



An Online Survey to Evaluate Knowledge, Attitude and Practices Regarding Immuno-nutrition during COVID Pandemic in Indians Staying in Different Countries

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Abstract

The objective of the study was to evaluate knowledge and attitude regarding immuno-nutrition in Indians residing in different parts of the world and to evaluate practices adopted during lockdown to boost immunity. A rapid assessment survey was conducted using Google Forms which was circulated amongst Indian community residing in different countries using various social media platforms. Data was collected from 325 Indians from 11 different countries. Participants were regrouped into 4 groups: South Asia, Europe, East Africa and Western Asia based on geographical location. About 85% participants identified most factors that either boost or suppress immunity. More than 90% participants reported vitamin C, vitamin D, vitamin B12, proteins and iron as the nutrients that boost immunity. Higher percentage of Indians from South and Western Asia reported that holy basil, asafoetida, cardamom, nuts and Chawanprash helped boost immunity as compared to Indians from Europe and East Africa ($p < 0.05$). The overall minimum knowledge score obtained by participants was 45% and maximum was 100%. Highest marks were obtained by Indians from Western Asia followed by Indians from South Asia then Europe and lastly East Africa. However, there was no significant difference marks obtained by participants



Article History

Received: 09 February 2021

Accepted: 24 May 2021


Keywords

Covid 19;
Home Remedies;
Immuno-Nutrition;
Immunity;
Kap Study.

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Doi: <http://dx.doi.org/10.12944/CRNFSJ.9.2.03>

of 4 regions ($p > 0.05$). Almost 1/3rd participants had misconception that immunity can be boosted in short amount of time. There was a significant difference in practices adopted by participants across different regions ($p < 0.001$). Indians from Western Asia and South Asia adopted supplement and food based approaches to boost immunity as compared to Indians from other 2 regions. Though the overall knowledge regarding immuno-nutrition was similar in Indians from all 4 regions, the attitude and strategies adopted to boost immunity varied from region to region. There is a need to conduct educational programs to help improve the attitude and strategies adopted to boost immunity in Indians staying across the globe.

Introduction

As life moves on and humans begin to age, the risk of exposure to pathogens and serious infections become more probable. This is when the competence of the immune system is relied on.¹ The immune system is a complex web of relationships that allow our body to fight off aggressive germs, harmful pathogens and other dangerous substances that might affect our body in a negative way. The immune system is also required to identify and neutralise substances and fight disease causing illness such as cancer.²

When the body has to fight off unknown pathogens, it utilizes three layers of defence mechanisms which depend on the severity of the threat. These layers are: i) physical layer which include the skin and the epithelial lining of the gastrointestinal and respiratory tract ii) the biochemical layer which secretes mucus and gastric acid iii) antibodies.¹ The cells of the immune system can also be divided into an innate response which is responsible to attack the pathogen at the first response and the adaptive immune response which has the quality to specifically identify a pathogen and remember it if the body is attacked by it again.³

Globally, in the year 2020, the world experienced Covid-19, a respiratory disease caused by the novel coronavirus, SARS-COV-2 that has been declared a pandemic by the WHO.⁴ It has since then affected many; the young, the elderly and those with comorbidities being at a much higher risk.⁵ As of April 2021, India is facing a surge in the number of Covid-19 cases with approximately 250,000 new cases each day.⁶ India has the 2nd highest Covid-19 case tally in the world after United states and has suffered from more than 180,000 deaths over the last 1 year.^{6,7}

The increase in global consumption of diet high in saturated fats and refined carbohydrates contributed to the prevalence of chronic diseases, placing this population at a higher risk of being affected severely by Covid-19. An unhealthy diet further affects the immune system which then leads to chronic inflammation, impairing the body's defence mechanism against the virus.⁸ Nutrition is a key determinant for prevention and treatment of many acute and chronic diseases.⁹⁻¹¹

Moreover, the peripheral inflammation caused by the Covid-19 virus may have long lasting neurological effects to those that shall recover. This neuro-inflammatory mechanism leading to the effects can be compounded by an unhealthy diet.⁵

