Research Journal of Family, Community and Consumer Sciences _____ISSN 2320 – 902X
Vol. **14(1),** 36-41, January **(2026)** *Res. J. Family, Community and Consumer Sci.*

Relation between Nutrient intake, Dietary diversity and Physical activity in Indian adults

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Available online at: www.isca.in
Received 10th December 2025, revised 31st December 2025, accepted 25th January 2026

Abstract

Early screening of NCDs and nutritional deficiency disorders among the general healthy population is essential to reduce morbidity and mortality. Most of the recent nutritional assessment studies focus on certain disease conditions or age groups, and the apparently healthy adult group is not considered. The present study was undertaken to assess the nutritional status in adults of Raipur city and to identify the association of nutritional intake with various health-related factors in adults aged 16 to 45 years. The study adopted an exploratory, cross-sectional design employing a convenience sampling technique in selecting 65 willing, healthy adults aged between 16 and 45 years from urban and rural areas of Raipur District. The excluded subjects included those below 16 or above 45 years of age, or those with disabilities or physiological conditions such as pregnancy. Data was collected using a self-prepared semi-quantitative food frequency questionnaire containing 40 questions. Scoring was calculated across five sections including Dietary diversity and Nutrient Intake. The SPSS version 27 was used for data analysis. Intake of calories (60%), carbohydrates (47%), and fat (48%) was lower than the Recommended Dietary Allowance, while the protein intake was higher (104%). Macronutrient contribution to total calories did not fully correspond to EAT-Lancet recommendations, with higher carbohydrate intake (63.06%) and lower fat (17.56%). The dietary diversity score averaged 6.83 out of 10, and the physical activity score was 0.70 out of 5. The overweight/obese group had the highest intake of unhealthy foods. With an increased BMI, the score for dietary diversity and good cooking practices decreased. The present study will contribute valuable inputs on how dietary diversity, physical activity, nutrient intake, and lifestyle practices influence the BMI and nutritional status of adults in Raipur. Results indicate that the overweight population consumes fewer essential nutrients and has higher daily consumption of unhealthy/packaged foods compared to their underweight counterparts, reflecting the impact of poor dietary choices. Further investigation is needed to study the impact of additional factors such as genetic predisposition and psychosocial conditions on nutritional health.

Keywords: Nutritional Assessment, Physical Activity, Nutrient intake, Dietary diversity.

Introduction

Nutrition status, from Indian perspective, seems to be in a dire need of critical consideration and policy reformation, by the government and health organizations, as well as concern and action by the population itself. While a majority of the Indian population is facing the triple burden of malnutrition[1], i.e., undernutrition, hidden hunger, as well as obesity, food wastage also exists at an alarming extent[2]. While the proportion of underweight women between 15 to 49 years of age declined from 23% in 2015-16 to 19% in 2019-21, showing a reduction in the underweight population, there was also an increase in the existence of obesity in women from 21% to 24% at the same time period. Similar changes were also observed among men[3].

NCD and Nutrition deficiencies in India- 65% of all deaths in India are due to Non-Communicable diseases (NCDs). These include obesity, hypertension, raised blood glucose levels, and raised total cholesterol levels in the blood. The recent NFHS-% data shows that 57% of women and 25% of Indian men are anemic. 5.5% of Indian men between 15 to 49 have diabetes, 2.4% have some heart diseases. 5.1% of Indian women between 15 to 49 have diabetes, 2.0% have some heart diseases. 21% women and 24% men above 15 have hypertension[3].

An overall dietary assessment includes food-related activities at various levels - at the national level it includes food supply and production; at the household level, it includes food purchases; and at the individual level, it is about food consumption. This study focused on individual-level food intake[4].

There exist a number of nutrition assessment and metricising tools. These are country-specific or of a Global level, however, there is still a lack of an individual-level dietary assessment tool specific for Indian adults. Also, scores for disease conditions and physiological conditions are available, however, in search for prevention and cure of various other health conditions[5], the general healthy population are often been neglected in the recent

years. Most NCD and nutritional deficiency disorders can be reduced by early and proper screening and thus reduce morbidity and mortality, even from the seemingly healthy populations. In an attempt to address this gap, this study aimed to assess the nutritional status of the individuals living in Raipur aged between 16 to 45 years of age; and to compare the various factors[6] associated with nutritional status of an individual, with their nutritional intake.

