which a total of 180 schools are categorized as Primary (1 to 5 grades) Upper Primary (Grades 1 to 8), and Secondary Schools (Grades 6 to 10). and Higher Secondary (Grades 6 to 12)- inclusive of all types of schools like MNC schools, Government aided schools, self-finance schools, social welfare schools, and unaided schools. In these 180 schools total of 1,85000 students are enrolled as per student enrolment data details available on the data portal.

Schools are selected by cluster sampling method and respondents are selected by simple random sampling method.

Sample Size- I used OpenEpi Software to calculate the sample size. This software is supported by CDC Atlanta. As per my study design, I plugged in the values the software asked to get the desired sample size. These are all the values that I had rather plugged-in in this software so 97 is my sample size.

The sample size was calculated based on the estimated size of the adolescent population, 95% confidence level, and a 10% margin of error.

Population Size – The estimate Adolescents population of Pune city is 337,062 as per the figure from the Census India report in 2011. Adolescents comprise 10.79% of the total population of Pune City.

Sample Size for Frequency in a Population

Population size (for finite population correction factor or fpc) (*N*):	337062
Hypothesized % frequency of outcome factor in the population (*p*):	50%+/-10
Confidence limits as % of 100(absolute +/- %) (*d*):	10%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for 95 % Confidence Levels - 97

Sample Size Equation-

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1) +p*(1-p)]$

The setting of the study— The study was conducted in selected secondary and upper secondary schools of PMC limits. The clusters are assigned 1-10 numbers. From that, 2 clusters of schools were chosen for the study by simple random sampling based on the availability of a number of students/respondents to get the desired sample size.

Assent was thereafter taken from each and every adolescent, and only those who agreed were chosen for the study.

Study Duration- November 2022-April 2023

Data Collection Methods

Preliminary Visits-

The formal approval letter was obtained from MIT WPU -University. The letter of permission to conduct the study was acquired from the Principal of the school. The purpose of the study was well explained and Informed consent was taken from all included students assuring the confidentiality of the study.

Before the study, all the students were explained the purpose of the study and the extent of their involvement in presence of the respective class teachers. The same was also conveyed to their parents through the class teachers.

Data Collection Tool-

Data was collected for the outcome variables- 1) Dietary Diversity 2) Nutritional Status and 3) Socio -demographic data-, a structured questionnaire was designed with both open-ended and closed-ended questions with three sections. Section A) Personal Details and Socio demographic Details Section B) Dietary Intake Details for the dietary diversity Assessment

Section C) Anthropometric Indices – for weight status Assessment. Section A and Section B was presented in Marathi and English so that it was well understood and interpreted by the participants.

1) Dietary Diversity

Development of Data Collection Tool and Method for Dietary Diversity- To assess the dietary diversity at individual level IDDS was calculated using the Dietary Diversity Scores as per FAO, 2007 Guidelines. To construct the IDDS a dietary intake assessment within past 24 hours of each individual/ participant was done as guided by FAO. The complete information on the dietary intake was obtained from the participants by an interviewer-led structured questionnaire.

A qualitative 24-hour recall "open" method was conducted to collect dietary intake/ food consumption information. The students were divided in small groups of 8-10 participants. A focus group discussion method was used to orient the participants about the study, with the help of the class teacher. The participants were made understood all the instructions and details to complete the questionnaire. In order to gather correct information on dietary intake, the researcher supervised the participants by dictating questions and encouraging the responders to comprehend and interpret the questions. To aid the reporting pictorial depictions on the food items were presented. The respondents were asked to list/recall all the foods and drinks, he/she had the previous day and night, both inside and outside the home. As the participants are older children there was no need to rely on caregivers or parents to collect the information on the dietary intake assessment. However, parents may be unaware of the food intake of children when they are away from home. The information from this dietary intake was recorded in 16 food groups in the dietary diversity Questionnaire. This list of food groups was based on the FAO guidelines for measuring household ad individual dietary diversity.

Table 3.1 shows the detailed food group classification with examples.

Table 3.1 Food Group Classification with Examples

Question number	Food group	Examples
1	CEREALS	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + *insert local foods e.g. ugali, nshima, porridge or paste*
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + *other locally available vitamin A rich vegetables (e.g. red sweet pepper)*
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach*
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant) + *other locally available vegetables*
6	VITAMIN A RICH FRUITS	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + *other locally available vitamin A rich fruits*
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects
10	EGGS	eggs from chicken, duck, guinea fowl or any other egg
11	FISH AND SEAFOOD	fresh or dried fish or shellfish
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products
14	OILS AND FATS	oil, fats or butter added to food or used for cooking
15	SWEETS	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes
16	SPICES, CONDIMENTS, BEVERAGES	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages
Household level only	Did you or anyone in your household eat anything (meal or snack) OUTSIDE the home yesterday?	
Individual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday?	

Source: Adapted from the Guidelines for Measuring Household and Individual Dietary Diversity, FAO

After the respondent's recall is completed, all the foods and drinks consumed by the respondent, underlined the corresponding food item in the list in the appropriate food group and write in the column next to the food group if at least one food item in this food list has been consumed. We excluded a very small quantity and a cut -of more than 15 gm (1 tablespoon) has been set as adequate enough to include as consumed. To estimate this cut out of papers and measuring tools were displayed to the participants to have an idea about the portion size that will be more than 15 gms. If no food from that list has been consumed, it was marked as 0. Where no food group was underlined, probing for that food group was done by simply asking about fruits, vegetables or tubers if these food groups not previously mentioned. We also did not consider outside eaten food while grouping the food items. For computing IDDS certain food groups are aggregated and combined into a single food group. Based on FAO criteria, 9 food groups were included to calculate the dietary diversity. Table 3. 2 shows the aggregation of 16 food groups into 9 food groups.

Table 3.2 Nine Food Groups of Dietary Diversity Score

Nine food groups of dietary diversity scores.