It is essential to maintain good nutritional status to fight the virus. A lot of information has been released on the social media, where some articles explore the importance of nutrition to boost immunity and also give some authentic guidelines about nutrition and food safety.^{12,13} However, some of this information is misleading people and cannot be completely relied on.¹⁴ With more than 2 billion individuals accessing social media regularly for long periods of time, they have become contaminated with the spread of false information, which increases the degree of panic amongst people. During a crisis, any data is valuable if it is truthful. However, during this Covid-19 pandemic, a lot of false information has been repeatedly shared online. With such news being circulated repeatedly, social media becomes a danger in misleading people.¹⁵

Hence, the importance of knowledge regarding immune-nutrition, to help improve immunity, needs to be advocated rightly; now more than ever.⁹

Few studies have been conducted in knowledge, attitude and practices regarding Covid-19 in specific countries such as China,^{16,17} Ecuador,¹⁸ United States of America and United Kingdom,¹⁹ Bangladesh²⁰ and Sudan.²¹ Most of these studies explored knowledge, attitude and practices regarding basic information regarding Corona virus, spread of virus, social distancing and measures taken to prevent spread of infection.

To the best of our knowledge, there has been no study conducted to analyse the knowledge and practices specifically regarding immuno-nutrition. Hence, the objective of the study was to evaluate knowledge and attitude regarding immuno-nutrition in Indians residing in different parts of the world and to evaluate the food and nutrition based practices adopted during lockdown to boost immunity.

Methodology

A rapid assessment survey was conducted using Google Forms. The Form was distributed through various social media platforms such as WhatsApp, Facebook and LinkedIn in Indian Community residing across the globe.

Place of Residence

Data regarding country of residence was collected. Total data was collected from 325 Indians from 11 different countries. Based on the geographical locations of the countries, participants were clubbed into 4 categories:

- South Asia: Indians residing in India (n=101)
- Europe: Indians from UK (n=40)
- East Africa: Indians from Kenya, Tanzania, Uganda (n=60)
- Western Asia: Indians from United Arabs Emirates, Saudi Arabia, Kuwait, Qatar, Oman (n=124)

Demographic Data

Information regarding gender, highest education, and age was collected using pre-structured questionnaire.

Knowledge, Attitude and Practice (KAP)

KAP regarding immunity was assessed using a pre-structured questionnaire (Appendix A). Knowledge regarding what is immunity; factors suppressing and boosting immunity were assessed. Knowledge

regarding nutrient, food components and foods that increase immunity were also assessed.

Attitude of participants regarding how they rate their immunity, whether immunity can be improved in short period of time and if foods eaten can have an effect on immunity was assessed.

Practices adopted by participants during the COVID lockdown to boost their immunity was assessed using a structured questionnaire too. An open-ended question was used to assess the herbal tea recipes consumed by participants.

Statistical Analysis

Total knowledge score was calculated by adding up all the correct answers for knowledge questions for each participant and a percentage marks obtained was calculated. Thereafter, participants were categorised in 4 categories as those obtaining: <70% marks, 70-80% marks, 80-90% marks and >90% marks.

Analyses were performed using SPSS software for Windows (version 25, 2007, IBM Corporation, Armonk, New York, United States). Cross tabulations were computed by region of residence and compared using chi-square test. The difference in knowledge score of the 4 groups were assessed using One-Way ANOVA. $P < 0.05$ was considered to be statistically significant.

Results

Demographics

Table 1 give the demographic data of the study participants. Almost 3/4th participants were females while about 1/4th were males. A little more than 3/4th (77.2%) were graduates or had higher education. Most participants were >35 years of age.

Knowledge about Immunity

Table 2 gives knowledge about what participants understand about immunity. Similar percentage of Indians from all 4 regions reported that immunity is ability to defend from "foreign bodies" and immunity is ability to resist a particular disease/ infection ($p > 0.05$). Higher percentage of participants from South and Western Asia reported that immunity is a state of being protected from infection as compared to participants from Europe and East Africa ($p < 0.05$). Similarly, higher percentage of participants from

South and Western Asia reported that immunity is ability to eliminate toxic and allergenic substances that enter through mucosal surfaces as compared to participants from Europe and South Africa ($p < 0.05$)

Table 1: Demographic data of study participants

	South Asia (n=101)	Europe (n=40)	East Africa (n=60)	Western Asia (n=124)	Total (n=325)
Gender					
Males	14.9	20	26.7	36.3	25.8
Females	85.1	80	73.3	63.7	74.2
Education					
High school	21.8	25	18.3	25	22.8
Graduation or higher	78.2	75	81.7	75	77.2
Age					
<35 years	75.3	52.5	95	68.5	73.5
>35 years	24.5	47.5	5	31.5	26.5