The available nutrition assessment tools use various other tools to assess nutrition intake of the people. These may be a 24-hr dietary recall, questionnaire, interview schedule, Food diary, etc. While it is true that every such nutrient/nutrition assessment tools and methodologies have their own advantages and limitations. Some are burdensome for the participants while the majority rely on the participant's memory and honesty[7,8]. Food Frequency Qusetionnaire has come up as a popular and effective means of measuring nutrient intake, without being burdensome to the subject, or requiring specific gadgets like a camera. This study opted to use a self-prepared semi-quantitative food frequency questionnaire to assess nutrient intake.

A detailed study of review of past literatures highlighted the lack of assessment of seemingly healthy adult population for their nutrition status. Inclusion of other factors that impact the nutrition status among them was absent. This gave rise to the importance of conducting of such nutrition assessment to be done. As per the Dietary Guidelines for Indians[6], published by ICMR-National Institute of Nutrition (2024), Other previously conducted researches, relate the impact of sleep pattern, physical activity, junk-food consumption, etc. to general health and nutrition[6].

Inclusion of various other factors that have impact on nutrition status of people, is done keeping in mind the various researches previously done. Dietary diversity has been long associated with diet quality[9].A number of researches link alcohol to interfere with absorption of various macro and micro-nutrients such as glucose, glutamine, vitamin B2, vitamin C, vitamin B1, vitamin B9, iron, zinc and selenium, etc.[10]. Disturbance of digital media such as television and time spent on watching televisions has also been linked to dietary intake, as well as obesity, higher consumption of unhealthy foods, and also to impact vitamins and mineral intake[11]. Sleep times and patterns also influence nutrition and health, multiple researchers have found associations between the two. Meal timings and chronotype are associated with lower BMI[12]. Consumption of alcohol and smoking has also been linked to reduction in absorption of many micro-nutrients such as Vitamin C and beta-carotene, while cadmium present in tobacco decreases the bioavailability of minerals like selenium[13]. Importance of breakfast has also been studied extensively, and its omission has been linked to increased risk of diseases like obesity, diabetes, etc.[14]. Following these and many such similar researches certain factors, that have been found to impact nutrition status, were included to asses overall nutrition status to better precision.

Materials and Methods

Research Design: The research was of an exploratory type where the researchers were aiming to metricise the general dietary pattern and other practices that affect the health of people, and formulating metrics that could help quantify the nutrition score of people. For this purpose, the researchers chose a cross-sectional research design where they had the samples fill out the interview schedule. This research design was selected because the researchers attempted to study a given set of variables (namely- nutrient intake, dietary diversity, extent of physical activity, environmental factors, cooking and eating practices) among the spread population at the given time period.

Selection of Area: The samples were collected by convenient sampling method from western and central areas of Raipur District.

Sample Size and Sample Selection: The study was a pilot study designed to investigate the dietary pattern and formulating metrics for nutritional status of young-adult and adult population in the Raipur district of Chhattisgarh state of India. People of both urban and rural areas in Raipur were targeted. A total of 65 willing healthy adults between 16 to 45 years of age were selected for the present pilot study and provided sociodemographic, diet and other lifestyle information via interview schedules. The sample selection included both genders and people from both urban and rural areas. Sample selection was done by convenient sampling method. They were assured that the data they provided would be kept confidential and would not be provided to others.

Inclusion criteria: i. Age: Only people between 16 to 45 years of age were included as a sample. ii. Health issue: Only those people without any health issues. iii. Location: The area of sample selection was Raipur tehsil. Both urban and rural areas were included.