1. Starchy staples	Cereals (corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g., bread, noodles, porridge, or other grain products) and white tubers and roots (e.g., white potatoes, white yam, or other foods made from roots)
2. Dark green leafy vegetables	Dark green/leafy vegetables, such as, Chinese cabbage, spinach, coriander, rape, etc.
3. Other vitamin A rich fruits and vegetables	Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (e.g., red sweet pepper), cantaloupe, apricot (fresh or dried), dried peach, and 100% fruit juice made from these
4. Other fruits and vegetables	Other vegetables (e.g., tomato, onion, eggplant) + other locally available vegetables, such as cabbage, green pepper, lettuce, radish, garlic, tomato, and other fruits, including wild fruits and 100% fruit juice made from these
5. Organ meat	Liver, kidney, heart, or other organ meats or blood-based foods
6. Meat and fish	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects, fresh or dried fish or shellfish
7. Eggs	Eggs from chicken, duck, or any other egg
8. Legumes, nuts and seeds	Cowpea, peanut, dried beans, dried peas, lentils, seeds or foods made from these
9. Milk and milk products	Milk, yogurt or other milk products

Source: Adapted from FAO Guideline

Food Groups -Starchy staples, Dark green leafy vegetables, Other vitamin A rich fruits and vegetables, Other fruits and vegetables, Organ meat and fish, Eggs, Legumes, nuts and seeds, Milk and milk products. A dietary diversity score was computed by summing the number of food groups included in the dietary diversity questionnaire and that will be within the range of 0-9. The maximum attainable score is 9. The dietary diversity score does not reflect the quantity consumed by the individual.

1 The starchy staples food group is a combination of Cereals and White roots and tubers. 2 The other vitamin A rich fruit and vegetable group is a combination of vitamin A rich vegetables and tubers and vitamin A rich fruit. 3 The other fruit and vegetable group is a combination of other fruit and other vegetables. 4 The meat group is a combination of meat and fish. Table 3.3 - Aggregation of Food Groups to Calculate IDDS

Food Group No.	Food Group	Combination of food groups
1	Starchy Staples	Cereals+ White Tubers
2	Dark Green Leafy Vegetables	DGLV
3	Other Vit A Fruits and vegetables	Vit A rich vegetables and tubers +Vit A rich Fruits
4	Other Fruits and Vegetables	Other fruits +Other Vegetables
5	Organ Meat	Organ Meat
6	Meat and Fish	Meat+ Fish
7	Eggs	Eggs
8	Legumes, Nuts and Seeds	Legumes, Nuts and Seeds
9	Milk and Milk Products	Milk and Milk Products

Dietary Diversity Assessment (Dietary Diversity Score- Outcome variable) - The dietary diversity was analysed by the dietary diversity tercile. Dietary diversity terciles include Lowest dietary diversity (≤ 3 food groups) Medium dietary diversity (4 and 5 food groups) High dietary diversity (≥ 6 food groups). Nutrition expert guidance was sought to assign the food items to the appropriate groups.

2) Weight Status (Outcome Variable)

Data was collected for the Anthropometric Measurements to assess the nutrition status- Standard anthropometric methods were used to measure the subjects' basic anthropometric height in meters and weight in kilograms, using a measuring tape and a digital weighing scale, respectively. Weight in kilograms/height in meters squared was the formula used to compute the Body Mass Index (BMI).

Weight Status Assessment-

BMI is calculated to assess underweight and overweight / obesity. Underweight is generally defined as BMI less than 18.5 kg/m^2 corresponds to -1 Z-score. It is generally useful in determining the current nutritional status reflecting decreased fat and muscle mass. Because underweight can reflect both low weight and low height, BMI is useful to assess the extent of weight deficit in relation to height. Overweight among adolescents defined as BMI is greater than or equal to 25 and less than 30kg/m^2 and 25kg/m^2 corresponds to +1 Z-score. Obesity among adolescents can be defined as s a BMI greater than or equal to 30 kg/m2, greater than +2 Z-score of a reference is approximately the same (29.7 kg/m2).

3) Socio demographic data – The personal details and socio-demographic data included age, and sex, number of family members, and information of family members like their age, gender, education and occupation. The socio demographic details were obtained from the Administrative office through a Students Registry wherever available or by telephonic communication with the family member of the respondents or by the respondents themselves.

Before starting the data collection, the pilot study was conducted on 10 adolescents from our friends and relatives and this data was not included while performing the data analysis.

Data Analysis-

All the socio-demographic, dietary intake and Anthropometric data collected from the questionnaire were tabulated in Excel 2019. BMI was calculated from Height and weight measurements in the Excel 2019. Descriptive statistics was done by Excel 2019 and frequency(n), percentage (%) , mean, mode and median with standard deviation was used to summarize the data. The data was represented in the form of charts, tables, and graphs. Cross tabulation and association between the variables were performed using Minitab Statistical Software version 21.1. IDDS was calculated as the number of food groups consumed over a previous 24 hr period. As per FAO guidelines, the aggregation of foods was done into 9 food groups to produce IDDS. Based on the operational definitions indicated previously, the nine food groups identified by the FAO guidelines were divided into diet diversity terciles of low (equal to or more than 3 food groups) , medium (4 to 5 food groups) , and high (equal to 6 or more than 6 food groups). BMI was calculated from Height and weight measurements in the Excel Sheet. Underweight/ thinness (BMI less than 18.5 kg/m^2), overweight **(**greater than or equal to 25 and less than 30kg/m^2) , obesity (BMI greater than or equal to 30 kg/m2) and normal weight (BMI between 18.5 to 24.9) were used as operational for weight status. The chi -square was performed to assess the statistical significance of association between variables. using independent sample t-test, the descriptive statistics i.e., means+/- SD of IDDS and height weight and BMI was compared by sex.

Results

The primary objective of the research is to estimate the IDDS, so excluded the atypical consumption of food on the previous 24 hours due to various reasons like fast, feast, Birthday celebration, or festival. So that data was excluded from the analysis. Out of total of 260 responses, 35 responses were excluded from the study due to this. It was observed that 30 girls (11.53%) had fast on the previous day and 5 respondents were having atypical consumption due to other reasons.

Data collected from 225 adolescents were analysed.

