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Dietary Sustainability Knowledge and Practice among College-Going Students in Delhi

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ABSTRACT

Background: The current food systems are affecting the planet in an adverse manner. If people switch to sustainable diets, which are food group compositions that are good for both the health of people and the planet, they can help bring down the costs of health care and climate change. This study was conducted to assess dietary sustainability and its relation with the knowledge regarding food sustainability. **Methods:** This was a cross-sectional analytical study. The sample (n=131) included male and female college-going students in urban Delhi. The tools used included standardised questionnaire for knowledge assessment, 24-hour dietary recall to assess the dietary intake and World Index for Sustainability and Health (WISH) score for the assessment of dietary sustainability. **Results:** The participants achieved a low WISH score of only 70.8 out of 130. When assessing the knowledge, based on the survey responses, the participants were aware of terms like 'local products' and 'environmental impact' but their knowledge of 'carbon footprint' was limited. There was a positive correlation of WISH score with knowledge of sustainability terms. Also, People who understood how food groups affect the environment had higher WISH scores. **Conclusion:** Those who possessed greater knowledge of dietary sustainability; followed a more sustainable dietary pattern. Thus, nutrition education and behaviour change communication programs must be developed to impart knowledge regarding dietary sustainability which will create demand for more sustainable food groups to be included in the diet. This would promote the production of these foods and contribute towards transformation of food systems.

Introduction

Diets are not only the outcomes of food systems but also their drivers. Population dietary patterns determine food demand, thus guiding food system operations (Meybeck and Gitz, 2017). These systems cover the entire farm-to-fork cycle, including production, processing, packaging, distribution, marketing, purchasing, consumption, and waste disposal (Pingault *et al.*, 2017). The easiest way to establish sustainable food systems is to approach them at the consumption level, through the pathway of diets (Fanzo *et al.*, 2022).

Sustainable, healthy diets are multidimensional. Along with promoting the health and well-being of individuals, these diets are accessible, safe, affordable, unbiased, culturally acceptable, and have a low environmental impact. These diets can thus

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support both human and planetary health (World Health Organization, 2019). Owing to their low environmental impact, various diets have been categorized as sustainable, like the Mediterranean diet, vegan diet, and even the Indian diet; however, some of these are devoid of certain nutrients, while others are not culturally appropriate to be used globally (Allès *et al.*, 2017, Kovacs *et al.*, 2021, O'Keefe *et al.*, 2018, Sharma *et al.*, 2020). In the Anthropocene era, the EAT-Lancet Commission proposed a universal healthy reference diet - termed a 'win-win diet' - that benefits both human health and planetary well-being (Willett *et al.*, 2019). The proportions of food groups prescribed in this diet lie in 'safe operating space', which is a consumption limit up to which they are within the planetary boundaries, and help decrease the level of Greenhouse Gas Emissions (GHGEs) (Cambeses-Franco *et al.*, 2022, Kesse-Guyot *et al.*, 2021, Laine *et al.*, 2021). EAT-Lancet Diet is also beneficial in lowering the risk of various chronic degenerative diseases (Berthy *et al.*, 2022, Cacau *et al.*, 2023, Ibsen *et al.*, 2022, Xu *et al.*, 2022).

Knowing how to consume a sustainable diet is both a science and an art, and can be accomplished if one understands the impact of various food groups on health and the environment (Arlinghaus and Johnston, 2018). It is essential to assess the knowledge of young adults, as they are the future changemakers (Vantamay, 2018). Many studies have assessed the knowledge regarding food and diet sustainability (AlBlooshi *et al.*, 2022, Alnasser and Musallat, 2022, García-González *et al.*, 2020, Gaspar *et al.*, 2022, Teng and Chih, 2022). While some studies have identified correlations between knowledge and sustainable food consumption practices, they have exclusively relied on self-reported behaviours rather than actual practices (AlBlooshi *et al.*, 2022, Culliford and Bradbury, 2020).