Exclusion criteria: i. Age: People below 16 and above 45 yrs of age were not included in this study. ii. Physiological conditions: Pregnant and lactating females were not included in the study. iii. Health issue: Anyone with disabilities or health issues were not included as a sample. iv. Location: People from outside Raipur tehsil were not included in the study.

Tools for Data Collection and Analysis: A self-structured questionnaire was used. After a thorough study of various questionnaires already in use for different dietary purposes like cooking and eating practices, a 62-questions questionnaire was prepared. 4 amendments were made after 5-5 samples consecutively. These amendments included scrutiny, rephrasing and reduction of questions in the questionnaire. The final questionnaire had 40 questions apart from the demographic profiles of individuals. The questionnaire was divided into the following sections - Demographic information, Anthropometric data, Physical activity, Eating and hygiene practices,

Consumption of junk foods and other lifestyle malpractices, 24-hr diet recall, and Food frequency and serving. The data was collected using Google form on mobile (as PDA) and analysis was done on Google Sheet.

Demographic profile -Questions related to general demography were asked in this section, which included name, age, gender, address, locality, number of family members, education, occupation, monthly family income, and disease status.

Anthropometric data - Anthropometric measurements like weight in kilograms, and height in centimeters, were included in this section. Heights were measured using a centimetre tape, and the weight was weighed on an electronic weighing machine. Further, the above information was used to calculate BMI.

Physical activity - Physical activity was graded as per their frequency and type.

Eating and Cooking practices - General cooking and eating practices with some questions on hygiene were included. The subjects were asked to score themselves on the basis of their understanding and practices during cooking and eating.

Junk food consumption and other lifestyle-related mispractices - The subjects were asked about their consumption and frequency of alcohol, cigarettes, and tobacco. Questions about the consumption of sugar and the consumption and frequency of packaged foods, convenience foods and dining out were also asked.

Food frequency questionnaire - A semi-quantitative food frequency questionnaire was prepared which included 8 range in 14 food groups which were subdivided into 19 food items. 4 classes of serving sizes were added to these food groups. This data was also used to assess the subject's dietary diversity.

Data Analysis and Interpretation: The scoring was done under 5 sections - Dietary diversity, Physical activity, Eating and Cooking Practices, Nutrient Intake, and Consumption of junk foods and other lifestyle mispractices. All scores were ranged between 1 to 5. Descriptive statistics by age groups, including means, medians, and 10th and 90th percentiles, standard deviations were generated. The data was analyzed on Google sheets and SPSS version 27. Frequency, mean, and standard deviation were calculated for each major section of questions. The scores were divided into low-score and high-score according to the relation of value from the value of mean score. The scores were calculated out of 5. A subject was considered part of the high group if the score was above the mean of all scores, and in the low group if the score was below the mean. For nutrient intake Carbohydrate, proteins, fat, Vitamin A and folates were calculated.

Results and Discussion

Demographic inference: Table-1 shows the demographic characteristics of the subjects comprising the high and low nutrition score groups. The population with a score less than the mean in all scores is labelled as low group, while the population with a score more than the mean of all scores is labelled as a high group. The low group comprised about 44.62% females and 7.69% males, while the high group comprised 46.15% females and 1.54% males, indicating no significant difference in the gender distribution between women but a drastic difference in men. In the low group, 20% were aged 16-25 yrs; and 32.31% 26-45 yrs of age. In the high group, 47.69% were between 16-25 yrs of age, and none in 26-45yrs of age. Figure-1 represents the distribution of population through the income groups.

Table-1: Demographic distribution of Subject Sample.

General Characteristics			
Items	Low group (52.3%)	High group (47.7%)	Total
Sex			
Male	7.69%	1.54%	9.23%
Female	44.62%	46.15%	90.77%
Age (yrs)			
16-25	20.00%	47.69%	67.69%
26-45	32.31%	0.00%	32.31%
Education			
High school	6.15%	0.00%	6.15%
Senior Secondary School	4.62%	12.31%	16.92%
College	29.23%	35.38%	64.62%
Professional	10.77%	0.00%	10.77%
Income			
Items	Low group (48.89%)	High group (51.11%)	Total
Less than □12,000	9.23%	10.77%	20.00%
□12,001 - □25,000	7.69%	15.38%	23.08%
□25,001 - □50,000	6.15%	7.69%	13.85%
□50,001 - □70-000	10.77%	9.23%	20.00%
□ 70,001 - □1 Lakh	6.15%	1.54%	7.69%
□1 Lakh - □2 Lakh	3.08%	3.08%	6.15%
More than □ 2 Lakh	9.23%	0.00%	9.23%

Questionnaire items analysis: Minimum, maximum and average of scores are presented in Table-2.