A) Respondents' Profile

The details of age, gender, and sociodemographic characteristics are detailed and illustrated in Table 4.A

Characteristics	Frequency (N)	Percentage (%)
Gender		
Male	151	67
Female	74	33
Standard		
7^{th}	52	23
8^{th}	48	21
9^{th}	57	25
10^{th}	68	30
Age		
12 years	52	23
13 years	47	21
14 years	49	22
15 years	48	21
16 years	29	13
Household size		
Up to 4	125	56
5 or more 5	100	44

Educational Status of Mother		
Up to Higher Secondary	29	13
Graduation	184	82
P. G.	4	2
No response	8	4
Educational Status of Father		
Up to Higher Secondary	8	4
Graduation	185	82
P. G.	21	9
No response	11	5
Occupation of Mother		
Homemaker	27	12
Working	198	88
Occupation of Father		
Employed	184	82
Self-employed	41	18
Total Number of Earning Members in Family		
1	19	8
2	190	84
3	15	7
4	1	0

Table 4.A Socio-demographic Details of Study Participants.

Table 4.A shows the demographic information of the study participants, of whom 151 were males (67%) and 74 (33%) were females. Class 10 students (30%) participated more in number than the students from the remaining classes.

The age distribution of the participants showed that more than half of the students (66%) belong to 12 to 14 years of age and the rest (34 %) of the students were of age 15 and 16 years. The mean age reported of the participants was 13.8+/-1.35. The mode age reported was 12 years.

The study participants had an approximately equal household size of up to 4 members (56%) and a household size of 5 or more than 5 members (44%). The mode calculated for household size was 4.

The educational status of the mother showed that 82% of the mothers graduated and an equal number (82%) of fathers graduated. The study reported that a smaller number of mothers (2%) were post-graduated than fathers (9%).

The occupational status of the mothers of participants showed that most of the mothers were working (88%) and only a few (12%) were homemakers. Among the fathers, a few (18%) were having their own business (self-employed) while most of the fathers (82%) were employed (doing jobs in the Private or Government sector). Most of the participants (84%) had 2 earning members in their family. The mode for total number of earning members in the family was 2.

B) Dietary Habits/ Intake –

1) Beverage Consumption – In the previous 24 hours, out of 225 students, almost all (98%) students had tea and very less (2%) students consumed coffee.

Beverages Intake	Frequency	Percentage
Tea	220	98
Coffee	5	2
TOTAL	225	100.00%

Table 4.B.1a Beverage Intake

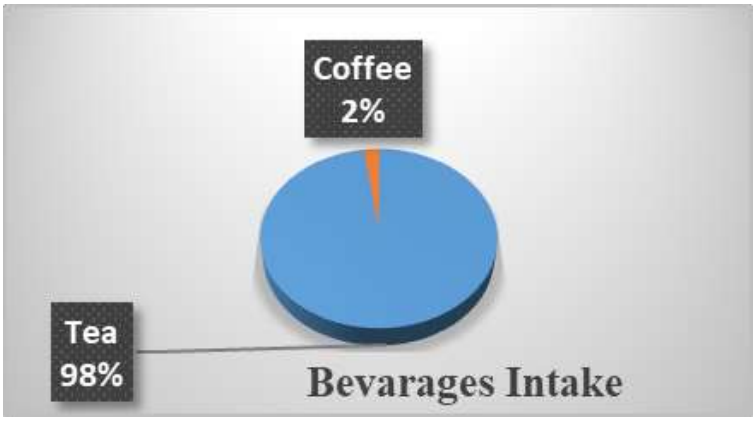
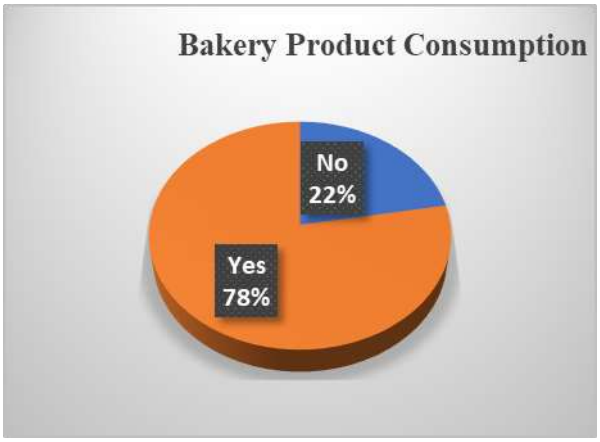


Chart 4.B.1b-Pie Chart Beverage Intake

2) Bakery Products Consumption— In the previous 24 hours, out of 225 students, 78% of students had consumed bakery products in the form of Biscuits, Khari, or toasts.

Bakery Products	Frequency	Percentage
No	50	22
Yes	175	78
TOTAL	225	100.00%

Table 4.B.2a Bakery Products Consumption

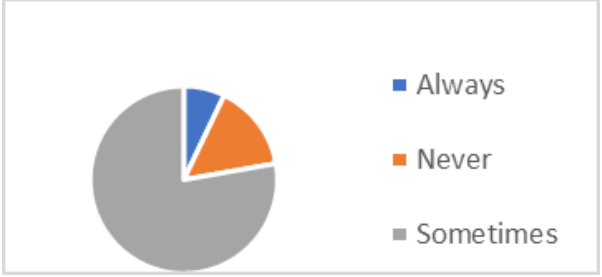


4.B.2b Pie Chart Bakery Products Consumption

3) Breakfast Consumption (Weekly)- The study reported that a very less (7%) number of participants had their breakfast daily, and a majority of the participants consumed breakfast sometimes- 2-3 days/week (78%), and 15% of the participants did not consume breakfast.

Weekly BF Consumption	**Count of Breakfast Consumption (weekly)**	**%**
Always	16	7%
Never	34	15%
Sometimes	175	78%
Grand Total	**225**	

Table 4.B.3a Weekly BF Consumption



4.B.3b Pie Chart Weekly BF Consumption

4) Number of Meals (24 Hours) – Out of 225 students, half of the students (51%) were taking 3 meals per day.

