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Knowledge and consumption of traditional probiotics and prebiotics among adults in India

Arshia Shireen & Mitravinda Savanur*
Department of Food Science and Nutrition, Mount Carmel College, Autonomous, Bengaluru 560 052, India
*E-mail: mitravinda@mccblr.edu.in

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Traditional Indian cuisines are a rich repository of diverse probiotic and prebiotic food sources. However, the level of knowledge and consumption of traditional probiotics and prebiotics among free-living populations are not well-documented. The current study assessed knowledge and consumption of traditional Indian probiotic and prebiotic foods among Indian adults. This cross-sectional study was conducted Pan-India among 240 participants aged over 18 years. Information regarding sociodemographic parameters and knowledge and consumption pattern of Indian probiotics and prebiotics was collected. Knowledge was assessed using a self-designed questionnaire and consumption was assessed using a semi-quantitative food frequency questionnaire and food variety scores. Results showed knowledge of probiotics (*Mdn*= 5.00*)* was better than prebiotics (*Mdn*= 4.00*)* ($p<0.001$). Urban residence ($U = 3155.00$, $p=0.021$) and higher education level ($\chi^2 = 7.440$, $p=0.024$) influenced knowledge of probiotics. Less than 45% of participants consumed at least one traditional probiotic food daily whereas 76.67% of participants consumed a minimum of one Indian prebiotic food source per day ($p<0.001$). Body mass index of the participants was inversely associated with overall food variety scores ($r_s= -0.184$, $p= 0.004$) and prebiotic food variety scores ($r_s= -0.171$, $p=0.008$). Obese participants had lower overall food variety scores than others ($\chi^2 = 8.091$, $p=0.044$). These findings underline the need to improve knowledge of probiotics and prebiotics among the general public and to re-establish traditional probiotic and prebiotic food consumption to reduce non-communicable disease risk.

Keywords: *Fermented foods, Gut health, Prebiotics, Probiotics, Traditional foods*

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As per the World Health Organization, NCDs claimed more deaths in the world than any other causes[1]. India is experiencing a rapid increase in NCDs. In the past two decades, the Indian diet has shifted from the consumption of nutrient-dense traditional foods to refined, high-fat, sugary foods, and fast foods[2]. This nutrition transition accompanied by a reduction in discretionary physical activity has culminated in higher risks of NCDs like obesity, type 2 diabetes, and cardiovascular disease (CVD). Simultaneously, research shows that a healthy gut microbiome can help prevent and manage NCDs[3]. However, existing food habits dampen the inclusion of dietary fiber and replenishment of beneficial microorganisms in the gut.

*Corresponding author

List of abbreviations:
BMI: Body Mass Index, CVD: Cardiovascular Disease, FFQ: Food Frequency Questionnaire, FVS: Food Variety Score, MCQ: Multiple Choice Question, NCD: Non-communicable Disease, SES: Socio-economic Status, SPSS: Statistical Package for Social Sciences, COVID-19: Coronavirus Disease 2019

Traditional probiotics and prebiotics in India

Today, probiotics and prebiotics have taken center stage in both therapeutic and general health promotion. Probiotics are live microorganisms that naturally occur in selected foods that provide relief from gastrointestinal and metabolic disorders[4]. Ethnic cuisines in India have been rich repositories of fermented foods with probiotic properties from *Idli* (steamed rice cake made from fermented batter), *Dosa* (pancake made from fermented batter of rice and pulses), *Koozhu* (fermented millet porridge), and *Ambali* (fermented finger-millet malt)in the South to *Dhokla* (spongy fermented rice and pulse-based steamed cake), *Lassi* (curd-based sweet drink), *Kanji* (fermented beetroot and carrot drink), and *Bhatura* (sourdough bread)in the North[5,6]. North-eastern Indian cuisines especially have foods like *Chhu* (cheese-like preparation with cow's milk), *Philu* (cream-like preparation from yak's milk), *Sinki* (*fermented radish root*), *Gundruk* (fermented mustard, cauliflower, and radish leaves), *Soibum*

(fermented bamboo shoot), and fermented meats and fish[5,7-13].