Due to the lack of literature in this domain, the present study aims to estimate the sustainability of the diets of college-going students, assess their knowledge, and explore the association between knowledge and actual practice of sustainable diet consumption.

Materials and Methods

The present study was analytical cross-sectional study and was conducted in various colleges across Delhi, India. The study enrolled college students currently pursuing undergraduate or postgraduate degrees at urban Delhi college. The sample size calculation was based on the prevalence data of knowledge regarding dietary sustainability from a previous study among South Asian (Saudi Arabian) individuals. Based on the mean prevalence of knowledge, confidence level of 95%, and precision level of 5%, a total of 196 participants were required to be sampled (Alnasser and Musallat, 2022). Due to paucity of time, a sample size of 131 participants was purposively selected for the study. The inclusion criteria for the study were all college-going students (males and females), who were between 18-24 years old and were willing to participate in the study. The exclusion criteria for the study were those individuals who were suffering from any psychological ailment or were currently on any medications.

Tools and study procedures

Various tools were administered on the college-going students of urban Delhi which included questionnaires to assess the socio-demographic profile and knowledge assessment; two-days of 24-hour diet recall to evaluate the dietary intake and World Index for Sustainability and Health (WISH) score to assess the sustainability of the diet.

Assessment of socio-demographic profile

A pretested questionnaire was used to elicit information regarding the socio-demographic profile. The participants were asked about the type of family they come from which included either nuclear or joint families. A nuclear family is defined as the one where a married couple lives either with or without their kids. A joint family is where the paternal or maternal grandparents also live along with the married couple and their kids. The assessment of socio-economic status was based on three parameters: education level of the head of the family, occupation of the head of the family and average family monthly income in

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rupees. The classification of socio-economic status of the families was made in to 5 classes (lower, upper lower, lower middle, upper middle and upper class) which was done based on a score which ranged from 3 to 29. A score of <5 signified lower (V) socio-economic class while a score between 26-29 defined upper (I) socio-economic class (Sood and Bindra, 2022).

Primary and secondary objectives

The primary objective of the study was to assess the sustainability of the diet. Operationally, sustainable diets refer to food group compositions and combinations which are good for the health of the people and have a low environmental impact. The secondary objectives of the study were to assess the knowledge of the participants regarding dietary sustainability and explore the association between knowledge and actual practice of sustainable diet consumption.

Tools used

For the primary objective, a two-day 24-hour recall was used to collect the dietary intake data, and WISH score was used to assess the sustainability of the diet. For the secondary objective, a validated questionnaire was used to assess knowledge regarding dietary sustainability. These are discussed below in detail.

A two-days 24-hour dietary recall: It is essential to assess the dietary intake patterns of the participants to understand what foods they consume and in what amounts which will also facilitate the evaluation of dietary sustainability. The dietary intake of the participants was assessed using two days of 24-hour diet recall method. In this study, one working day and one holiday was selected for dietary data. It was ensured that the days selected were representative of the individual's usual routine and did not involve feasting or fasting of any kind. A standardised four-stage multiple pass interviewing technique was used to elicit the information from the respondents (Steinfeldt *et al.*, 2013). This multiple pass technique is considered to provide dietary intake data with great accuracy which has been validated in many low and middle-income countries (Gibson *et al.*, 2017). To minimize misreporting of quantities, the authors used standard measuring cups and spoons for estimating the household measures of the ingredients for recipes and consumed food items.

World index for sustainability and health (WISH): Sustainability of the diet was calculated using the World Index for Sustainability and Health (WISH). It is a global tool that can help assess the environmental and health aspects of sustainable diets. This is a standard tool which is based on the food group recommendations given in the EAT-Lancet report. This score ranges from 0 to 10 for each food group component where 0 means least dietary adherence or low sustainability while 10 specifies the maximum range (Trijsburg *et al.*, 2020).