Data presented as percentage

Table 2: Knowledge about immunity

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Ability to defend from "foreign bodies"	89.1	92.5	93.3	97.6	93.5	6.707	0.082
Able to resist a particular disease/ infection	90.1	85	90	94.4	91.1	3.662	0.300
State of being protected from infection	79.2	67.5	56.7	81.5	74.5	15.393	0.002
Ability to eliminate toxic and allergenic substances that enter through mucosal surfaces	76.2	65	58.3	83.9	74.5	16.031	0.001

Data presented as percentage

Factors Boosting and Suppressing Immunity

Table 3 gives knowledge regarding factors that boost or suppress immunity. More than 85% participants identified most factors that either boost or suppress immunity. Drinking adequate water and a healthy diet were the top 2 factors reported for boosting immunity whereas nutritional deficiencies and smoking were the top 2 factors reported for suppressing immunity. Similar percentage of participants from all 4 regions reported various factors that boost or suppress immunity ($p > 0.05$).

Nutrients/ Food Components that Boost Immunity

Table 4 gives knowledge regarding nutrients/ food components that boost immunity. More than

90% participants reported vitamin C, vitamin D, vitamin B12, proteins and iron as the nutrients that boost immunity. Lowest percentage of participants reported polyphenols for boosting immunity.

Higher percentage of participants from East Africa and Western Asia reported that selenium, copper and flavonoids can boost immunity as compared to participants from South Asia and Europe ($p < 0.05$). Lower percentage of participants from South Asia reported polyphenols as a nutrient that can boost immunity as compared to other 3 regions ($p < 0.05$). Lower percentage of participants from Europe reported that antioxidants, prebiotics and flavonoids can boost immunity as compared to other 3 regions ($p < 0.05$).

Table 3: Knowledge regarding factors that boost or suppress immunity

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Factors that boost immunity							
Reducing stress	95	97.5	91.7	93.5	94.2	1.718	0.633
Good sleep	97	100	93.3	96.8	96.6	3.440	0.329
Regular exercise	98	100	98.3	96.8	97.8	1.639	0.651
Healthy diet	99	100	100	96.8	98.5	4.094	0.252
Moderate consumption of salt/ sugar	82.2	85	86.7	86.3	86.3	0.918	0.821
Drinking adequate water	97	95	93.3	99.2	99.2	5.236	0.155
Factors that suppress immunity							
Alcohol	93.1	92.5	90	94.4	92.9	1.180	0.758
Smoking	94.1	95	91.7	96	94.5	1.487	0.685
Tobacco	93.1	95	90	96	93.8	2.701	0.440
Stress	93.1	90	90	93.5	92.3	1.101	0.777
Lack of sleep	92.1	90	85	96	92	6.865	0.076
Nutritional deficiencies	95	95	90	97.6	95.1	4.965	0.174
Anaemia	87.1	90	80	92.7	88.3	6.619	0.085
Hypovitaminosis D	89.1	87.5	78.3	91.1	87.7	6.415	0.093
High fat and high sugar foods	87.1	80	85	91.1	87.4	3.871	0.276

Data presented as percentage

Table 4: Knowledge regarding nutrients/ food components that boost immunity

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Vitamin C	99	97.5	98.3	97.6	98.2	0.738	0.864
Vitamin D	92.1	90	85	95.2	91.7	5.657	0.130
Vitamin B12	91.1	90	90	91.9	91.1	0.255	0.968
Proteins	93.1	90	85	93.5	91.4	4.305	0.230
Zinc	84.2	77.5	83.3	89.5	85.2	3.972	0.265
Selenium	61.4	55	80	79	70.8	15.671	0.001
Copper	66.3	57.5	73.3	79.8	71.7	9.532	0.023
Iron	95	90	88.3	92.7	92.3	2.737	0.434
Omega 3 fatty acids	80.2	85.5	85	90.3	85.5	4.646	0.200
Polyphenols	59.4	60	73.3	77.4	68.9	10.482	0.015
Antioxidants	90.1	75	93.3	90.3	88.9	9.445	0.024
Prebiotics	77.2	62.5	83.3	87.1	80.3	12.588	0.006
Probiotics	84.2	77.5	91.7	87.9	86.2	4.695	0.196
Flavonoids	64.4	55	75	78.2	70.5	10.588	0.014