Prebiotics are selectively utilized substrates of gut microorganisms that aid in the management of allergic diseases and intestinal disorders and help in nutrient absorption and weight reduction[14,15]. Evidence of prebiotic consumption in the form of cereals, pulses, onions, and garlic dates back to the Indus Valley and Vedic civilizations in 4000 BC[16]. Ethnic Indian cuisines comprise a wide spectrum of seasonal and non-seasonal foods with prebiotic properties like milk, wheat, barley, black rice, black gram, red lentil, vegetables like yam, sweet potato, chicory root, and fruits like jackfruit, custard apple, *Nendran, Sugandhi,* and Robusta banana[8,16,17]. Condiments used in daily preparations- onion, ginger, garlic, and other sources like sugarcane and honey have prebiotic properties and form an integral part of our traditional food[13,16,18,19].

Knowledge and consumption of probiotics and prebiotics in India

There is limited research regarding the awareness and knowledge of probiotics and prebiotics in India. Recent Indian studies show a generally high level of awareness of probiotics among the free-living population[20-22]. Despite the substantial increase in awareness of probiotics in the past 10 years, Indians are still unaware of their sources and benefits[20,23].

Scientific evidence on the consumption of probiotics in India is scarce. Existing research reported occasional intake of selected popular probiotics like *Dahi, Lassi*, and *Chaas*[20,21,23]. Consumption appeared to be higher among middle-aged and older adults and in high and middle-income households[20,21,23-25]. Though a handful of probiotic foods are popular, traditional fermented foods are not being consumed by the vast majority of Indians today. Simultaneously, there is a dearth of information about the consumption of prebiotics among Indians. Albeit their presence in ethnic cuisines, fermented and prebiotic foods have been forgotten in the course of the ongoing nutrition transition. Therefore, our study aimed to assess the knowledge of probiotics and prebiotics and to examine the consumption pattern of traditional probiotics and prebiotic sources in India.

Materials and Methods

Study design

A cross-sectional study was conducted to assess the knowledge of probiotics and prebiotics and the consumption of traditional Indian probiotics and prebiotics among Indian adults.

Setting

The study was conducted Pan-India for five weeks and individuals participated by completing the online survey during December 2020 and January 2021.

Ethical consideration

The study was approved by the Institutional Human Ethical Committee, Mount Carmel College, Autonomous, Bengaluru, India (IHEC-MCC No. 007 M.Sc./2020-21). Participants were included in the study after obtaining electronic informed consent.

Participants

We recruited 240 participants using snowball sampling method. Individuals who were residents of India, aged 18 years and above, and understood English were included in the study. Nutritionists, health professionals (doctors, pharmacists, nurses), and students in these fields were excluded. We determined the sample size to be 192 using the formula $N= Z^2 S^2/ d^2$, where a confidence interval of 95% and a margin of error of 0.5% were considered[17]. A pilot survey was conducted with 15 participants to obtain knowledge scores and the standard deviation of these scores was used to ascertain the sample size.

Variables

A self-administered questionnaire containing 27 mandatory questions was used. The variables studied included the knowledge and consumption of probiotics and prebiotics, and the motivators and barriers of consumption of these foods.

Knowledge of probiotics and prebiotics

Knowledge of probiotics and prebiotics was studied using six multiple-choice questions (MCQs) regarding the definition, traditional/natural food sources, and their health benefits. An overall knowledge score was ascertained out of 20 points, with probiotics and prebiotics knowledge scores calculated out of 10 points each.

Consumption of traditional Indian probiotics and prebiotics

Consumption of probiotics and prebiotics was studied using a 50-item semi-quantitative food frequency questionnaire (FFQ). We carried out an extensive literature search and an online market survey to identify probiotics-based traditional Indian preparations, commercially available probiotic

products, and naturally-occurring prebiotics foods. Twenty traditional probiotic foods and 30 natural prebiotic food sources of India were identified from the literature[5,7-19] and included in the FFQ. The frequency of consumption of each item was reported as '2 or more times/day', 'once a day', '3-5 times/week', '1-2 times/week', or 'rarely or never'. Additionally, we quantitatively examined consumption by calculating food variety scores (FVS)[26]. The FVS was calculated by summing the number of listed probiotic and prebiotic foods consumed by the participants in a 24 h period. An overall FVS was ascertained out of 50 points, with probiotic and prebiotic FVS calculated out of 20 and 30 points respectively.