Questionnaire to assess knowledge regarding dietary sustainability: The dietary sustainability knowledge questions were adapted from a standardized, validated instrument previously used in a cross-sectional study assessing sustainable food knowledge among Spanish adults (≥18 years) (García-González *et al.*, 2020). It assessed the awareness of people regarding certain terms like ecological footprint, carbon footprint, green-house gas emissions, environmental impact, local food and many more. People's perception regarding the important attributes of sustainable diets was assessed on a 5-point Likert scale (this ranged from 'not important at all' having 1 point to 'very important' having 5 points). The final question evaluated the viewpoint of participants regarding the impact of various food groups on the planet. The food groups assessed were 'vegetables,' 'meat, shellfish, and derivatives,' 'milk and dairy,' 'eggs,' 'processed foods' and 'soda and processed drinks.'

Ethical considerations

The approval for conducting the study was obtained from the Institutional Ethical Committee of Lady Irwin College, University of Delhi, New Delhi, India. An informed consent form was signed by every participant who agreed to be a part of the study.

Data analysis

The average nutrient intake from two-day 24-hour diet recall data was computed using a

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validated software "DietCal" version 13.0 (Profound Tech Solutions) which is based on values from Indian Food Composition Tables 2017, National Institute of Nutrition, ICMR (Longvah *et al.*, 2017). The data was entered into Microsoft Office Excel, version 2019. The food group intake data obtained was clubbed into 13 food group categories specified by EAT-Lancet Commission. WISH score was calculated by following the standard procedure. The component scores (ranging from 0-10) for each of the 13 food groups were added to obtain final WISH score for each participant. The total WISH score ranges from 0 to 130, with 0 indicating the least sustainable dietary pattern and 130 representing optimal dietary sustainability (Trijsburg *et al.*, 2020). After that, univariate analysis was used to describe participants' sociodemographic characteristics. The continuous variables were reported as mean and standard deviation and categorical variables were summarized using frequencies and percentages. A normal curve was used to represent the WISH scores of the entire population which showed that the WISH score data was not normally distributed, and thus, multivariate non-parametric tests were applied to study associations of other variables with WISH score. The nominal variables on the knowledge assessment were studied for their relation to WISH score by application of the Kruskal-Wallis H test. The ordinal variables were assessed for their relation to WISH score by application of Spearman's Rank Correlation. Results with a P-value of <0.05 were considered statistically significant.

Results

The results for the present study are discussed under the following heads: socio-demographic profile, sustainability of the diet, and knowledge assessment and its correlation with dietary sustainability.

Socio-demographic profile

Out of the total study sample (n=131), 53% (n=70) were females and 47% (n=61) were males. Chi-square test showed that there was no statistically significant difference in the number of males and females (*P*=0.48). The mean age of the college students was 21.00±1.96 years, and about half of the participants (48.1%) belonged to upper middle-income group (**Table 1**).

Table 1. Socio demographic profile of the participants (n=131).

Parameters	n (%)
Locale	
Central Delhi	29 (22.1)
North Delhi	39 (29.8)
South Delhi	31 (23.7)
West Delhi	32 (24.4)
Age group (y)	
18-19	21 (16.0)
19-20	17 (13.0)
20-21	13 (9.9)
21-22	13 (9.9)
22-23	31 (23.7)
23-24	25 (19.1)
24-25	11 (8.4)
Course currently enrolled in	
Bachelor's degree	58 (44.3)
Master's degree	55 (42.0)
Undergraduate diploma	14 (10.7)
Postgraduate diploma	4 (3.0)
Type of family	
Nuclear family	86 (65.6)
Joint family	45 (34.4)
Socio-economic class *	
Upper (I)	23 (17.3)
Upper middle (II)	64 (48.1)
Lower middle (III)	33 (24.8)
Upper lower (IV)	11 (8.3)
Lower (V)	0 (0.0)

Sustainability of the diet

As shown in **Figure 1**, the population scored well in the consumption of whole grains and cereals (9.9 out of 10) and red meat (9.5 out of 10). This shows that the intake of these food groups was in line with the recommendations given by EAT-Lancet Commission. However, as shown in **Table 2**, the mean intake of fruits and legumes was almost half of the recommended intake by the EAT-Lancet commission, thereby leading to a lower WISH score for these food groups (**Figure 1**).

