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Impact of the COVID-19 pandemic on immune boosting food consumption and overall dietary pattern among selected Indian adults: An observational study

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ABSTRACT

Background: /Objectives: The rise of the pandemic of the coronavirus SARS-CoV-2 (COVID-19) has upset the diet and lifestyle of individuals. This study was designed to highlight the choices of individuals across different ages to quantify food consumption using the Food Consumption Score, to assess changes, if any, that were caused by the COVID-19 pandemic, and to identify the factors that affected these changes. It also assessed the consumption of immune -boosting foods, including spices and gooseberries, taken as a preventive measure against the virus. **Methods:** An online survey in a questionnaire format was used in this study to collect information from adults aged 18 to 55 (categorized into young and middle-aged adults) across India. The Food Consumption Score, a tool validated by the World Food Programme, was used to assess frequencies of food consumption per food group. **Results:** The study revealed that young adults had higher Food Consumption Scores than their middle-aged counterparts during the two time points, pre COVID-19 (55.25 & 32, $p = 0.001$) and during COVID-19 (57.25 & 32, $p < 0.001$). The pandemic also led to a tangible rise in the consumption of various foods known for their immune-boosting abilities such as spices, gooseberries, and Neem. **Conclusion:** The findings of the study indicate an increase in awareness with respect to dietary habits, specifically in terms of consumption of immune boosting foods observed during the COVID-19 pandemic across the age groups.

1. Introduction

COVID-19 is caused by the novel coronavirus and is characterized by severe acute respiratory syndrome.¹ Those affected primarily show symptoms of cough, sore throat, fever, and breathlessness.² Originating in the city of Wuhan in China, this virus has claimed 53,74,744 lives across the world, as of December 23, 2021, reported by the WHO. With India reporting 3,47,65,976 cases to date, the growing concern about this pandemic among individuals across all age groups, primarily adults, in regard to health and safety, is completely justified.³

The advent of the COVID-19 pandemic brought about a lot of disruption in the livelihoods of individuals owing to confinement. Although food procurement may not have been altered much during this

period, there has been a marked change in the dietary patterns of individuals as reported by several studies.⁴ The changes may be due to the effect of lockdown on the economic status or as a result of a decline in outside food consumption due to lack of access and/or fear of being infected.

A study conducted on outpatients with obesity post 1 month of lockdown due to the COVID-19 pandemic in Northern Italy showed a significant correlation between lower exercise, increased snacking of unhealthy foods, boredom, depression, and anxiety with weight gain.⁵ Micronutrients are known to boost the immune system of the body. The dietary status of micronutrients is being investigated as a modifiable risk factor for COVID-19. A study conducted in the United Kingdom concluded that prevention of micronutrient deficiencies, identifying the

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target risk group who are at suboptimal nutritional status, and implementing safe and effective nutrition strategies may help in resisting the infection.⁶

The Food Consumption Score (FCS), a tool validated by the FAO, categorizes foods under eight standardized groups and assigns each food group a value based on its nutrient contribution.⁷ While the Food Consumption Score is primarily used as a means to assess household food security, it is also an effective indicator of the extent of diversity in an individual's diet.

The pandemic has also led to an increase in the consumption of immune-boosting foods as a preventive measure against contracting the virus. Some nutrients that help confer immunity are Vitamins A and C.⁸ Vitamin A is known to enhance antibody responses to antigens and also prevents apoptosis, and deficiency of this vitamin brings about an alteration in immune function.⁹ Vitamin C plays a vital contributor to immunity. There is substantial evidence of vitamin C's role in potentiating B-cell and T-cell proliferation in addition to the prevention of respiratory infections.¹⁰ Spices are known to play a role in the maintenance of immunity. A study conducted during the progression of COVID-19 showed that countries with higher consumption of spices had a higher recovery rate from the condition. A higher death rate was also observed in those countries which had a lower per capita spice consumption.¹¹

The current study focuses on the impact of the pandemic on food habits of individuals quantified by the Food Consumption Score and compares differences in FCS between young and middle-aged adults. It also assesses the consumption of immune-boosting foods commonly consumed in India, including spices and gooseberries, and a comparison of the frequency of consumption of these foods before and during the first wave of the COVID-19 pandemic.

2. Materials and methods

This online cross-sectional survey was conducted between November 13, 2020 to December 16, 2020. Snowball sampling technique was employed and 218 responses were received during the study period. Majority of the respondents belonged to the States of Telangana, Karnataka, and Maharashtra.