Exercise: 42% are not involved in any sort of intentional physical exercise, while 52% are not exercising daily, i.e. only 6% of the sample exercises daily.

Consumption of unhealthy foods: From the series of questions concerning the consumption of junk food, while 52% of the subject sample never ordered food from online platforms (like Swigy/Zomato); about 88% consume unhealthy/packaged foods, and 14% of the sample subject consumes unhealthy/packaged food on daily basis.

Water intake: About 37% of the sample subjects drink less than 8 glass of water per day, while 46% of them drink more than 14 glasses of water per day.

Dietary Diversity: Majority of population shows a good dietary diversity score, with an average dietary diversity score of the population as 6.83 (Figure-1).

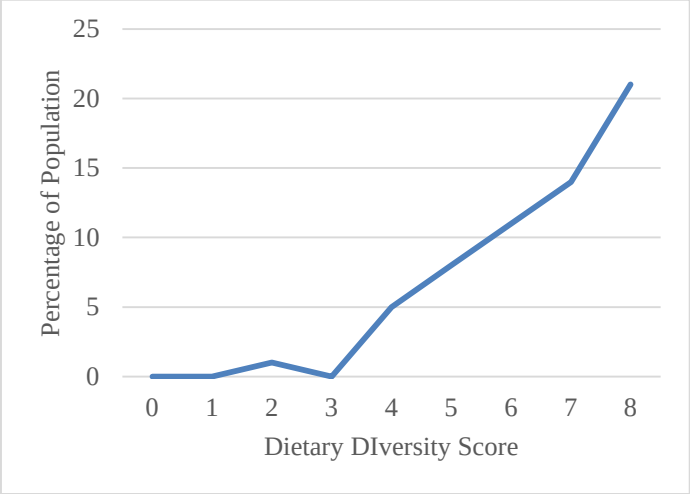

Figure-1: Dietary diversity score distribution across the population.

Correlation between various factors: On studying the impact of these factors on BMI of individuals, we gained a model =2.259+(X1*0.099)+ X2*0.019)+(X3*-0.313) +(X4*0.164) + (X5*0.001) +(X6*0.246) – unstandardised; = (X1*0.137)+ (X2*0.013)+(X3*0.229)+(X4*0.092)+(X5*0.001)+ (X6*0.295) - standardised. The score of individuals, when calculated according to this model, resulted in an average score of the sample subject as 3.9, and 1.69 respectively. However, the statistics also showed that these factors can only predict about 1% of the BMI. The model, however, confirms the general assumptions and predetermined facts that good nutrition intake, dietary diversity, good cooking and heating practices, less consumption of unhealthy foods, and good lifestyle practices positively impact BMI; and good, regular physical exercises is inversely proportional to BMI.

Table-2: Minimum, maximum and average scores of all the factors measured.

Variable	Minimum Score	Maximum Score	Average
Dietary diversity (X1)	2	10	6.83
Nutrition Intake (X2)	1	5	3.2
Physical Activity (X3)	0	5	0.7
Cooking and Eating Practices (X4)	1	5	3.95
Lifestyle practices (X5)	2.6	5	4.16
Consumption of unhealthy food (X6)	0	5	1.7

Nutrient intake inference: On an average, the subject sample intakes about 60% of the calories, 47% of the fat, 48% of the carbohydrates and 104% of the protein recommended by the RDA 2020. The intake of folate and Vitamin A is more than that recommended by the RDA (Figure-2).