The mean WISH score for the sample is only 70.8 out of 130 which indicates a poor dietary sustainability. An almost 50% adequacy shows that the population had a higher intake of certain less

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healthy and high environmental impact foods with a lower intake of healthy and low environmental impact foods. Thus, to obtain a greater dietary sustainability, this population must increase the consumption of vegetables, fruits, legumes, nuts, and unsaturated oils and simultaneously decrease the consumption of saturated fats and dairy products. **Figure 2** shows the distribution of WISH scores of the entire sample.

Table 2. Trends in dietary sustainability of the population.

Food group	Component WISH score	Non-consumers (%)	Recommended intake by EAT Lancet (g/d)	Mean ± SD intake (g/d)	Desirable direction of change
Whole Grains	9.9	0	≥125 (100–150)	230 ± 63	Good
Vegetables	6	0	300 (200–600)	292 ± 125	Increase
Fruits	3.6	20.6	200 (100–300)	107 ± 91	Increase
Dairy Foods	7.2	1.5	250 (0–500)	398 ± 162	Decrease
Red Meat	9.5	95.4	14 (0–28)	4 ± 21	Good
Fish	0.2	95.4	28 (0–100)	5 ± 31	Increase
Eggs	7.6	71.0	13 (0–25)	23 ± 42	Decrease
Chicken and Other Poultry	8.8	87.0	29 (0–58)	14 ± 39	Good
Legumes	5.3	8.4	75 (0–100)	48 ± 61	Increase
Nuts	1.8	18.3	50 (0–75)	9 ± 12	Increase
Unsaturated Oils	4.2	0	40 (20–80)	29 ± 10	Increase
Saturated Oils	0.3	0	11.8 (0–11.8)	27 ± 10	Decrease
Added Sugars	6.4	9.16	31 (0–31)	27 ± 21	Decrease