Foods that Help Boost Immunity

Table 5 gives knowledge regarding foods that help boost immunity. Ginger, lemon and oranges were reported by >95% as foods that boost immunity whereas asafoetida and betel leaves

reported by least participants (around 57-58%) as foods that boost immunity. Higher percentage of participants from South and Western Asia reported that holy basil, asafoetida, cardamom, nuts and Chawanprash help boost immunity as compared to

participants from Europe and East Africa ($p < 0.05$). Lower percentage of participants from Europe reported that betel leaves boost immunity as compared to participants from other 3 regions ($p < 0.05$).

Table 5: Knowledge regarding foods that boost immunity

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Ginger	98	95	93.3	93.5	95.1	2.878	0.411
Garlic	96	85	91.7	93.5	92.9	5.528	0.137
Holy basil	95	77.5	70	90.3	86.5	24.577	0.001
Cinnamon	88.1	82.5	80	87.1	85.5	2.573	0.462
Turmeric	97	95	93.3	91.9	94.2	2.752	0.432
Asafoetida	62.4	37.5	55	60.5	57.2	8.112	0.044
Carom seeds	85.1	70	68.3	78.2	77.5	7.616	0.055
Pepper	78.2	65	71.7	71.8	72.9	2.837	0.418
Cardamom	79.2	65	71.7	83.9	77.8	7.875	0.049
Cloves	86.1	75	75	83.9	81.8	7.749	0.191
Betel leaves	50.5	40	66.7	65.3	57.8	12.220	0.007
Black tea	73.3	62.5	63.3	74.2	70.5	3.895	0.273
Lemon	95	95	95	95.2	95.1	0.003	1.000
Oranges	97	90	98.3	95.2	95.7	4.683	0.197
Leafy vegetables	96	87.5	95	96	94.8	4.958	0.175
Nuts	88.1	72.5	78.3	94.4	86.8	17.189	0.001
Chia seeds	79.2	80	85	87.1	83.4	2.949	0.400
Flax seeds	81.2	80	83.3	84.7	82.8	0.722	0.868
Chawanprash	75.2	52.5	60	72.6	68.6	9.860	0.020

Data presented as percentage

Table 6: Overall Knowledge regarding immunity

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Mean	86	84	84	89	86	2.499	0.060
Standard deviation	13	14	16	14	14		
Minimum	57	51	45	45	45		
Maximum	100	100	100	100	100		
<70% *	15.8	25	20	8.9	15.1		
70 – 80% *	12.9	17.5	15	16.1	15.1		
80 – 90% *	19.8	15	15	11.3	15.1		
>90% *	51.5	42.5	50	63.7	54.8		

*data presented as percentage

Overall Knowledge

Table 6 gives overall percentage knowledge marks as obtained by study participants. As seen in Table 6, highest marks were obtained by participants

from Western Asia followed by South Asia then Europe and lastly East Africa. The overall minimum score obtained by participants was 45% and maximum was 100%. Apart from Europe, >50%

participants from all other 3 regions scored >90% marks on knowledge. Europe also had highest percentage of participants with <70% marks whereas Western Asia had least percentage of participants

with >70% marks. However, there was no significant difference marks obtained by participants of 4 regions, indicating that participants from all 4 regions had similar knowledge regarding immunity.

Table 7: Attitude of participants regarding immunity

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Rate your immune system							
1 (lowest)	-	-	1.7	0.8	0.6	17.890	0.119
2	4	2.5	1.7	7.3	4.6		
3	35.6	45	41.7	42.7	40.6		
4	49.5	50	43.3	31.5	41.5		
5 (highest)	10.9	2.5	11.7	17.7	12.7		
Attitude towards immunity							
Immunity can be boosted in short period	26.7	22.5	35	40.3	32.9	13.361	0.038
Do you need to improve your immunity	80.2	47.5	86.7	83.9	78.8	28.101	0.001
Eating healthy has kept immune system strong during pandemic	97	90	93.3	94.4	94.5	2.944	0.400
Can improve immune system through foods	97	100	100	95.2	95.2	4.836	0.184
Strong immunity is necessary to fight disease	94.1	95	91.7	89.5	92	2.120	0.548
People with co-morbidities have relatively low immunity	75.2	80	76.7	80.6	78.2	1.108	0.775
Healthy gut leads to good immunity	90.1	95	86.7	89.5	89.8	1.851	0.604

Data presented as percentage

Attitude of Study Participants Towards Immunity

Table 7 gives attitude of participants towards immunity. There was no significant difference in the participant’s rating of their immune system ($p>0.05$), however only 12.7% reported that they had the best immune system. Also, 0.6% participants rated only 1 and 4.6% rated only 2 for their immune system indicating that they believe that they need to boost their immunity.