No. of Meals Per Day	Frequency	Percentage
2	38	17
3	115	52
4	63	28
5	9	4
TOTAL	225	100.00

Table 4.B.4a Number of Meals in 24 hours

4.B.4b Bar Graph Number of Meals in 24 hours

5) Eating Outside of/ from Restaurants- It was observed that more than half (60%) of the participants ate outside from restaurants more than once a week.

Eating outside of/from restaurant	**Frequency**	%
At least once a week	91	40%
More than once a week	134	60%
Grand Total	**225**	

Table 4.B.5 Eating Outside from Restaurant

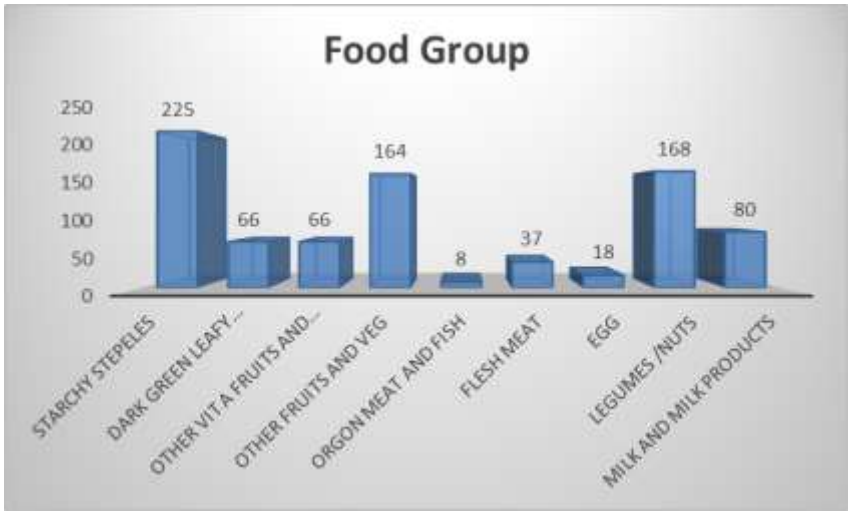
C) Consumption of each Food Group-

In this study, the most predominantly consumed food group was starchy staples (100%), followed by legumes and nuts (74.67%) and other fruits and vegetables (72.89%). Thereafter Milk and milk products (35.56 %) were consumed. Dark green leafy vegetables and other vit A fruits and vegetables were consumed by 29.33% of adolescents.

Notably, food from animal-origin organs meat (3.56%), meat and fish (16.44%), as well as Eggs (8.00%), were the least consumed by adolescents.

Food Group	Frequency	Percentage
Starchy Staples	225	100.00%
Dark Green Leafy Vegetables	66	29.33%
Other Vit A Fruits and Veg	66	29.33%
Other Fruits and Veg	164	72.89%
Orgon Meat	8	3.56%
Meat and fish	37	16.44%
Egg	18	8.00%
Legumes /Nuts	168	74.67%
Milk and Milk Products	80	35.56%

Table 4.C.1 Consumption of Each Food Group



4.C.2 Bar Graph % of Adolescents Consuming each Food Group

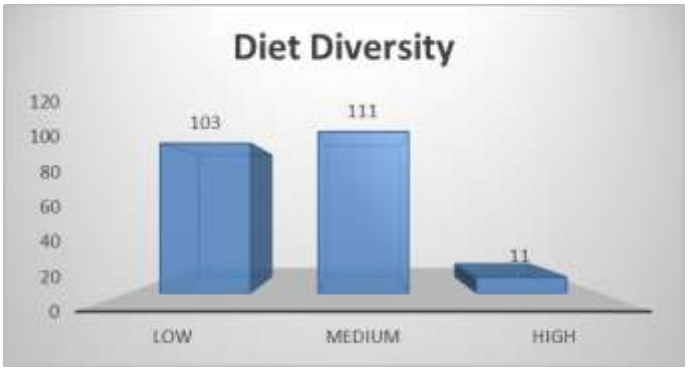
D) Dietary Diversity-

1) IDDS categorized as Low(equal to or less than 3), Medium (4 to 5) High (equal to 6 or more than 6.)

Out of 225 Students, low diet diversity was observed in 46% of participants, medium diet diversity was observed in nearly half of the participants (49.33%), and high diet diversity was observed in only (4.89%) of participants

Diet Diversity	Frequency	Percentage
Low	103	45.78%
Medium	111	49.33%
High	11	4.89%
TOTAL	225	100.00%

Table 4. D.1a Diet Diversity Score



4.D.1b Bar Graph Dietary Diversity

2) Dietary Diversity Score by Gender-

Of the 103 participants observed in the category of low dietary diversity score, 67% were male adolescents, and 33% were female adolescents. 111 participants were observed with a medium dietary diversity score of whom 66.7% were male adolescents and 33.3% were female adolescents. A high dietary diversity score was observed in 11 participants of which 72.7% were male and only 27.3% were females.

			Dietary Diversity			Total
			Low	Medium	High	
Gender	Male	Count	69	74	8	151
		%	67.0%	66.7%	72.7%	67.1%
	Female	Count	34	37	3	74
		%	33.0%	33.3%	27.3%	32.9%
Total		Count	103	111	11	225
		%	100.0%	100.0%	100.0%	100.0%

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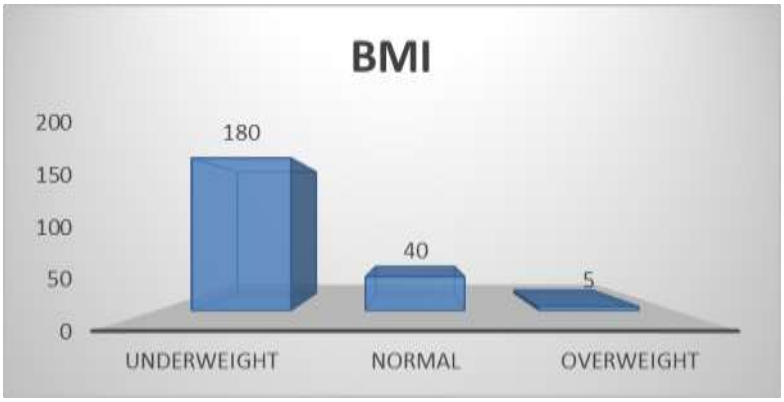
Table 4.D.2 Dietary Diversity by Gender

E) Weight Status-

1) The weight status was assessed by BMI value – Underweight, overweight, and Normal. In this study it was observed that 80% were underweight, only 18% were having normal BMI and very few (2.22%) were found overweight.