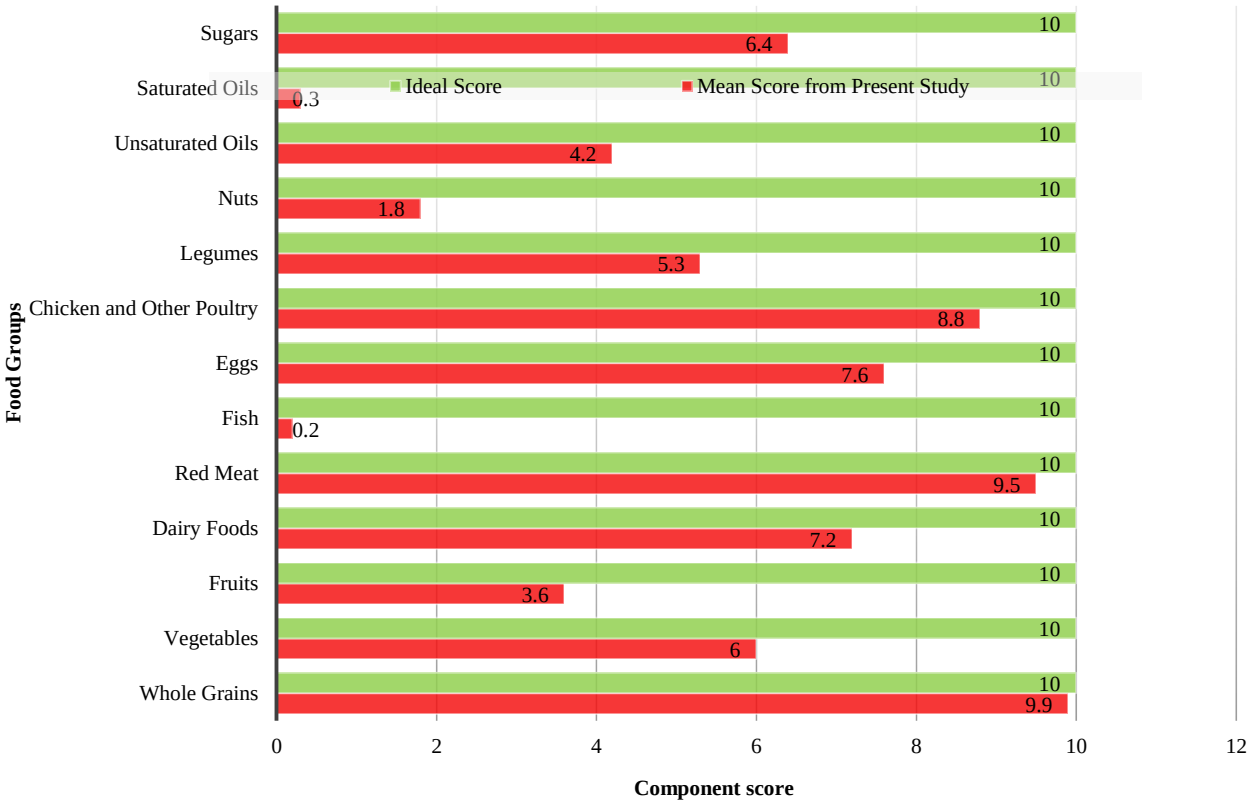

Figure 1. Food group adequacy based on component WISH score and EAT Lancet recommendations.

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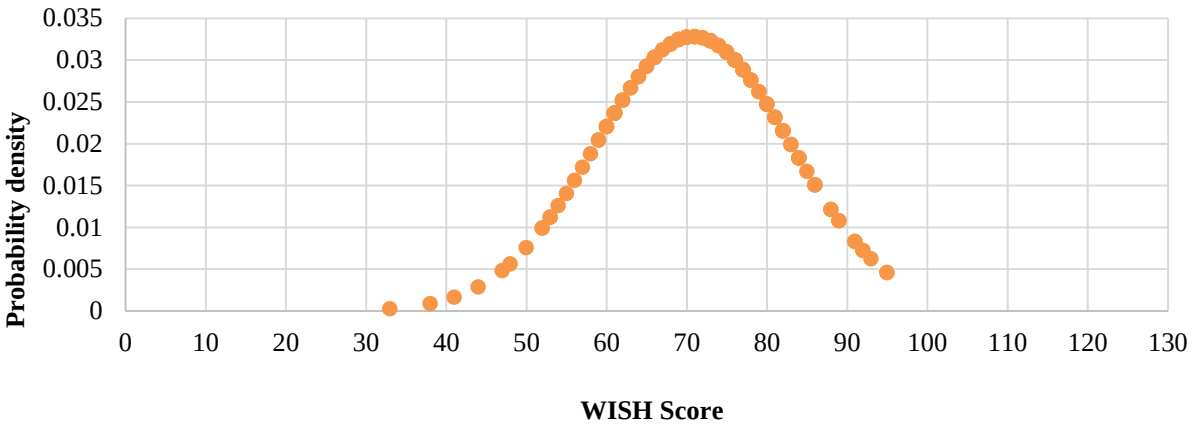

Figure 2. WISH Scores for the entire sample (n=131).

Knowledge assessment and its correlation with dietary sustainability

The participants seemed most familiar with the terms 'environmental impact' and 'local food' with about 87.8% and 89.3% being aware of the terms respectively as shown in **Table 3**. This also correlated positively with WISH score ($P<0.001$ with local foods; $P=0.01$ with environmental impact) indicating a higher dietary sustainability among those with greater knowledge.