Motivators and barriers of consumption of probiotics and prebiotics

We studied the reasons for consumption (motivators) and non-consumption (barriers) of probiotic and prebiotic foods using two MCQs.

Sociodemographic information of participants

The survey also collected sociodemographic details of participants concerning age, gender, place of residence, educational qualification, and socioeconomic status (SES). The modified and updated Kuppuswamy SES scale was used to determine SES[27]. Additionally, we collected the self-reported height and weight of participants to determine their BMI and classified as per Asian cut-offs[28].

Data collection

The online survey form was shared with the participants through two social media platforms-WhatsApp and Instagram. Data collection was conducted online as it was the most feasible mode during the COVID-19 pandemic. Participants were recruited from known contacts of the authors such as family, friends, and acquaintances who then shared the survey with their contacts. The survey link was sent on a weekend and reminders were sent on subsequent weekends as a follow-up for better response. Along with the online survey link, a message was sent explaining the investigator's education information, the purpose of the survey, the time required to complete the survey form (approximately 20 min), eligibility criteria for participation, and an appeal to further share the survey with their contacts. The maintenance of confidentiality of participants' responses was declared. We obtained informed consent from the participants before they filled the self-administered questionnaire. The participants' personal information was not collected keeping data privacy in view.

Statistical analysis

We analyzed the data using Statistical Package for Social Sciences (IBM SPSS version 20.0). The Shapiro Wilk test revealed that all continuous variables except the weight of participants were not normally distributed. Therefore, non-parametric statistical tests were performed. To compare knowledge and consumption scores between genders and places of residence, the Mann-Whitney U test was performed. The Kruskal-Wallis H test was used to compare knowledge and consumption scores across age groups, BMI statuses, monthly income categories, and SES of participants. Further, Spearman's correlation test was performed to examine possible relationships between age, BMI, and SES scores with knowledge and consumption scores. The Wilcoxon Signed Ranks test was used to compare knowledge scores of probiotics with prebiotics and consumption scores of probiotics with prebiotics among participants.

Results

Sociodemographic characteristics of participants

A total of 240 individuals participated in the study. Table 1 shows that participants primarily consisted of

Table 1 — Sociodemographic characteristics of participants

		Frequency (n)	Percentage (%)
Age group (years)	18-25	123	51.25
	26-50	67	27.92
	51-85	50	20.83
Gender	Male	85	35.41
	Female	155	64.58
Place of residence	City	199	82.91
	Town, village	41	17.08
Educational qualification	Post-graduate, professional, honors	100	41.66
	Graduate	121	50.41
	Diploma, school certificate, or less	19	7.91
Monthly family income (INR)	Above 1,99,862	43	17.91
	99,931 - 1,99,861	53	22.08
	74,756 - 99,930	53	22.08
	49,962 - 74,755	55	22.91
	29,973 - 49,961	20	8.33
	10,002 – 29,972	14	5.83
	Below 10,001	2	0.83
Socioeconomic status	Upper class	63	26.25
	Upper-middle class	153	63.75
	Lower-middle/ upper-lower class	24	10.00
	Total	240	100.00

urban dwellers. The mean age of participants (n= 239) was 34.44±16.01 years and the median age was observed to be 25 years. A large proportion of respondents were graduates or had post-graduate, professional, or honors degrees (Table 1). The Kuppuswamy SES scale revealed a mean SES score of 21±4.72. A large proportion of participants belonged to the upper-middle class, followed by the upper class.

BMI of the participants

The mean BMI of participants (n = 239) was found to be 24.43±4.53 kg/m^2 (15.12 to 43.35 kg/m^2). It was found that 31.38% of participants had a normal BMI status, whereas a considerable proportion was overweight (17.99%) and obese (42.26%) as per the Asian BMI classification[20]. We observed that 8.36% of participants were underweight and were all females aged 18 to 25 years. The BMI of participants was influenced by age, χ^2 = 46.036, p<0.001, and gender, χ^2 = 12.456, p=0.006. Also, BMI of participants was positively associated with their age, $r_s(238)$ = 0.389, p<0.001. Further, 66.66% and 52.00% of obese participants belonged to the age groups of 26-50 and 51-85 years respectively. Half of the overweight participants were aged 18-25 years. Interestingly, a larger percentage of males (48.24%) were obese compared to females (38.96%).