Frequency of fat intake is more at the lower end of the intake, i.e. more people consume less amounts of fat as compared to what is recommended by RDA, while more people consume vitamin A more than that recommended by RDA.

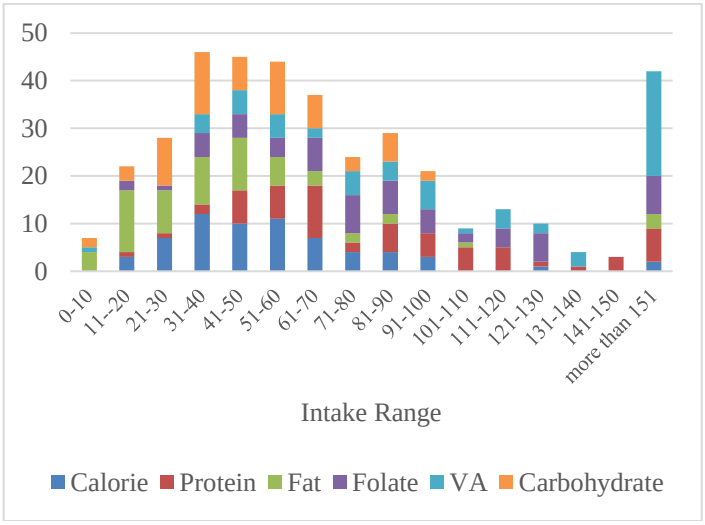

Figure-2: Distribution of nutrients as per their intake.

Contribution of various macronutrients to energy: The data collected reports the intake of macronutrients as shown in Table-3. This data indicates that the contribution of protein to total calories in the diets of people of Raipur is compatible to what is recommended by the Eat-Lancet Commission, however, this is not the case with carbohydrates and fat, where carbohydrates contribute about 63% to total energy, and contribution of fat to total calorie intake is much less than what is recommended[15].

Table-3: Contribution of macronutrients to total calorie intake and its comparison between the Underweight, normal and overweight/obese population (*in % of RDA).

Nutrient	EAT-Lancet recommendation	Intake by the subject population	Underweight population (BMI <18.5)	Normal population (BMI 18.5-22.9)	Overweight/Obese population (BMI >30)
Carbohydrate	50-55%	63.06%	50.06%	47.41%	47.73%
Protein	15-25%	19.39%	142.59%	98.76%	80.35%
Fat	29-30%	17.56%	67.17%	41.55%	38.48%
Calorie	-	-	68.19%*	53.78%	50.77%

Table-4: Distribution of Scores of all the measured factors as per BMI.

	Mean Dietary diversity score	Mean Cooking and eating practices	Mean Lifestyle Practices	Mean Nutrient intake	Mean Physical activity score	Mean Consumption of Unhealthy food
Underweight (BMI <18.5)	7.19±1.72	4.19±0.53	4.04±0.70	3.19±0.91	0.45±0.53	2.03±1.14
Normal (BMI 18.5-22.9)	6.81±1.57	3.91±0.71	4.12±0.66	3.26±0.76	0.63±0.75	2.15±1.52
Overweight/Obese (BMI >23)	6.59±1.76	3.81±0.71	4.29±0.49	3.14±0.00	0.95±1.16	0.91±1.25

With respect to BMI, as the BMI increases, the contribution of carbohydrates to total calorie intake increases as shown in Figures-3a–3c. This may be linked to an increase in junk food consumption among the overweight/obese sample subjects as shown in Table 5, which shows that consumption of unhealthy foods is maximum among those who are overweight/obese.

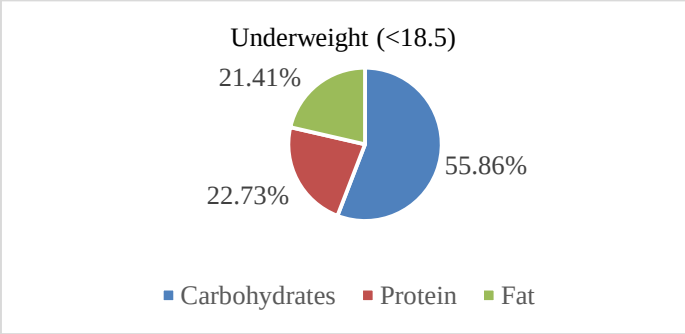

Figure-3a: Contribution of Nutrients in total Caloric intake of Underweight sample.