There was less awareness about the 'ecological' and 'carbon footprints' with only 35.9% and 38.2% claiming to know these terms respectively. However, knowledge of carbon footprint ($P<0.001$) and GHGEs ($P=0.03$) also correlated positively with WISH score indicating that those who had a greater knowledge of these terms also followed a more sustainable dietary pattern.

More than 95% of the participants considered that consumption of vegetables has a positive environmental impact while about two-thirds (65.6%) of the participants believed meat and its derivatives to have a negative environmental impact (**Figure 3**). Assessing the perceived importance of certain attributes of sustainable diets on a 5-point Likert scale, it was found that the participants considered "rich in vegetables" (4.3) and "plenty of fresh products" (4) as most important attributes while "typical from own culture" (2.1) and "few ingredients" (2.5) were considered the least important. For all the variables, a positive correlation was obtained with WISH score, and the results were also statistically significant ($P<0.05$, **Table 4**).

Table 3. Familiarity with sustainability terms.

Terminology	Yes	No	Heard of the term but did not know what it means
	n (%)	n (%)	n (%)
Ecological footprint	47 (35.9)	49 (37.4)	35 (26.7)
Carbon footprint	50 (38.2)	48 (36.6)	33 (25.2)
Greenhouse gas emissions	83 (63.4)	21 (16.0)	27 (20.6)
Environmental impact	115 (87.8)	10 (7.6)	6 (4.6)
Biodiversity	87 (66.4)	19 (14.5)	25 (19.1)
Local food	117 (89.3)	10 (7.6)	4 (3.1)
Green water	29 (22.1)	74 (56.5)	28 (21.4)
Blue water	74 (56.5)	36 (27.5)	21 (16.0)

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Table 4. Attributes of sustainable diets and their correlation with WISH score.

Attributes of sustainable diets	Mean score in perceived importance (out of 5)	Spearman correlation coefficient (r)	P-value
Low environmental impact	3.3	0.30	<0.001
Respectful of biodiversity	3.3	0.36	<0.001
No additives	2.7	0.40	<0.001
Low processing	3.0	0.38	<0.001
Organic foods	3.6	0.29	<0.001
Plenty of fresh products	4.0	0.33	<0.001
Few ingredients	2.5	0.50	<0.001
Rich in vegetables	4.3	0.36	<0.001
Typical from own culture	2.1	0.58	<0.001
Locally produced	3.2	0.67	<0.001
Affordable	3.6	0.55	<0.001
Easy to follow	3.5	0.51	<0.001