32.9% reported that they feel that immunity can be boosted in short period indicating that almost 1/3rd of the study participants had the wrong perception that immunity can be boosted quickly. Higher percentage of participants from Western Asia and East Africa reported the same as compared to participants from South Asia and Europe ($p<0.05$).

Lower percentage of participants from Europe reported that they needed to improve their immunity

as compared to participants from other 3 regions ($p<0.05$).

Almost 92% participants reported that strong immunity is necessary to fight disease, 78.2% reported that people with co-morbidities have relatively low immunity and 89.8% participants reported that healthy gut leads to good immunity. There was no significant difference in percentage of participants from different regions reporting these factors ($p>0.05$).

Practices followed to Boost Immunity

Table 8 gives the practices followed by study participants during lockdown to boost their immunity. The most commonly adopted technique to boost immunity during lock down was to increase intake of eggs, meat and poultry and water. The least common method adopted technique during lock down to boost immunity was to take zinc supplements. There

was a significant difference in practices adopted by participants across different regions.

Higher percentage of participants from Western and South Asia consumed vitamin C supplements, Zinc supplements, omega-3 supplements, drank minimum 2 litres of water every day and took steam to boost immunity during the lockdown period as compared to participants from Europe and East Africa ($p < 0.05$). Lowest percentage of East African

participants used multi-vitamin supplements to boost immunity as compared to other 3 regions ($p < 0.05$). On the other hand, food-based strategies such as increasing intake leafy vegetables, curd/ yoghurt and meat/ poultry was found least in participants from Europe ($p < 0.05$). Herbal tea and green tea were used least by East African participants ($p < 0.05$). Highest percentage of participants from South Asia used turmeric milk to increase immunity ($p < 0.05$).

Table 8: Practice followed during lockdown to boost immunity by participants

	South Asia	Europe (UK)	East Africa	Western Asia	Total	χ^2 value	P value
Vitamin C supplement	57.4	47.5	35	67.7	56	18.933	0.001
Zinc supplement	27.7	12.5	15	41.9	28.9	21.190	0.001
Omega 3 supplement	36.6	25	15	45.2	34.5	18.144	0.001
Multi-vitamin supplement	40.6	47.5	25	63.7	47.4	27.182	0.001
Citrus fruits/ fruit juices	90.1	75	88.3	88.7	87.4	6.487	0.090
Increase intake of leafy vegetables	79.2	57.5	71.7	86.3	77.8	16.165	0.001
Increase intake of Curd/ yoghurt	78.2	65	68.3	87.1	78.2	13.251	0.004
Increase intake of Egg	83.2	70	80	87.9	82.8	7.199	0.066
Increase intake of Meat and poultry	78.2	60	81.7	90.3	81.2	19.157	0.001
Herbal tea	59.4	45	26.7	56.5	50.5	19.079	0.001
Green tea	57.4	57.5	35	65.3	56.3	15.243	0.002
Turmeric milk/ water	82.2	50	51.7	69.4	67.7	22.619	0.001
Drink minimum 2 litres of water	93.1	70	73.3	87.9	84.6	19.005	0.001
Steam	64.4	37.5	31.7	62.9	54.5	24.761	0.001

Herbal Tea Recipes

South Asia

Homemade herbal tea called Kadha made from readily available spices was the most commonly consumed herbal tea in South Asia. Cloves, cinnamon, black pepper, ginger and turmeric were the most commonly used ingredients. Some participants reported using holy basil, lemon, cardamom, carom seeds and tea leaves in their herbal tea concoction. Liquorice, fennel seeds and cumin seeds were among the less commonly used ingredients to make herbal tea.