An online form was circulated using various social media platforms to record the responses, in addition to a brief description regarding the study. The participants were required to provide e-consent before answering the survey. The Institutional Ethics Committee was notified regarding the e-consent process and approval was sought (IEC: 519/2020). The data thus received from the responses was only accessible to the authors. No personal identifiers of participants were used in the study.

The survey included a validated questionnaire that recorded information including age, gender, residence, socioeconomic status, medical history, anthropometric measurements (height and weight), food consumption pattern (according to FCS) and practices pertaining to the use of immune-boosting foods.

The study population was categorized into young adults (18 and 35 years) and middle-aged adults (36 and 55 years).¹² The categorization of age groups was done prior to data collection. Responses on the food consumption pattern and practice of consumption of immune boosters at two different time points i.e., before and during the first wave of COVID-19 pandemic were elicited. Information was recorded during the latter time period and participants were asked to recall their diet habits before the pandemic. Each participant could submit only one response and the information provided were subjected to data analysis.

The sociodemographic details recorded included place of residence, marital status, type of family, educational qualification, occupation, and income class. Educational qualification, occupation of the head of the family and family income class were used to calculate the Socio-Economic Status (SES) based on the modified Kuppuswamy scale.¹³ The effect of the pandemic on the job status of subjects was questioned,

as it was expected to be a potential determinant of changes in dietary practices in the time points mentioned earlier.

The Body Mass Index (BMI) was calculated, and the individuals were classified based on Asian criterion for BMI classification.¹⁴

To understand the change in the dietary pattern observed during the COVID-19 pandemic, information pertaining to the consumption and frequency of consumption of meal, snack, non-home-made food, immune boosters, and herbal concoction were recorded. Based on the World Food Programme tool, 8 food groups were considered for the purpose of calculating FCS. The consumption pattern of these food groups for a period of 7 days was recorded as per the guidelines.⁶

R software version 4.0 was used to carry out the statistical analysis. Kolmogorov-Smirnov Test was applied to check the normality. Since some of the variables did not exhibit normal distribution of data, non-parametric tests were carried out to ascertain the difference observed between the two time points for the said variables. Linear regression model was applied on FCS to understand the factors affecting the score. Descriptive statistics were used to summarise personal and sociodemographic details. Paired *t*-test, non-parametric Wilcoxon's signed rank test, McNemar test, Mann-Whitney *U* test, and linear regression were performed to test the objectives. *p*-value <0.05 were considered as statistically significant.

3. Results

3.1. Personal and sociodemographic details

Table 1 comprises of a detailed summary of personal, socio-demographic, and economic data of the participants. It was observed that a greater number of respondents were female (61.01%). This online survey covered respondents from different states of the country and a higher number of respondents were from the southern states of India (79.8%). It was observed that a higher number of respondents belonged to Upper SES category (52.29%) as opposed to other categories. COVID-19 had a substantial effect on the job status of many people. 26% of the respondents had their occupations affected due to the pandemic in terms of reduced salary, long working hours, or unforeseen termination from the job.

3.2. Anthropometric measurements

The average height among male and female participants were 173.12 ± 8.96 cm and 159.96 ± 7.82 cm respectively and the average weight was 75.25 ± 12.46 Kg and 64.16 ± 10.81 Kg respectively. Self-reported height and weight of the respondents were considered and thus the accuracy could not be ascertained.

Height and weight were used to compute the BMI and classify the participants into different categories based on the Asian Criteria for BMI classification.¹² 2.7% of the total population were underweight, 44% of them were overweight, and 23.8% were classified into three obese categories of obesity for BMI higher than 27.5 kg/m².

3.3. Diet pattern

The survey recorded different diet patterns followed by the individuals. The number of non-vegetarian participants (53.77%) was greater than other diet patterns. The other diet patterns followed were Lacto-vegetarian (30.7%), Ovo-lactovegetarian (6.9%), Ovo-vegetarian (1.8%), Pescatarian (1.4%) and Vegan (5.5%).

To determine the consumption pattern of meal, snack, and non-homemade food consumption, pairwise comparison tests were performed for the two time points – pre and during COVID-19. Meal frequencies did not change much from pre-COVID to during COVID times (*p* = 0.19) as assessed by a paired *t*-test. A significant increase (*p* = 0.013) was observed in the frequencies of snack consumption from pre to during COVID-19 times. A significant decrease in non-homemade

Table 1
Personal and sociodemographic details of the participants.