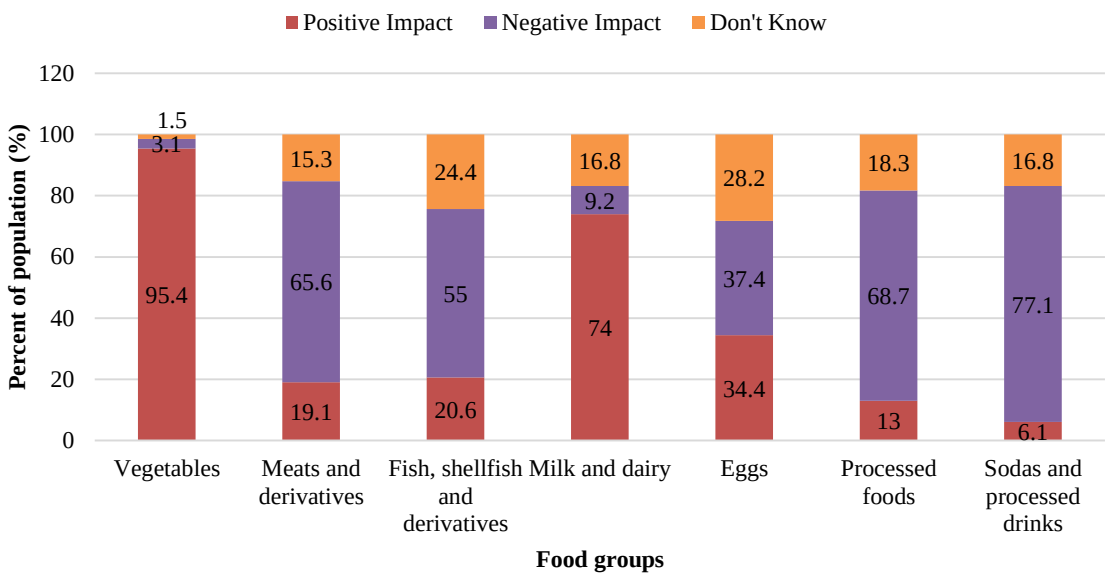

Figure 3. Perceived impact of food groups on environment.

Discussions

This study evaluated the dietary sustainability practices among college students in urban Delhi and examined their association with knowledge of sustainable food systems. The mean WISH score for the sample was only 70.8 out of 130 which indicates a poor dietary sustainability. The observed dietary adequacy of approximately 50% indicates a population-level pattern of greater consumption of less nutritious, high-environmental-impact foods alongside reduced intake of healthier, low-impact alternatives. Knowledge assessment revealed participant familiarity with concepts like 'local products' and 'environmental impact,' but limited awareness of 'carbon footprint' as a dietary consideration. There was a positive correlation of WISH score with knowledge of sustainability terms. Moreover, people who had a correct perception about impact of food groups on the environment had a higher WISH score.

Assessing sustainability of the diet has become extremely important in recent years for identifying consumption patterns which are not just good for

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the health of the people but also for the planet. Among the food groups, whole grain and cereal consumption was found to be adequate with a score of 9.9 out of 10. According to the Global Burden of Disease Report, 2019, adults (25-50) who had a low intake of whole grains were more likely to suffer from mortality (Afshin *et al.*, 2019). A generous consumption of whole grains by the study population led to a higher component WISH score. Whole grain cereals have a low environmental impact but rice has a high carbon footprint (Clark *et al.*, 2019). The EAT-Lancet Commission has defined the range for this food group as an average consumption of whole grains and other cereals including millets, rice, wheat and products made up from cereal grains (Trijsburg *et al.*, 2020, Willett *et al.*, 2019).

The mean intake of legumes (48.3±60.8 g) was almost half of the recommended intake by the EAT-Lancet Commission. This population also had a lower consumption of nuts with 18.3% non-consumers and the mean intake (8.8 g) was below the dietary recommendation. The findings in the present study were in line with another Indian study that assessed the consumption patterns of people from different income groups and included both rural and urban areas. Their findings reported that whole grain cereals constitute the major proportion of the Indian diet while the share of calories from protein sources like legumes, nuts, meat, fish etc. was 6-8% against the recommended 29% in the EAT-Lancet reference diet (Sharma *et al.*, 2020).

This population also had a low intake of non-vegetarian food items. The percentage of non-consumers were quite high for red meat (95.4%), fish (95.4%), eggs (71.0%) and chicken and other poultry (87.0%). Red meats have a 100 times larger negative impact on the environment as compared to plant foods in terms of GHGEs, land use, and acidification (Almeida *et al.*, 2023, Godfray *et al.*, 2018). Red meats also pose a threat to health by increasing the risk of mortality (Clark *et al.*, 2019). Fish consumption on the other hand has shown to be quite beneficial for the health (Mohanty, 2021). However, its production poses a high negative impact on the environment. Recirculating aquaculture systems and bottom trawling fisheries emit a great amount of GHGs due to higher energy use as compared to other fish production systems (Clark *et al.*, 2019). However, due to its positive health impacts, consumption of fish can be slightly increased by this population.