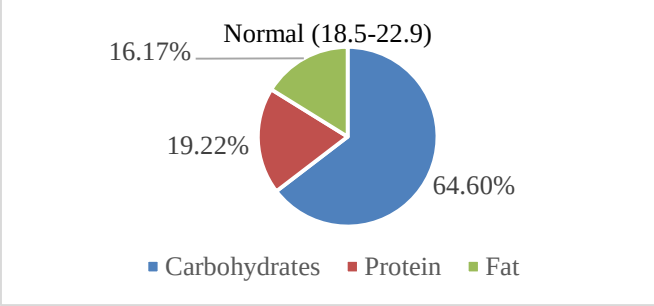

Figure-3b: Contribution of Nutrients in total Caloric intake of sample with Normal BMI.

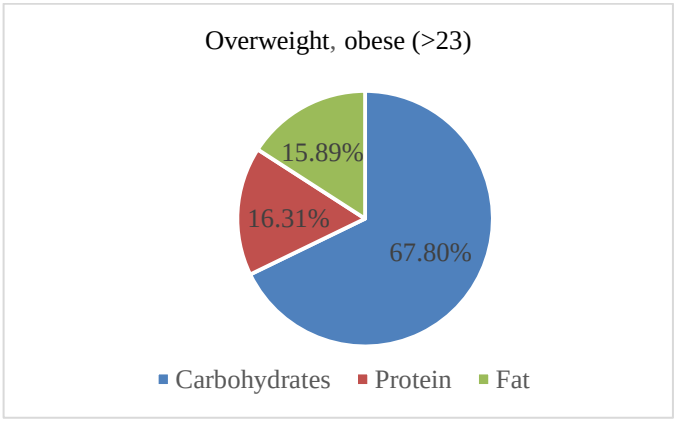

Figure-3c: Contribution of Nutrients in total Caloric intake of Overweight/Obese sample.

Conclusion

Contribution of carbohydrate in total calorie intake is seen less in underweight samples than in overweight/obese samples. In all nutrients, consumption by underweight people is more than obese, which depicts that there is more consumption of unhealthy/packaged foods on a daily basis by overweight/obese people. In conclusion, this study provides valuable insights into how dietary diversity, physical activity, nutrient intake, and lifestyle practices collectively influence the nutritional status and BMI of adults in Raipur. The findings reveal that while individuals with better dietary diversity and regular physical activity tend to maintain healthier BMI levels, unhealthy practices such as frequent consumption of junk and packaged foods are more common among overweight and obese individuals.

Additionally, the analysis underscores the need to address broader lifestyle factors, such as cooking and eating habits, meal timings, and physical activity frequency, as they play a critical role in shaping overall health. Interestingly, the results suggest that the overweight population consumes fewer nutrients essential for a balanced diet compared to their underweight counterparts, reflecting the impact of poor dietary choices.

This study also identifies significant gaps in understanding how other factors, such as genetic predisposition, environmental influences, and psychosocial conditions, contribute to nutritional health. These areas require further investigation to develop comprehensive strategies for improving health outcomes.

The findings highlight the importance of targeted public health initiatives and policies to promote healthy eating habits, reduce reliance on unhealthy foods, and encourage physical activity among adults. Such measures could help mitigate the rising prevalence of lifestyle-related health issues like obesity and malnutrition, contributing to improved community health and well-being.

It is understood that many other factors are possibly responsible in constituting a person's health and BMI, including body composition, genetics, health status, etc. Further research is needed to study the correlation between these factors and how they impact each other.

Acknowledgement

We humbly pay our gratitude to the Principal, Govt. D. B. Girls' P.G. College, Raipur, CG, the Head of the Department of Home Science, and all the members of the Department.

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