Europe

Most participants from Europe used ready mix herbal tea mix to make herbal teas. Some of the participants reported making fresh herbal tea at home using turmeric, cloves, black pepper, lemon and honey

East Africa

Very few participants from East Africa reported herbal tea recipes. Most commonly they boiled some ginger with lemon and honey as herbal tea. Some participants reported to using green tea along with turmeric to make herbal tea during Covid lockdown.

Western Asia

Mint leaves along with lemon and green tea were commonly used ingredients to make herbal tea in Western Asia. Some participants also reported using whole spices, ginger and turmeric to make the herbal tea.

Discussion

In the current study, knowledge, attitude and practices regarding immuno-nutrition in Indians staying in various parts of the world are presented.

Participants achieved 87% marks on average for knowledge regarding immuno-nutrition and there were no significant differences in knowledge in Indians across the globe. The attitude and practices however varied from region to region.

Ever since the COVID-19 pandemic came about, various platforms and media channels have been flooded with information regarding ways to prevent and boost immunity to be able to better tackle the virus. About 92% of participants in this study reported that having strong immunity is necessary to fight disease. This can be explained by the surge of information regarding immunity as mentioned above. When scoring Indians from different countries regarding their knowledge on immunity, Indians from Western Asia obtained the highest marks followed by South Asia, Europe and then East Africa. This may be due to accessibility to social media platforms, time available to browse through the news and cultural myths and misconceptions.

Comorbidity significantly lowers our immune response and makes it harder to fight the virus. Level of comorbidity correlates with the magnitude of immune response in older adults.²² In the current study, 78.2% participants were aware that people with co-morbidities have relatively low immunity. Studies show that susceptibility to colds is increased by smoking.²³ Various studies have also reported that vaccine response is influenced by stress, alcohol consumption, sleeping habits and nutritional status.²⁴ In the current study, more than 85% participants accurately identified various factors affecting immunity.

Vitamins and minerals are said to boost immunity and immune function.^{11,25} A study done on how vitamins and trace elements support immune function showed that inadequate intake and status of trace elements may have led to suppressed immunity which predisposes to infections. It further stated that a deficiency or oversupply may impact virulence of otherwise harmless pathogens.²⁶ In this study, 90% of participants had the knew the importance of vitamins and minerals in improving immunity. However, these nutrients are required at adequate quantities for immune system to operate optimally.

There was a slight variation in nutrient knowledge across the continents as a higher percentage of Indians from East Africa and Western Asia reported that nutrients like selenium, copper and flavonoids can boost immunity compared to Indians from South Asia and Europe. This may be due to availability and accessibility of the knowledge as well as food and supplements available that could vary the knowledge and application of knowledge to improve immunity. For instance, even though 98.3 % of East Africans reported to know that vitamin C supplementation improves immunity however only 47.5% of them took in the supplement.

A recent study done on herbal remedies for immune boosting during Covid-19 pandemic, which stated that moonseed, liquorice, holy basil, ashwagandha and turmeric are most decorated single herbal drugs used as home remedies for boosting the immunity during Covid-19.²⁷ A recent review published on traditional foods and their antiviral and immune system modulating properties, emphasised the role of black-cumin (*Nigella Sativa*), garlic, cinnamon, licorice root, black pepper, *Moringa oleifera*, yoghurt, honey, mushrooms as foods one should include in the diet to help fight against infections include Covid-19 infection and for maintaining good health.²⁸ Bioactive components of spices²⁹ and probiotics³⁰ have also been widely identified as potential immune-modulators. Indians in the current study were also aware of the role of most of natural and traditional foods in boosting immunity.

Functional foods such as these, however, are not universal²⁵ and the ways in which they are incorporated in diets vary according to which part of the world the people come from. It was reported, in this study, that South Asians made homemade teas with readily available spices which could be due to availability of fresh and affordable spices in the region. Most participants from Europe used readymade herbal mixes to make teas. This may be due to greater availability of ready-made packets available in Europe compared to other regions. Mint leaves along with lemon and green tea were commonly used ingredients to make herbal tea in Western Asia.

One of the flaws of collecting data through an online survey form is that participants may use search engines to look for correct answers. To overcome this issue, the participants were requested specifically to not use search engines by mentioning it in form description. Also, this study only consists of Indians from 4 regions of the world and Indians are now located in almost all parts of the world. It is also essential to assess knowledge of participants coming from various socio-economic strata and educational background. Hence, a further detailed survey on a larger sample size needs to be conducted across the world to add on to the results of the current study.