BMI	Frequency	Percentage
Underweight	180	80.00%
Normal	40	17.78%
Overweight	5	2.22%
TOTAL	225	100.00%

Table 4.E.1a Weight Status



4.E.1b Bar Graph Weight Status

2) Weight Status and Dietary Diversity Score- The study reported that from the Low category of dietary diversity, 80% were underweight, 17% were normal BMI and nearly 3% were overweight. Nearly equal proportion was observed for underweight (80%) and normal (18%) in the medium category of Dietary Diversity except for the overweight (2%) proportion. In the high category of Dietary Diversity, nearly one-fourth (73%) of the proportion were underweight, and three–fourth (27%) of the participants were normal BMI. No (0%) participant was overweight in the High category of Dietary Diversity.

			Dietary Diversity			Total
			Low	Medium	High	
BMI	Underweight	Count	83	89	8	180
		%	80.6%	80.2%	72.7%	80.0%
	Normal	Count	17	20	3	40
		%	16.5%	18.0%	27.3%	17.8%
	Overweight	Count	3	2	0	5
		%	2.9%	1.8%	0.0%	2.2%
Total		Count	103	111	11	225
		%	100.0%	100.0%	100.0%	100.0%

Table 4.E.2 Weight Status and Dietary Diversity Score

F) Association between sociodemographic factors and Dietary Diversity- Chi-Square Test was carried out to test the association between Dietary Diversity between socio-demographic factors and wight status.

1) Dietary Diversity and Gender/Sex- From the table, we can observe that P-Value is greater than 0.05. Hence, we can conclude that there is no significant association between dietary diversity and gender.

	Chi-Square	**DF**	**P-Value**
Pearson	0.168	2	0.920
Likelihood Ratio	0.173	2	0.917

2**) Dietary Diversity and Age-** From the table, we can observe that P-value is greater than 0.05. So, the study showed no statistically significant association between dietary diversity and age.

	Chi-Square	**DF**	**P-Value**
Pearson	0.403	2	0.818
Likelihood Ratio	0.404	2	0.817

3) Dietary Diversity and Standards – The P-value observed was greater than 0.05 concluding there was no association between the variables.

	Chi-Square	**DF**	**P-Value**
Pearson	2.613	6	0.856
Likelihood Ratio	2.864	6	0.826

4) Dietary Diversity and Occupation of Mother- The P-value observed in this study was greater than 0.05. Therefore, we can conclude that there is no statistically significant association between dietary diversity and the occupation of the mother.

	Chi-Square	**DF**	**P-Value**
Pearson	1.979	2	0.372
Likelihood Ratio	1.974	2	0.373

5) Dietary Diversity and Occupation of Father- In this study, no statistically significant association was observed between the dietary diversity and occupation of the father because P-value was greater than 0.05 as shown in the table

	Chi-Square	**DF**	**P-Value**
Pearson	0.717	2	0.699
Likelihood Ratio	0.827	2	0.661

6) Dietary Diversity and Household size- The study showed a statistically significant association between dietary diversity and household size. The P-value reported was less than 0.05.

	Chi-Square	**DF**	**P-Value**
Pearson	7.578	2	0.023
Likelihood Ratio	7.606	2	0.022

G) Association between Dietary Diversity and BMI – Chi-Square Test is carried out to test the association between Dietary Diversity and BMI. From the table, we can observe that P-Value is less than 0.05. Hence, we can conclude that there is a significant association between dietary diversity and BMI.

Chi-Square Test			
	Value	df	P-Value
Pearson Chi-Square	10.239	4	0.037

H) Comparison of anthropometric value and IDDS of Adolescents by Sex-

The comparison was illustrated in Table 4.H

	All (n=225)	Girls (n=74)	Boys (n=151)	P-Value
Weight	45.11±11.92	42.78±8.58	46.25±13.13	0.040
Height	154.51±9.34	149.78±6.29	156.82±9.72	0.001
BMI	14.51±3.34	14.25±2.62	14.63±3.64	0.415
IDDS	3.68±1.06	3.67 ±1.00	3.68±1.09	0.931

Table 4.H

An Independent sample t-test was carried out for comparison. The P-Value for weight and height is less than 0.05. Hence, it can be concluded that there is a significant difference in weight and height for girls and boys whereas there is no significant difference observed in BMI and IDDS for girls and boys. Mean values of height and weight were significantly different in boys and girls.

Discussion

The current study was carried out to assess the dietary diversity and nutritional status among secondary school-age adolescents in Urban Pune, with the help of the FAO IDDS tool, which comprises 9 food groups and a 24-hour recall period. Several researchers have documented the importance of a diversified diet in a healthy and balanced diet and the consequences of an undiversified diet. The dietary diversity score reflects the dietary quality and nutrient adequacy of the children.

Though the study excluded the participants who had atypical consumption of food on the previous day from the data analysis, it was a matter of fact that most (12%) of the female participants had fast on the previous day due to which female participants ate atypical foods. This finding reflects that how the cultural practices are imposed on girls. Adolescent girls are particularly vulnerable to malnutrition as it is the faster growing period when there is an increased demand and needs of micro as well as macro nutrients to support the growth spurt. The IDDS was classified as Low, Medium, and High. According to the current study results, approximately half and an equal proportion of secondary school-going adolescents from Urban Pune had Medium (49.33%) and Low (45.47%) DDS with only a few proportions (4.89%) having high dietary diversity with mean IDDS(3.68±1.06). The present study showed no difference in the mean IDDS of boys (3.68±1.09) and Girls (3.67 ±1.00). In this study, no statistically significant association was found between DDS and the sex of adolescents. It implies that there is no difference in the intra-household allocation of food and food preferences between girls and boys. The study conducted in Northeast Ethiopia by Endalifer et al., 2021observed that the overall mean dietary diversity score was 4.73 (SD ± 1. 186) by applying the food group scores ranging from 2 to 10 food groups. The findings that have been reported by Isabirye et al., (2020), a study done in a developing country like Uganda and the study conducted by Nithya & Bhavani,(2018) by using the three measurements of dietary diversity score in 2 different regions of Rural India showed lower dietary diversity among adolescents. The present study reported Medium DDS which was conducted in an urban area where children may have better access to a variety of foods than their peers from the rural area. Living in an urban area also means better household income and a higher proportion of household income expenditure allocated to food. In India, variation in the seasonal availability of various foods may also be the reason.