Variables	Frequency (n = 218)	Percentage
Gender		
- Male	85	38.99%
- Female	133	61.01%
Age		
- Young Adult (20–35 years)	138	63.3%
- Middle-aged Adult (36–55 years)	80	36.7%
Religion		
- Hindu	194	89%
- Muslim	7	3.2%
- Christian	10	4.6%
- Others	7	3.2%
Marital Status		
- Married	97	44.5%
- Unmarried	119	54.6%
- Widowed	2	0.9%
Type of family		
- Nuclear	168	77.1%
- Joint	38	17.4%
- Extended	12	5.5%
Locality		
- Urban	187	85.8%
- Rural	31	14.2%
- North	17	7.8%
- South	174	79.8%
- East	3	1.4%
- West	24	11%
Educational qualification of the participant		
- Professional degree, post-graduate and above	106	48.62%
- B.A. or B.Sc. degree	101	46.33%
- Intermediate or past high school diploma	11	5.05%
Occupation of the participant		
- Profession	94	43.11%
- Semi profession	24	11%
- Clerical, shop owner, -farmer	13	5.96%
- Skilled worker	1	0.46%
- Semiskilled worker	1	0.46%
- Unemployed	85	38.99%
Monthly income of the participant		
- ≥ 78,063	46	21.1%
- 39,033–78,062	41	18.8%
- 29,200–39,032	11	5%
- 19,516–29,199	25	11.5%
- 11,708–19,515	12	5.5%
- 3,908–11,707	3	1.4%
- ≤ 3,907	3	1.4%
- Not applicable	77	35.3%
SES category		
- Upper Lower	8	3.67%
- Lower Middle	20	9.17%
- Upper Middle	76	34.86%
- Upper	114	52.29%
If the lockdown or pandemic affected one's job		
- Yes	58	26.61%
- No	160	73.39%

food consumption (p = 0.001) from weekly once before COVID-19 to no consumption during COVID-19 was observed.

3.4. Food consumption score

The Food Consumption Scores of individuals who had normal sugar/oil diets were categorized into “Poor” (0–21 points), “Borderline” (21.5–35 points) and “Acceptable” (>35 points). At both time points, those individuals who consumed oil and sugar on a daily basis and were thus classified under the “High sugar/oil” category, had acceptable Food Consumption Scores (>42 points).

Analysis of Food Consumption Scores for both age groups at individual time points, represented in Table 2, revealed that for Food Consumption Scores both before and during the pandemic, the p-value was

Table 2
Variation in Food Consumption Scores between young and middle-aged adults.

Time period	Age group	N	FCS	p-value
			Median (Q1, Q3)	
Pre COVID	Young-aged adults	138 (63.3%)	55.25 (27.125, 77.75)	0.001***
	Middle-aged adults	80 (36.69%)	32 (22.5, 66.5)	
During COVID	Young-aged adults	138 (63.3%)	57.25 (30.375, 79.25)	<0.001***
	Middle-aged adults	80 (36.69%)	32 (21.375, 61.875)	

*** indicates significance level at 0.1%.

0.001. This indicated that the FCS scores of young adults were significantly higher than those of their middle-aged counterparts at each time period considered.

While analysing the change that was expected between the two time points under the study, it was observed that the median value of FCS for young adults was fairly higher (before COVID-19 = 55.25; during COVID-19 = 57.25) than that of middle-aged adults at both time points (before and during COVID-19 = 32). The p-value for young adults was 0.465, and for middle-aged adults it was 0.732, indicating that there was no significant difference observed in Food Consumption Score of pre and during COVID -19 times for both age groups.

3.5. Predictors of FCS

Multiple linear regression was performed to find the effect of job status, SES score, age group, gender, BMI, frequency of meal, snack and non-homemade food consumption, consumption pattern of immune-boosting foods, and disease status on the Food Consumption Scores of the subjects during COVID-19 times. The overall model fit was 0.114 (adjusted R²) which implies that the explanatory variables included in the regression model were not good predictors of Food Consumption Scores. Table 3 shows the regression model for FCS.

The fitted regression model is of the form:

$$\text{Food Consumption Score} = 45.365 + 13.78 * \text{Job status} - 13.88 * \text{Age group}$$

β1 = 13.78 implies that the Food Consumption Score on an average increase by 13.78 units for someone whose job was not affected by the pandemic as compared to someone whose job was affected after adjusting for the effect of age group.

β2 = - 13.88 implies that the Food Consumption Score on an average decrease by 13.88 units for a person belonging to the middle-aged group as compared to someone belonging to the young-aged group, after adjusting for job status.