Conclusion

To conclude, though the overall knowledge regarding immuno-nutrition was similar in Indians from all

4 regions, the attitude and strategies adopted to boost immunity varied from region to region. There is a need to conduct educational programs to help improve the attitude and strategies adopted to boost immunity in Indians staying across the globe.

Acknowledgement

Authors would like to thank all the participants for filling the Google Forms for this survey.

Funding

No external funding was availed for this study.

Conflict of interest

The authors declare no conflicts of interest

References

1. Maggini S, Pierre A, Calder PC. Immune function and micronutrient requirements change over the life course. *Nutrients*. 2018;10(10). doi:10.3390/nu10101531
2. Chowdhury MA, Hossain N, Kashem MA, Shahid MA, Alam A. Immune response in COVID-19: A review. *J Infect Public Health*. 2020;13(11):1619-1629. doi:10.1016/j.jiph.2020.07.001
3. Childs CE, Calder PC, Miles EA. Diet and immune function. *Nutrients*. 2019;11(8). doi:10.3390/nu11081933
4. Harapan H, Itoh N, Yufika A, Winardi W, Keam S, Te H, Megawati D, Hayati Z, Wagner AL, Mudatsir M. Coronavirus disease 2019 (COVID-19): A literature review. *J Infect Public Health*. 2020;13(5):667-673. doi:10.1016/j.jiph.2020.03.019
5. Butler MJ, Barrientos RM. The impact of nutrition on COVID-19 susceptibility and long-term consequences. *Brain Behav Immun*. 2020;87:53-54. doi:10.1016/j.bbi.2020.04.040
6. Covid 19 Inida. <https://www.covid19india.org/>
7. Ciara Linnane. Global tally of COVID-19 cases top 142 million as India's surge raises the alarm - MarketWatch. Accessed April 20, 2021. [https://www.marketwatch.com/story/global-tally-of-covid-19-cases-top-142-](https://www.marketwatch.com/story/global-tally-of-covid-19-cases-top-142-million-as-indias-surgings-cases-raise-the-alarm-11618929916)
8. million-as-indias-surgings-cases-raise-the-alarm-11618929916
8. Yaqinuddin A, Kashir J. Innate immunity in COVID-19 patients mediated by NKG2A receptors, and potential treatment using Monalizumab, Cholroquine, and antiviral agents. *Med Hypotheses*. 2020;140:109777-undefined. doi:10.1016/j.mehy.2020.109777
9. Headey D, Ruel M. The COVID-19 nutrition crisis: What to expect and how to protect | IFPRI : *International Food Policy Research Institute*. Published 2020. Accessed December 29, 2020. <https://www.ifpri.org/blog/covid-19-nutrition-crisis-what-expect-and-how-protect>
10. Thirumdas R, Kothakota A, Pandiselvam R, Bahrami A, Barba FJ. Role of food nutrients and supplementation in fighting against viral infections and boosting immunity: A review. *Trends Food Sci Technol*. 2021;110:66-77. doi:10.1016/j.tifs.2021.01.069
11. Shakoor H, Feehan J, Al Dhaheri AS, Ali HI, Platat C, Ismail LC, Apostolopoulos V, Stojanovska L. Immune-boosting role of vitamins D, C, E, zinc, selenium and omega-3 fatty acids: Could they help against COVID-19? *Maturitas*. 2021;143:1-9. doi:10.1016/j.maturitas.2020.08.003