The mean IDDS reported in our study is significantly lower (3.68±1.06) than the study conducted on Chinese children from Urban area. Zhao et al. (2017) and Jiang et al. (2018) conducted their studies among children mostly from urban areas of China reported mean IDDS 6.8 and 7.12 respectively by using 24 hr. recall period based on 9 food groups. The prevalence of Low and Medium DDS is an implication of nutritional status and indicate poor dietary quality of study participants even though it is accessible and available to the individual. It also reflects the food choices and preferences over a healthy and balanced diet of the individual. Lack of awareness about importance of diversified diet and its consumption in the diet is major issue in developing countries. It is essential to emphasize on the dietary diversity and importance of variety of foods and food groups to ensure nutrient adequacy in developing countries. (Ruel, 2002)

Comparisons between studies are difficult and the variation might occur since there is currently no universal consensus on the way to assess dietary diversity, including the number of food groups included in the score, the minimal quantity of food that must be consumed, and the reference period difference to calculate the DDS and study settings. The diverse study samples and variations in the measurement of DDS may be the cause of variations in the DDS results between studies. Researchers used different methods to measure the dietary diversity. A 24-hour dietary recall method is recommended by FAO 2013 while Hooshmand and Udipi (2013) used food frequency to measure dietary diversity. A longer recall might be preferrable as the 24-hour recall period does not always precisely reflect the dietary pattern of individual. However, a longer recall period might potentially result in greater recall bias.

Further, the current study reported that a significant proportion of adolescents (100%) consume food items from starchy-based staples with very less consuming animal source food. Aurino et al., 2017 shed light on features of adolescents' diets in developing countries. In their study, the researchers' reported that rural and urban Indian adolescents' tend to eat plant-based diet and a little intake of animal based food and diets are similarly diverse in rural and urban India. In the present study a less proportion of adolescents having animal source foods may be due to the cultural and social customs and constraints. The current study reported pre dominance of monotonous diet with starchy based staples in the diet. It has been reported by various studies in developing countries conducted by Isabirye et al.,(2020) and Jikamo & Samuel, (2019) Mukherjee & Chaturvedi, (2017), Endalifer et al., (2021) that diets in these countries are predominantly based on starchy staples. Our study confirms the findings of other studies showing the prevalence of monotonous diets.

In addition to the aforementioned food groups, the majority of the participants consumed the legumes, nuts, and oilseeds (74.67%) were in the form of dal preparations, which are boiled and spiced legumes, as well as chatni, which are typically eaten as a side dish with Indian meal .Just about ¾th the of the participants reported eating vegetables and fruits (74.5%). Dark green leafy vegetables and other vit A fruits and vegetables eaten by ¼th of the participants (29.33%). Similarly, just 34.56% of adolescents consumed milk and milk products inadequately, despite they are being a very significant source of calcium and nutrients for vegetarians. These results denote that adolescents did not consume important dietary components and some foods are grossly inadequate in their diets leading to nutritional inadequacies. Furthermore, the study findings showed that majority of the participants (98%) having beverage consumption in the form of Tea and more than ¾th (77.75%) of the participants consumed bakery products either Khari/biscuits or toasts/ chips as a part of evening snack. It has been observed that these products are cheap and packed in attractive and small packets increasing availability and affordability This is the area of concerned. Adolescents are starting point – what I like, my choice, my mood, my wish. The findings could be attributable partly to poor awareness among participants, partly to attraction towards junk foods, influenced by social media, advertisements, and marketing of foods. To note the dietary practices of adolescents it was observed in our study that more than 90% of the participants skipped breakfast and just a very few (7%) of the adolescents ate breakfast daily. Breakfast is the most important meal of the day and provides energy and stamina for study and play at school.

Regular breakfast consumption is essential to keep healthier weight. Another finding regarding dietary intake was, more than half of the participants (60%) eat from restaurants more than once in a week. Eating outside from the restaurants are increasing day by day and traditional home cooked meal is in danger of becoming a thing in the past. It is associated with poor intake of micro nutrients and overall higher total calorie and fat intake. It is a big threat to public health and alarming signal to the developing country like India where health burden of NCDs is raising.

In the current study, no statistically significant association was found between dietary diversity and age, sex, standard of the participants. Furthermore, the study noted no significant association between dietary diversity and occupation of mother and occupation of father. The research study done by Gokhale, D., & Rao, S. (2022). showed similar findings regarding the association between the dietary diversity and socio-economic and socio-demographic factors among rural pregnant women from Pune. The present study showed significant association between household size and dietary diversity score of the participants. A contrast finding from the study done by Isabirye et al., (2020) which reported association between the socio demographic factors and dietary diversity among the school going children.

The present study reported the anthropometric indices status of the adolescents of age 12-16 years. The mean height of participants examined in this study was 154.51±9.34. The findings correlate with research by Patil S et al. (2015) and Das S (2017), in which the authors discussed the mean height of adolescents in various regions of India at various age groups.. According to the findings of our study, there was a significant difference between the mean heights of boys (156.829.72) and girls (149.786.29). The significant difference between mean height of boys and girls might be due to different maturation period of girls and boys as girls reached maturation earlier than boys. As reported in the study done by Pathania & Biswas, (2021) the mean reported heights available in different studies varied from 153.6 cm for urban adolescent boys of south Gujarat and 161.2 cm for urban children of Nagaland and Himachali boys were taller (167.2 to 168.9 cm) as compared to these populations.