Knowledge of probiotics and prebiotics in India

An overall score was calculated out of 20 points. The overall mean knowledge score was 9.40±3.94, and the median knowledge score was 9.00. Overall knowledge of probiotics and prebiotics was not influenced by age, gender, educational qualification, or SES. However, participants residing in cities (*Mdn* score = 9.00) had better overall knowledge than those residing in towns/villages (*Mdn* score=8.00), *U*=3131.00, p=0.019.

Knowledge of probiotics

Probiotics knowledge score was calculated out of 10 points. The mean knowledge score was found to be 5.12±2.26, with a median score of 5.00. It was noted that 40.42% of participants obtained a score of above 5. A majority (67.50%) of participants chose the right definition of probiotics, whereas 18.75% chose the incorrect definition and 14.00% of participants were unaware of what probiotics were. However, a large proportion (89.17%) of respondents rightly chose yogurt and curd as natural sources of probiotics whereas fewer respondents knew about traditional sources like millet porridge & fermented rice (38.75%), soy-based fermented products (30.83%), and *Sauerkraut* & *Kimchi* (29.58%). A majority (82.92%) of respondents knew the positive impact of probiotics on the immune system and 40.00% of them knew their colon cancer-preventing effects. Nearly one-third of respondents knew the benefits of probiotics in controlling cholesterol levels (37.50%) and lowering blood pressure (28.75%).

Factors associated with knowledge of probiotics

Our results revealed no significant relationship between the knowledge of probiotics and age and gender of participants. Interestingly, city-dwellers (*Mdn* score = 5.00) had higher knowledge scores compared to town/village-dwellers (*Mdn* score = 4.00), *U*=3155.00, p=0.021. Participants with post-graduate, professional, or honors degrees had more knowledge of probiotics than those with a diploma, school certificate, or less, χ^2 (2) = 7.440, p=0.024 (Table 2).

Knowledge of prebiotics

Prebiotics knowledge score was calculated out of 10 points. The mean knowledge score of participants was 4.28±2.14 and the median score was 4.00. The Wilcoxon signed ranks test revealed that knowledge scores of prebiotics were significantly lower than that of probiotics, *Z* = -6.541, p<0.001. One-fourth (27.08%) of participants obtained a score greater than 5. Less than 45.00% of participants chose the right meaning of prebiotics, whereas 30.83% of participants were unaware of what prebiotics were. One-fourth of respondents thought prebiotics were microorganisms residing alongside probiotics in the gut. About 63% of participants correctly selected bananas, but fewer were aware of tomatoes (25.42%), garlic (48.33%), and oats (41.25%) as sources of prebiotics. A majority (79.17%) of respondents chose improvement of digestion and enhancement of

Table 2 — Knowledge of probiotics across educational qualification

Educational qualification	Mean score ± SD	Median score	Mean Rank	Chi square[a]
Post-graduate, professional, or honors	5.40±2.32	5.00	128.72	7.440* (p=0.024)
Graduate	5.10±2.27	5.00	119.75	
Diploma, school certificate, or less	3.79±1.35	4.00	82.00	

Note: *At 5% level of significance, [a]Using Kruskal-Wallis H test

immunity as benefits of prebiotics. However, fewer participants were aware of their role in reduction of body weight (33.33%) and management of diabetes mellitus (32.50%).

Factors associated with knowledge of prebiotics

Prebiotics knowledge scores did not have any relationship with the sociodemographic characteristics of participants.

Consumption of traditional probiotics and prebiotics in India

An overall FVS was calculated from a total of 50 points. The overall mean FVS of respondents was 4.39±3.53, and the median score was 4.00. Overall consumption score was not significantly influenced by sociodemographic characteristics of participants. Additionally, overall consumption was not associated with overall knowledge of probiotics and prebiotics either.

Consumption of traditional Indian probiotics

Probiotic FVS was calculated out of 20 points. The mean probiotic FVS of participants was noted to be 0.86±1.27. More than half of the participants did not consume any probiotics on a daily basis. Further, 44.59% of participants consumed at least one traditional probiotic food daily.