Possession of knowledge and having awareness is the key to behaviour change (Liu *et al.*, 2020). The observed dietary adequacy of approximately 50% indicates a population-level pattern of greater consumption of less nutritious, high-environmental-impact foods alongside reduced intake of healthier, low-impact alternatives. Knowledge assessment revealed participant familiarity with concepts like 'local products' and 'environmental impact,' but limited awareness of 'carbon footprint' as a dietary consideration. These results align with those other similar studies on Spanish and Saudi Arabian populations (adults 18-29 years) which used similar tool for knowledge assessment. They were most familiar with the terms "environmental impact" and "local food" and least familiar with the term "carbon footprint." The attributes of sustainable diets which were perceived as most important were "plenty of fresh products" (Spanish scored 4.6 and Saudi Arabians scored 3.7) and "rich in vegetables" (Spanish scored 4.4 and Saudi Arabians scored 3.7). Both Spanish and Saudi Arabian participants assigned relatively low importance to minimal-ingredient diets as a sustainability attribute (Alnasser and Musallat, 2022, García-González *et al.*, 2020). Another study conducted among college students from the United States reported similar findings where more than 45% of the students reported organic, local and seasonal produce to be more sustainable (Torabian-Riasati *et al.*, 2017).

To understand the knowledge towards the environmental impact of food group production and consumption, the participants were asked to give their perception about the impact of different food groups on the environment in terms of either 'positive' or 'negative' impact. About 95.4% of the people in the present study said that vegetables

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have a positive impact on the environment while processed foods, sodas and meat products were reported to have a negative impact by 68.7%, 77.1% and 65.6% of population respectively. Another study from the United States also reported that about 40% of the college students consider that beef and red meat production contribute to the highest amount of carbon dioxide emissions (Torabian-Riasati *et al.*, 2017). Garcia-Gonzalez *et al.* reported contradicting trends in perception of meat derivatives where 50% reported these to have a positive environmental impact (García-González *et al.*, 2020). The reason for these contradictory trends could be because Indians have the second lowest meat consumption in the world and their usual diets are mostly plant-based (Food and Agriculture Organization, 2015). Trends were similar for other food groups where majority (more than 80%) reported vegetables to have a positive environmental impact and processed foods and sodas to have negative environmental impact respectively (García-González *et al.*, 2020).

A greater knowledge of dietary sustainability leads to adherence to a more sustainable dietary pattern, and this hypothesis was justified by the results of the present study wherein WISH score correlated positively with majority of the knowledge parameters ($P<0.05$). This study advances dietary sustainability assessment by employing 24-hour recall data, providing a more comprehensive and accurate representation of consumption patterns compared to previous research relying on secondary household data, which may underestimate actual intake. Moreover, an association of knowledge with actual practice of dietary sustainability was assessed which was not studied earlier. The study, however, had certain limitations. Due to time constraints, a smaller sample size was taken for the study. While the EAT-Lancet reference diet classifies starchy vegetables (e.g., potatoes) as a distinct food category, the present study grouped them with roots and tubers. This methodological difference may have led to an overestimation of vegetable intake in our dietary assessments.

Conclusions

The results of this study show that the diet of college-going students is not very sustainable. However, those who possessed greater knowledge of dietary sustainability, eventually followed a more sustainable dietary pattern as reflected by significantly positive correlation of WISH scores with the knowledge parameters. This has opened doors for further interventions including nutrition education and behaviour change communication programs which must be developed to impart knowledge regarding dietary sustainability among the youth. This is expected to modify their dietary intake towards a more sustainable pattern. A greater demand for sustainable food groups would promote production of these foods and hence contribute to the transformation of the food systems.

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Authors' Contributions

Gandhi N and Shukla P designed the study. Gandhi N carried out the study, collected and analysed data and prepared the first draft of the manuscript. Shukla P reviewed the drafts and suggested modifications. The final draft of the manuscript was reviewed and approved by both the authors.

Conflicts of interest

The authors declared no conflicts of interest.

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