Like the height, the mean weight reported in the present study was 45.11±11.92. There is significant difference found in the mean weight for girls (42.78±8.58) and boys (46.25±13.13) . Two reports, which were mentioned in the study by Pathania & Biswas in 2021, revealed a mean weight of 36.2 kg for urban adolescents in South Gujarat; this estimate was significantly lower than the mean weight found in the results of the present study. In the second Longkumar T. (2013) study, the Naga children's mean weight was 48.7 kg. The study done in Karad Maharashtra by Patil S et al (2015) and in other study done by Das S (2017) the mean weight was found 52.24 kg and 54.44 kg respectively which is significantly higher than the average weight reported in present study. The Himachali boys mean weight found 52.4 kg.in a study done by Pathania & Biswas, (2021). The variations in the results of different studies might be due to the regional environmental variation, genetic and social factors. The difference in the mean weight of boys and girls might be due to socio -cultural differences where parents give extra care to boys than girls.

The current study results showed a higher prevalence (80%) underweight participants and a relatively low prevalence (2.22%) of overweight participants. The findings of the current study indicate that there may be severe malnutrition among study participants due to inadequate nutrient intake and a lack of wholesome, energy-dense foods. It is therefore imperative to improve the diversity of foods consumed by children, in order to reduce various forms of malnutrition. The magnitude of underweight (thinness) was much higher than other studies conducted in Urban Bengali adolescents (20.8%). The reason for the difference in the prevalence may attribute from the difference in study setting in socio-demo- graphic, cultural and economic characteristics. In the current study, the mean BMI was found to be 14.51 3.34, and there was no significant difference between the mean BMI of boys and girls. In contrast to the results of the current study, Nithya & Bhavani's (2018) research found that gender and BMI were positively correlated in Wardha but not in Koratpur. Positive associations between DDS and BMI were found in the study conducted on Iranian children by Golpour-Hamedani et al. (2020). Since there may be regional variations and children may be mistakenly classified as underweight or overweight, local references may be useful when reporting the results. (Patil S et el ,2015.)

The contrast and inconsistent in key findings may have different reasons. Firstly, different tools were used to assess the dietary diversity status (DSS method). Second, the statistical evaluation of this did not account for calorie consumption. Also, the major finding may alter depending on the number of food groups were categorized in each study. The serving cut offs may be different.

While considering the results, it is essential to take the limitations of the study into account. As the data was collected from the secondary school going adolescents of 12-16 years of ages so it is representative of the secondary school going children and not for all school going children. The sample population is limited to one region /area, making it difficult to generalise to other region considering the fact that India has diversified socio economic and cultural settings. The multiple determinants of dietary diversity have not been included in the present study. Due to the time and financial constraints, we did not estimate the serving size / quantity of the food consumption which needs to be further explored. The study was done on small sample size. Our study identified dietary quality by quantifying the dietary diversity score. The study may not reflect the regular dietary pattern and habits of the adolescents. This study was used cross-sectional study design which unable to determine causality that means temporal sequence between adolescents' dietary diversity and nutritional outcome and its related / associated factors cannot be established. This study may have been underpowered to detect small or modest differences in nutritional outcomes. The data was collected through a 24-h dietary recall method which may be prone to recall bias while reporting the food eaten on previous day. Despite these limitations, this study adds valuable information and provides evidence on the dietary diversity and nutritional status of urban adolescent children from Pune region, for which data is lacking. In order to ensure consistency and accuracy throughout the entire data collecting process, the researcher employed the FGDs to dictate and explain the questions to the participants as well as aiding the picture depictions to support the participants in reporting the food items.

Conclusion

The study demonstrated that half and an equal number of adolescents had Medium and Low dietary diversity. In this region, consumption of common starchy staples was prevalent. The consumption of animal and plant protein sources (eggs, fruits, fish, and other seafood) and vegetables were not consumed in sufficient quantities, which could impact growth and development. The diets are becoming less diverse, despite the fact that there is a vast variety of foods available to us. Dietary diversification through increased consumption of a variety of all food groups is an effective strategy for this. Underutilized crops comprise the multitude of species that are currently largely neglected which include cereals, millets, legumes, fruits, vegetables, flowers, roots, seeds, and nuts. Malnutrition especially undernutrition is still a major public health issue in the locality. Adolescents must consume diverse diets in order to get the nutritional advantages related to them. Locally produced food is a feasible and affordable option that enhances dietary output without altering dietary practices in the community. By consuming traditional foods and utilizing locally accessible options, diversity is possible. With little to no additional expense, even modest dietary modifications can increase nutrient consumption.

The NITI Aayog's National Nutrition Strategy (2017) acknowledges the importance of a diverse diet in addressing malnutrition. To enhance diet diversity, which depends on the availability, acceptability, and affordability of food items other than rice and wheat, very few policies, if any, pay focus on these fundamental aspects.

PDS, MDM, and Minimum Support Price constitute an important set of programs aimed at improving the country's nutritional status. Wheat and paddies alone won't be enough to defeat malnourishment

The nutritional status of adolescents is influenced by several interrelated factors in addition to their diversified diets. There is still a need for nutrition interventions and programs that will help in improving and sustaining dietary diversity in adolescents. While designing the intervention program Consideration must be given to crucial factors like health, sanitation, and household infrastructure. To enhance local food diversity, the policy must incorporate strategies that focus on nutrition-sensitive agriculture methods as well as population-based nutritional education to caregivers, parents, school staff, and adolescents themselves that emphasizes the need for diversified diets, to achieve the outcomes. (Bukania et al., 2014).

There are a few recommendations for future researchers in this field of study. The first recommendation is to have a large sample size to represent the population of Pune City. This will help to improve the reliability, precision, and accuracy of the results of the study. The next recommendation is to include the portion size and assessment of macro and micronutrients in the diets. More studies are recommended to address the association between dietary diversity and nutritional status of adolescents and other factors associated with lower dietary diversity and undernutrition among adolescents to increase the data and get insights for future research.