Among a wide range of Indian probiotics, participants were found to consume curd, *Dosa, Idli,* and buttermilk, mostly once or twice a week (Fig. 1). Curd was the most commonly consumed probiotic food on a daily basis among all age groups. However, the frequency of consumption of curd differed significantly across age groups as 40.00% of 51 to 85 year-olds consumed curd at least once daily, followed by 18 to 25 year-olds (30.07%), and 26 to 50 year-olds (16.41%), χ^2 = 17.731, p=0.023. *Paneer* (cottage cheese), *Kimchi* (fermented cabbage, garlic, chilies), *Mor Kuzhambu* (curd gravy), *Ambali, Kanji, Pazhaya Sor* (fermented leftover rice), *Appam* (pancake made with fermented rice flour and coconut milk), fermented leafy vegetables and beans, *Lassi,* and *Dhokla* were consumed daily by less than five percent of participants. The least consumed traditional probiotics were *Rabdi* (sweet thickened milk), *Bhatura, Sauerkraut,* and fermented fish and meat products.

Consumption of natural Indian prebiotics

Prebiotic FVS was calculated out of 30 points. The mean prebiotic FVS score of respondents was 3.53±2.83 while the median score was 4.00. The Wilcoxon signed ranks test found that consumption scores of prebiotics were significantly higher than that of probiotics, Z = -11.118, p<0.001. Nearly 77% of respondents consumed at least one prebiotic food daily, which was higher than that observed for probiotics.

Over one-fourth of participants consumed onion, tomato, ginger, garlic, milk, and wheat at least once a day (Fig. 2). Milk consumption was higher among 18- to 25-year-olds than older age groups, χ^2 = 27.949, p<0.001. Other prebiotic foods consumed daily by almost 10 to 20% of participants included banana, apple, honey, green and black gram, and red lentil. Flax seeds, oats, and carrots were consumed daily by five to seven percent of participants. The least consumed Indian prebiotic food sources were barley, black rice, chickpeas, soybeans, kidney beans, pumpkin seeds, sugarcane juice, beetroot, sweet potato, bitter/snake gourd, pumpkin, cabbage, radish, and yam.

Association of consumption of probiotics and prebiotics with BMI

BMI and overall FVS of participants were negatively correlated, $r_s(239)$ = -0.184, p=0.004. Therefore, participants consuming a larger variety of

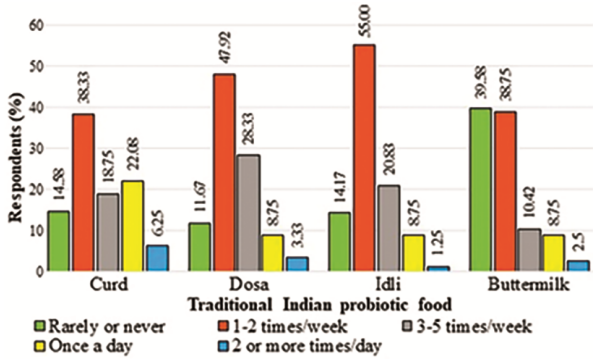

Fig. 1 — Frequency of consumption of common traditional probiotic foods of India

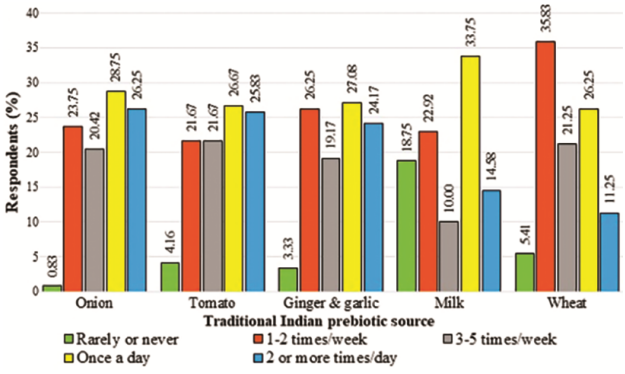

Fig. 2 — Frequency of consumption of common traditional prebiotic sources of India

traditional probiotic and prebiotic foods had a lower BMI. We also found that obese participants had a significantly lower overall mean FVS than other BMI categories, χ^2 (3) = 8.091, p=0.044 (Table 3). Probiotic FVS did not have any significant relationship with the BMI of participants. However, consumption of prebiotics was inversely associated with the BMI of participants, $r_s(239)$= -0.171, p=0.008.