3.6. Consumption of immune boosters

The study focused on the consumption pattern of immune boosters during the two time points. It took into account information regarding whether or not a certain immune booster was consumed, and how its consumption changed across the time points under study.

Table 3
Linear regression model for food consumption scores.

Model	Unstandardized Coefficients		p-value	95% Confidence Interval	
	B	Std. Error		Lower Bound	Upper Bound
(Constant)	45.365	9.745	<0.001	26.57	64.15
Job status	13.78	4.2	0.001***	5.49	22.06
Age group	-13.88	3.7	<0.001***	-21.37	-6.39

*** indicates significance level at 0.1%.

A significantly higher number of participants ($p < 0.001$) consumed herbal juice/concoction during the pandemic compared to earlier times.

There was a significant increase in the consumption of condiments, fruit, gooseberries, honey, neem, and spices during COVID-19 times, as represented in Table 4. Although there was also an increase in the consumption of aloe vera and dark green leafy vegetables reported during the pandemic, the difference was not significant.

4. Discussion

The COVID-19 pandemic brought about tangible changes in the lifestyles of individuals. This has had an effect on food patterns, which was investigated in this study to determine a possible explanation for micronutrient deficiencies in individuals. The study participants were mostly from urban areas and had educational qualifications ranging from intermediate or diploma degrees to professional degrees as classified by the Kuppuswamy scale.¹³ With the imposition of the nationwide lockdown, many had either lost their jobs or received reduced pay. This had a direct effect on their livelihood. The effect of the COVID-19 pandemic on jobs and the lockdown that followed was taken into consideration in order to determine if these factors affected the FCS. A telephonic survey conducted in Sonipat, Delhi, Chennai, and Vishakapatnam to assess the health, psychosocial and economic impacts of chronically ill people during the COVID-19 pandemic reported that there were about 59% of the total participants reporting reduced income, while there were about 38% of participants who lost their job.¹⁵ In the present study, there were about 26% of total participants whose job routine was altered either by reduced salary, inappropriate and long working hours, problems due to improper facility to commute, stress, anxiety, and depression, or due to job termination. The SES score of the family was also used to check the proportion of individuals belonging to different strata of the socioeconomic classification. A little above half of the individuals (52.29%) belonged to the upper strata of the SES score classification.

Nearly half of the respondents (44%) were in the overweight category, both in young and middle-aged adults. There have been studies conducted around the world to correlate the changes in weight and its subsequent impact on health conditions during the lockdown. A cohort study conducted in non-diabetic households to assess the risk of diabetes

due to weight during the COVID-19 lockdown had concluded that 40% of the total participants had gained weight during the lockdown and 7% of them were at a higher risk of diabetes.¹⁶

A study conducted in Northern Italy during lockdown due to COVID-19 demonstrated significant evidence about a higher consumption of meals, snacks, and unhealthy foods, lower exercise, increased self-reported boredom and anxiety, and these were significantly correlated with weight gain.⁴ In the current study, a significant difference was observed in the frequency of consumption of non-homemade foods, wherein there was a decrease in the frequency during COVID-19 in comparison with pre-COVID-19 times, owing to restricted movement during the lockdown.

The Food Consumption Score was used as a means to determine household food security among the participants. The current study reported no significant difference in FCS scores in both age groups. Studies conducted during COVID-19 used either an online survey or telephonic interview to elucidate the information. This limitation was highlighted in a recent study conducted in Addis Ababa, when there was no significant difference in the food consumption score between the two consecutive years 2019 and 2020.¹⁷ FCS was affected by various predictor variables such as the effect of job status, socioeconomic status, age group, and gender, among others. The current study showed that job status and age group had a significant effect on FCS. A similar result was observed in a study conducted on a population in Northern Lao PDR during COVID-19 pandemic wherein FCS was affected by low income and increased difficulty in the procurement of food.¹⁸ On further analysis, it was found that there was a statistically significant difference observed between the two age groups in both pre and during COVID-19 times. Young adults had higher scores of FCS in comparison to middle-aged adults both before and during the pandemic.