Despite the importance of dietary diversity as an indicator of nutrient adequacy, increasing the variety of foods in children's diets requires careful consideration in terms of energy intake, and dietary diversity should be improved in selective food items. Also, more well-designed prospective studies are needed to clarify the effect of dietary diversity on nutritional status. It is recommended to scale up the data on Dietary diversity at individual level to improve the health outcomes.

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Appendix A: Letter to Principal for Permission to Conduct Study

Dr. Vishwanath Karad
MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

Date: 13th February 2023 To,

_____

_____

Subject: Regarding data collection for the academic study titled, 'The association of diet diversity on nutritional status among the school going children'

Greetings and Peace from MIT World Peace University!!

MIT World Peace University is on a mission to promote the 'Culture of Peace' through the Value-based 'Universal Education System'. We at MITWPU firmly believed that 'union of science and spirituality alone will bring peace to mankind'. MIT World Peace University is being recognised as an excellence in education and creating professionals to serve the society at large.

This is in connection with academic structure, Ms. Seema Satbhai is conducting a research on, 'The association of diet diversity on nutritional status among the school going children' as a fulfilment of MPH programme. For this purpose, she will be conducting interviews with 7th to 10th standard students from the age group of 10 to 15 years. She will also record weight and height of students.

The collected information will be kept confidential and data will not be shared with anyone. This is a kind request you to permit Ms. Seema for interacting and conducting interviews with the students.

She will contact you for the same. This is to assure you that school's time table and students' schedule will not be disturbed for this purpose.

Looking forward for your kind cooperation.

With Best,

Dr. Sucheta Deshpande Dissertation Mentor,

School of Public Health,

MIT World Peace University, Kothrud, Pune

Appendix B: Application Form

To,

Principal Madam,

Date-

Sub- Permission to conduct a study in your school

Respected Madam,

Myself Dr Seema Satbhai. I have done BAMS and now pursuing MPH at MIT- WPU, Pune.

I am conducting research on diet diversity and nutrition status among school-going children.

The purpose of the study is to assess diet diversity and nutrition status among children.

The research will entail collecting data from students of 7^{th} to 10^{th} standards both boys and girls. The data will be collected on anthropometric measurements (height, weight); data on diet will be collected from a questionnaire. No invasive tests will be done. I request permission to study the children from your school. Their responses will be treated confidentially, and their identities will be anonymous. Individual privacy will be maintained in all published and written data resulting from the study. The results will be communicated in the Dissertation. There are no foreseeable risks in participating in this study. I, hereby attaching the letter from the University where I pursuing the MPH.

I, therefore, request permission in writing to conduct my research at your organization.

The permission letter should be on your organization's headed paper, signed and dated, and specifically referring to me by name and the title of my study. Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Dr Seema Satbhai

Contact Number-9270144440

Email- seema.satbhai24@gmail.com

Supervisor- Dr. Sucheta Deshpande

Appendix C: Principal's Consent Form

School Name-

School Number

Date -

I _____ have been fully informed about the purpose of the study titled: "An observational cross-sectional study to assess the dietary diversity and nutritional status among secondary -school-going adolescents in Pune City"

I understand that Dr. Seema Satbhai will take anthropometric measurements of the children from 7^{th} to 10^{th} std. in the school. Also, she will interview the students. She has given me a copy of the questionnaire. I hereby give my consent for Dr Seema to conduct the study in this school provided that the children freely participate in the study and that permission is given by the parents.

Signature of the Principal:

Name of the investigator:

Signature:

Place:

Date:

Appendix D: Questionnaire

A) Personal Details -वैयत्तिक माहिती

1) Write your full name- तुमचे पूर्ण नाव लिहा

2) Sex/ लिंग - a) Male b) Female

3) How old are you - तुमचे वय काय-

4) Write your Birthdate- तुमची जन्मतारिख काय

5) School Name-तुमच्या शाळेचे नाव

6) Which Standard you are now? आता तुम्ही कोणत्या इय्यतेत शिकत आहात

7) How many members live in your family? तुमच्या कुटुंबात किती सदस्य राहतात

8) How many of them stays with you? त्यातले कितीजण तुमच्या सोबत राहतात

9) Family Information –

Sr. No.	Age	Gender	Education	Occupation	Relationship with Respondent

B) Dietary Intake

1) Do you eat breakfast? तुम्ही नाश्ता करता का?

a) Yes, daily (हो रोज) b) sometimes(कधीतरी) d) Never (कधीच नाही)

2) How many meals and snacks do you have every day? तुम्ही दिवसातून किती वेळा खातात किंवा जेवण घेतात?

a) 1or 2 (1 किंवा 2) b) 3 or 4 (3 किंवा 4) c) 5 or more than 5 (5 किंवा जास्त)

3) How often do you eat from restaurant? तुम्ही हॉटेल मधील अन्न पदार्थ किती वेळा खाता

a) Never (कधीच नाही) b) At least once a week (कमीत कमी आठवड्यातून एकदा) c) more than once a week आठवड्यातून एकापेक्षा जास्त वेळा

4) 24 hr. Dietary Recall - List every meal and beverage you consumed yesterday, starting from the time you woke up in the morning and ending at the time you went to bed at night.

मागच्या २४ तासांमध्ये काळ सकाळी उठल्यापासून झोपेपर्यंत तुम्ही काय काय खाल्ले आणि प्याले आणि किती वेळा खाल्ले हे नीट आठवून सांगा

आपण उठल्यापासून सुरुवात करूयात -सकाळी उठल्या उठल्या काय खाल्ले /प्याले ? मग काय खाल्ले /प्याले ? मग काय .....

5) Was yesterday a celebration/ feast day where you ate special foods or where you ate more or less usual----

काल एखादा सण किंवा उत्सव/मेजवानी दिवस- उदाहरणार्थ बर्थडे/ वाढदिवस होता जिथे तुम्ही नेहमी पेक्षा किंवा काल पेक्षा कमी किंवा जास्त प्रमाणात खाल्ले

C) Anthropometric Indices

1) Height

2) Weight

3) BMI