Motivators and barriers of consumption of probiotics and prebiotics

We found that 39.16% (n=94) of participants intentionally consumed probiotic and prebiotic foods. A majority of participants consumed these foods mainly for their nutritional and health benefits, followed by their taste (Table 4). A small proportion of respondents consumed probiotics and prebiotics because of recommendations by friends and family, advice from a nutritionist or doctor, and convenience of consumption.

Over half of the participants (n=135) did not consume probiotic and prebiotic foods intentionally, primarily because they were unaware of these foods and their health benefits and were uninterested in consuming them (Table 4). A considerable proportion of respondents did not consume these foods due to the lack of knowledge of probiotic and prebiotic food sources despite being aware of the importance of these foods.

Table 3 — Overall Food Variety Score (FVS) across BMI status

BMI status	Mean score ± SD	Median score	Mean Rank	Chi square[a]
Underweight	5.20±3.62	4.50	135.03	8.091*
Normal	4.28±3.31	4.00	119.55	(p=0.044)
Overweight	5.21±2.76	5.00	141.40	
Obese	3.92±3.91	3.00	108.25	

Note: *At 5% level of significance, [a]Using Kruskal-Wallis H test

Discussion

Our study found that knowledge and consumption of traditional probiotics and prebiotic sources were poor among participants. Consumption of traditional Indian probiotics was significantly less than prebiotics. Only a handful of popular Indian probiotic and prebiotic foods were being consumed.

Knowledge of probiotics

In the present study, two-thirds of participants knew the right meaning of 'probiotics'. Recent researches have reported higher awareness (90%) among the general public and college goers in Northern cities of India[21,22,29]. Traditional sources of probiotics like millet porridge, fermented rice, soy-based fermented foods, *Sauerkraut,* and *Kimchi* were not well-known to our study participants, whereas only popular sources like yogurt and curd were known much like the findings of Arora & Prabha[20]. Various studies worldwide also revealed that a large majority of respondents knew yogurt to be a source of probiotics despite reporting poor awareness and knowledge of probiotics among participants[30-32]. The benefit of probiotics to the immune system was known to a larger proportion of our respondents (83%) as compared to previous studies (25%)[23,33]. Our finding could be a result of increased awareness regarding immunity owing to the COVID-19 pandemic. At the same time, our participants were unaware of the benefits of probiotics to the cardiovascular system as observed in earlier

Table 4 — Motivators and barriers of consumption of probiotics and prebiotics

		Frequency (n)	Percentage (%)
Motivators	Taste	16	17.02
	Recommended by friends/family	6	6.38
	Advised by nutritionist/doctor	4	4.25
	Nutrition and health benefits	59	62.76
	Convenient to consume	6	6.38
	Affordable prices	3	3.19
	Attractive appearance or packaging	0	0.00
	Total	94	100.00
Barriers	Unaware of such foods and their health benefits	59	43.70
	Unaware of food sources despite knowing the importance of these foods	22	16.29
	Lack of interest in consuming these foods	24	17.77
	Unsure of their effectiveness	15	11.11
	Perception that these foods might have harmful bacteria, pesticides, or hormones	4	2.96
	Experienced side-effects in the past	5	3.70
	Unwilling to spend money on these foods	6	4.44
	Total	135	100.00

studies[33,34]. This may be due to the endorsement of probiotics in India that restrict the information about their benefits to gut health alone.

In our study, urban residents and those with higher educational qualifications had more knowledge of probiotics than town/village residents. This can be attributed to the influence of mass media and access to supermarkets in urban India, thus, indicating greater exposure to health foods-related information. Similar results were reported among hospitalized patients in Chicago[34] and residents of Hyderabad[35]. On the other hand, SES of participants did not influence their knowledge scores, which is consistent with research conducted in India[20] and abroad[36,37]. In congruence with recent research, we found that knowledge of probiotics and prebiotics was not influenced by the age of participants[36,37]. Contrary to our finding, some studies suggested that females had better knowledge of probiotics[20,30].