The COVID-19 pandemic also paved way to explore the kitchen for the purpose of immunity. It was observed that communication and social media were impactful in raising awareness on the effect of various home remedies in the prevention and treatment of COVID-19. Information regarding the consumption of immune-boosting foods, consumption of herbal juice or concoction, and other food items perceived as immune boosters, that were not included in our questionnaire, was collected. It was seen that there was a statistically significant increase in the consumption of herbal juice/concoction during COVID-19 times. A similar finding was reported in a survey conducted across various countries, wherein there were about 71.8% of total participants who were consuming Kadha (*spices/herbal concoction*) during COVID-19 as they considered it to help combat the viral infection, thereby boosting immunity.¹⁹ There was a significant increase in the consumption of condiments, fruit, gooseberries, honey, Neem leaves, and spices during the COVID-19 pandemic except in the consumption of Aloe vera and dark green leafy vegetables. These results were in agreement with a study conducted in Saudi Arabia, in which subjects reported an increase in consumption of immune-boosting foods such as ginger, garlic, and turmeric.²⁰ Besides the above-mentioned foods, there are many varieties of fruits and vegetables like oranges, guava, papaya, kiwi, beetroot, eggplant, broccoli, and mushrooms among others renowned as immune boosters during COVID-19 times as they are rich in minerals like zinc, magnesium, and Vitamin C, D, and E.²¹

Since the present study was based on an online survey, the authenticity of responses could not be ascertained, as a result of which the predictions made cannot be validated. For the computation of BMI, self-reported height and weight were used, which could be inaccurate. The information about pre-COVID times was gathered based on the person's ability to recall and may not be precise. Since the data on the socioeconomic status was calculated based on the participant's response, there is a possibility of under or over-estimating the SES. As a result of this, although the research question involved understanding the impact of the pandemic on individuals' dietary habits, these results may not be entirely representative of the population under study. The total number of participants was 218. A higher number can perhaps yield more

Table 4
Comparison of various immune-boosting food during the two points.

Consumption of immune boosters		Pre COVID	During COVID	p-value
Aloe Vera	Yes	36 (16.51%)	45 (20.64%)	0.11
	No	182 (83.49%)	173 (79.36%)	
Condiments	Yes	170 (77.98%)	193 (88.53%)	0.011**
	No	48 (22.02%)	25 (11.47%)	
Dark green leafy vegetables	Yes	177 (81.19%)	187 (85.78%)	0.12
	No	41 (18.81%)	31 (14.22%)	
Fruit	Yes	181 (83.03%)	195 (89.45%)	0.02*
	No	37 (16.97%)	23 (10.55%)	
Gooseberries	Yes	86 (39.45%)	109 (50%)	<0.001***
	No	132 (60.55%)	209 (50%)	
Honey	Yes	123 (56.42%)	138 (63.3%)	0.03*
	No	95 (43.58%)	80 (36.7%)	
Neem	Yes	55 (25.23%)	71 (32.57%)	0.015*
	No	163 (74.77%)	147 (67.43%)	
Spices	Yes	175 (80.28%)	191 (87.61%)	0.017*
	No	43 (19.72%)	27 (12.39%)	

*, **, *** indicates significance levels at 5%, 1% and 0.1% respectively.

accurate results.

5. Conclusion

The unanticipated damage that occurred due to the COVID-19 pandemic has had a severe impact on every individual. Schools, colleges, offices, shops, and markets were all closed when the nationwide lockdown was imposed. This further hampered the social, financial, and personal lives of the individuals. With the changing lifestyle, the change in dietary habits was inevitable. This study was thus designed to assess the overall change in dietary pattern and consumption of immune boosters in young and middle-aged adults pre and during the COVID-19 pandemic.

Results indicated that while the difference was not alarming, there were significant changes in the eating patterns of a majority of the participants. One such increase was observed in snack consumption, which may be attributed to the fact that people stayed inside their homes throughout the day during the lockdown and hence indulged in over-eating practices. However, there was also a significant decrease in consumption of non-homemade food, possibly owing to fear or poor information about the safety practices of restaurants during the pandemic.

The Food Consumption Scores of individuals were assessed and it was observed that a majority of the young adults had maintained acceptable scores of FCS before and during the lockdown, while more middle-aged adults, on an average, fell in the borderline category before the lockdown, and scores of many dropped even lower during the pandemic. Lower scores in middle-aged adults could likely be attributed to poor accessibility to markets courtesy of the lockdown, in addition to poor affordability owing to many having their jobs affected.

The pandemic saw people growing increasingly cautious about preventive measures against contracting the virus. This included the consumption of various foods known for their immune-boosting abilities with the media consistently raising awareness about the same. An increase in consumption was especially noted with respect to spices and condiments, fruit, gooseberries, honey, and Neem leaves. The pandemic also caused an increase in the consumption of herbal concoctions.

This study gives a bird's eye view to the changes in dietary patterns that occurred courtesy of the pandemic. Further in-depth analysis via multi-centric studies will provide more detailed information including specific causes for these changes.

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Declaration of competing interest

The authors declare no potential conflicts of interests.

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