12. Aman F, Masood S. How nutrition can help to fight against covid-19 pandemic. *Pakistan J Med Sci.* 2020;36(COVID19-S4). doi:10.12669/pjms.36.COVID19-S4.2776
13. Wagner DN, Marcon AR, Caulfield T. "Immune Boosting" in the time of COVID: Selling immunity on Instagram. *Allergy, Asthma Clin Immunol.* 2020;16(1):76. doi:10.1186/s13223-020-00474-6
14. Suarez-Lledo V, Alvarez-Galvez J. Prevalence of health misinformation on social media: Systematic review. *J Med Internet Res.* 2021;23(1):e17187. doi:10.2196/17187
15. Jayaseelan R, Brindha D, Kades W. Social Media Reigned by Information or Misinformation About COVID-19: A Phenomenological Study. *SSRN Electron J.* Published online May 13, 2020. doi:10.2139/ssrn.3596058
16. Zhong BL, Luo W, Li HM, Zhang QQ, Liu XG, Li WT, Li Y. Knowledge, attitudes, and practices towards COVID-19 among chinese residents during the rapid rise period of the COVID-19 outbreak: A quick online cross-sectional survey. *Int J Biol Sci.* 2020;16(10):1745-1752. doi:10.7150/ijbs.45221
17. Chen Y, Jin YL, Zhu LJ, Fang ZM, Wu N, Du MX, Jiang MM, Wang J, Yao YS. The network investigation on knowledge, attitude and practice about COVID-19 of the residents in Anhui Province. *Zhonghua Yu Fang Yi Xue Za Zhi.* 2020;54(4):367-373. doi:10.3760/cma.j.cn112150-20200205-00069
18. Bates BR, Moncayo AL, Costales JA, Herrera-Cespedes CA, Grijalva MJ. Knowledge, Attitudes, and Practices Towards COVID-19 Among Ecuadorians During the Outbreak: An Online Cross-Sectional Survey. *J Community Health.* 2020;45(6):1158-1167. doi:10.1007/s10900-020-00916-7
19. Geldsetzer P. Use of rapid online surveys to assess people's perceptions during infectious disease outbreaks: A Cross-sectional Survey on COVID-19. *J Med Internet Res.* 2020;22(4):e18790-undefined. doi:10.2196/18790
20. Ferdous MZ, Islam MS, Sikder MT, Mosaddek ASM, Zegarar-Valdivia JA, Gozal D. Knowledge, attitude, and practice regarding COVID-19 outbreak in Bangladesh: An onlinebased cross-sectional study. *PLoS One.* 2020;15(10 October):e0239254-undefined. doi:10.1371/journal.pone.0239254
21. Hezima A, Aljafari A, Aljafari A, Mohammad A, Adel I. Knowledge, attitudes, and practices of sudanese residents towards covid-19. *East Mediterr Heal J.* 2020;26(6):646-651. doi:10.26719/emhj.20.076
22. Castle SC, Uyemura K, Rafi A, Akande O, Makinodan T. Comorbidity is a better predictor of impaired immunity than chronological age in older adults. *J Am Geriatr Soc.* 2005;53(9):1565-1569. doi:10.1111/j.1532-5415.2005.53512.x
23. Cohen S, Tyrrell DAJ, Russell MAH, Jarvis MJ, Smith AP. Smoking, alcohol consumption, and susceptibility to the common cold. *Am J Public Health.* 1993;83(9):1277-1283. doi:10.2105/AJPH.83.9.1277
24. Zimmermann P, Curtis N. Factors that influence the immune response to vaccination. *Clin Microbiol Rev.* 2019;32(2). doi:10.1128/CMR.00084-18
25. Erickson KL, Medina EA, Hubbard NE. Micronutrients and innate immunity. *J Infect Dis.* 2000;182(3 SUPPL. 1):s5-s10. doi:10.1086/315922
26. Maggini S, Wintergerst ES, Beveridge S, Hornig DH. Selected vitamins and trace elements support immune function by strengthening epithelial barriers and cellular and humoral immune responses. *Br J Nutr.* 2007;98(SUPPL. 1):29-35. doi:10.1017/S0007114507832971
27. Bhokardankar P, Rathi B, Khan M, Rathi R. COVID-19 pandemic: Home remedies for immunity boosting. *Int J Res Pharm Sci.* 2020;11(Special Issue 1):734-738. doi:10.26452/ijrps.v11iSPL1.3075
28. Rahman MM, Mosaddik A, Alam AK. Traditional foods with their constituent's antiviral and immune system modulating properties. *Heliyon.* 2021;7(1):e05957. doi:10.1016/j.heliyon.2021.e05957
29. Natesh J, Mondal P, Penta D, Abdul Salam AA, Meeran SM. Culinary spice bioactives as potential therapeutics against SARS-CoV-2: Computational investigation. *Comput Biol Med.* 2021;128:104102. doi:10.1016/j.

- combiomed.2020.104102
30. Singh K, Rao A. Probiotics: A potential immunomodulator in COVID-19 infection management. *Nutr Res.* 2021;87:1-12. doi:10.1016/j.nutres.2020.12.014