Knowledge of prebiotics

A higher proportion of participants in our study knew the meaning of prebiotics as compared to earlier studies[22,23]. Similar to the findings of Raihing & Mageshwari[23], our respondents too thought of prebiotics to be microorganisms similar to probiotics. Also, a higher percentage of study participants selected cheese, an incorrect source, than tomato, as a prebiotic source probably because of their notion of prebiotics being similar to probiotics. Knowledge of prebiotics benefits on cardiovascular health was poor among participants. They were unaware of the weight-reducing benefit conferred by prebiotics, as was found by Betz and others[34]. Unlike probiotics knowledge scores, prebiotics knowledge scores did not significantly vary across sociodemographic characteristics because prebiotics is a fairly new and unexplored concept for Indians, thereby highlighting the need to improve awareness and knowledge.

Consumption of traditional Indian probiotics

Our results revealed only a few popular foods such as curd, *Idli, Dosa,* and buttermilk being consumed, as was found by Das *et al.*[21] and Raihing & Mageshwari[23]. Also, curd was found to be the most commonly and frequently consumed traditional probiotic which is consistent with the findings of earlier studies conducted in southern Indian cities[23,24]. The majority of our participants belonged to South India where these probiotic foods are common constituents of everyday meals. However, other native South Indian sources like fermented fish, *Mor Kuzhambu, Ambali, Koozhu, Pazhaya Sor,* and *Appam* were not being consumed regularly.

Consumption of natural Indian prebiotics

We noted that the consumption of prebiotics was significantly better than that of probiotics. The most commonly consumed prebiotic foods in our study like onion, tomato, ginger, and garlic are basic ingredients in Indian dishes[38]. Besides, their medicinal and immunoprotective properties encourage their intake. Milk and wheat were other commonly consumed prebiotics, which are also consumed widely by people across India. These findings are in line with a similar study conducted by Raihing & Mageshwari[23] in urban Coimbatore. Interestingly, milk consumption was lower among older age groups, which could be a consequence of gastrointestinal discomfort associated with aging[39]. We noted that natural Indian prebiotic sources like barley, black rice, chickpeas, kidney beans, tubers, and vegetables like pumpkin, bitter gourd, and snake gourd were not consumed commonly by participants despite their presence in North and South Indian cuisines.

BMI and consumption of traditional probiotics and prebiotics

Our study revealed that obese participants had lower overall FVS than other participants. Additionally, participants who had higher overall FVS had lower BMI than those who consumed a smaller variety of these foods. This can be associated with the combined lipid-lowering effect of probiotic and prebiotic foods[40-42]. Also, short-chain fatty acids released via fermentation of prebiotics by intestinal microflora are associated with reduction of ghrelin levels and reduced adiposity in the body[43].

Motivators and barriers of consumption of probiotics and prebiotics

Participants consumed probiotics and prebiotics mainly for their nutritional benefits which is consistent with recent research in India[20,24] and abroad[31,36,44]. On the other hand, unawareness of these foods and their health benefits was the primary reason for non-consumption as was found globally[30,45]. A considerable proportion of participants exhibited a perceived lack of necessity of these foods which was also reported in other Indian studies[20,29].

Our study has a few limitations. The height and weight used to calculate BMI were self-reported by participants. Also, the electronic nature of data

collection limited the participation of older adults and individuals from lower SES households.

Conclusion

In conclusion, the knowledge and consumption of probiotic and prebiotic foods were poor. The intake of probiotics and prebiotic foods was limited to commonly consumed foods. With nutrition transition underway, traditional foods are fast being replaced by processed foods that do not offer any probiotic or prebiotic benefits. It is imperative to decelerate this shift to prevent NCDs and promote health. To achieve this, awareness of these ethnic foods must be re-established, thereby increasing their utilization. Our study can guide health communicators to disseminate valuable information to individuals and increase their awareness of traditional probiotics and prebiotic foods.

Acknowledgment

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

The study was conceptualized by both authors and supervised by MS. AS conducted data collection and analysis and prepared the first draft of the manuscript. The final manuscript was edited and approved by both authors.

Availability of Data

The datasets associated with this research can be obtained from the corresponding author upon reasonable request.

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