

# Quality and Content of Online Information Related to “Immunity Boosting” During COVID-19 Pandemic: Comparison of Google and DuckDuckGo

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## ABSTRACT

Use of internet for assessing health-related information has been growing exponentially in the past few years. The objective of this study was to assess the quality of information on the websites on Google and DuckDuckGo. A total of 120 URLs were recorded from Google and DuckDuckGo using the search terms “immunity booster,” “immunity boosting foods,” and “immunity boosting drinks.” These were rated by three independent raters using DISCERN tool. The average ratings for the DISCERN questions were in the range of 2.01–3.82. More than 85% of the websites were of moderate quality. There was excellent inter-rater reliability among the raters. About 47% of the websites depicted immunity boosting as beneficial. About 11% of the websites recommended use of supplements for immunity boosting. Diet, exercise, and adequate sleep were the most commonly recommended strategies for immunity boosting. Vitamin C, Vitamin A, and gingerol were the most commonly recommended dietary components for immunity boosting. Overall, there was no statistically significant difference in the quality of websites on Google and DuckDuckGo. Most of the websites suffered from shortcomings in the quality of information based on DISCERN quality criteria.

**Keywords:** DISCERN tool, Immunity boosting, Information quality, Internet, Online health information

*Asian Pac. J. Health Sci.*, (2022); DOI: 10.21276/apjhs.2022.9.1.42

## INTRODUCTION

Online health information has become one of the most sought after source of information in the present times. It is estimated that almost 7% searches on Google are health related.<sup>[1]</sup> The key attributes of internet that attract a large number of health information seekers are that it is convenient, provides privacy and anonymity, enables access to large amount of information in less time, and is economical.<sup>[2,3]</sup> As the COVID-19 emerged as a global cause of concern, anxiety among people to know more about the virus and ways to protect themselves from it also increased simultaneously as can be seen from the analysis of Google trends, which shows a subsequent increase in searches related to coronavirus and ways to strengthen the immune system to fight off the novel virus. Several products on various media platforms were advertised as being protective against the novel coronavirus. The concern can be clearly seen from the statement of the WHO General Director, “We’re not just fighting a pandemic, we’re fighting an infodemic.”<sup>[4]</sup> During the times of any pandemic, accurate and reliable health information, at right time, is of vital importance as it also influences people’s reactions to such situations and enables them to make well-informed health related decisions.<sup>[5]</sup>

A person’s capability to identify poor quality information and the proportion of such information are the two important factors that together determine the chances of coming across such websites.<sup>[6]</sup> The previous studies done on the assessment of quality of information on internet have shown variability in overall results.<sup>[5,7-12]</sup> According to a review on the quality of information on the web, out of 79 studies reviewed, 70% reported quality of web-based information as an important issue. However, the review concluded that the amount of inaccurate information tends to differ across domains, with diet- and nutrition-related sites having 45–89% inaccurate information.<sup>[6]</sup> The domain of web-based information is highly unregulated leading to wide variability

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**How to cite this article:** Shrivastava A, Agarwal A, Jain S. Quality and Content of Online Information Related to “Immunity Boosting” During COVID-19 Pandemic: Comparison of Google and DuckDuckGo. *Asian Pac. J. Health Sci.*, 2022;9(1):142-147.

**Source of support:** Nil

**Conflicts of interest:** None.

**Received:** 15/07/21

**Revised:** 22/11/21

**Accepted:** 05/12/21

in its quality and accuracy.<sup>[13]</sup> Competencies in e-health literacy enable the people to use technology and modern communication channels for improving their health. e-health literacy is the ability of the people to acquire, understand, and utilize the information from electronic sources to solve health problems.<sup>[14]</sup> People with poor health literacy skills end up making incorrect health choices, leading to poor health outcomes.<sup>[15]</sup>

The quality of online health information has always remained a cause of concern for health-care professionals, as is evident in case of many researches and tools that have been designed to assess the quality of health information on the internet such as DISCERN, JAMA, HONcode, and other quality indicators given by various authors.<sup>[16,17]</sup> Each of these has a separate set of quality criteria for evaluating any piece of health information. DISCERN instrument is a standardized quality index which was developed at Oxford University.<sup>[4]</sup> It enables consumers of health information and those providing health information to assess information quality. It also helps the people in filtering out good quality information while discarding inaccurate and confusing advices.<sup>[18]</sup> This research study

was undertaken to analyze the quality of information available online with respect to “immunity boosting” on the search engines Google and DuckDuckGo in English language. The specific objectives were as follows:

- To rate the quality of information of the selected websites using DISCERN tool
- To study the correlation of the DISCERN score of the selected websites and their sequence of appearing during search on Google and DuckDuckGo
- To analyze the content of information available on selected websites
- To compare the content of information available on search engines Google and DuckDuckGo

## METHODS

### Keywords Selection

To find out the most commonly used phrases while searching information on Immunity Boosting, “Google Trends” was used. It is a website by Google that analyzes daily Google searches and provides data on geospatial and temporal patterns in search volumes for user-specified terms. The tool allows for the tracking of various words and phrases that are typed into Google’s search box.<sup>[19]</sup> On the Google Trends website, country “India” was selected and in the search box “Immunity Boosting” was typed. Then from the related queries section, most searched relevant terms were selected. The three terms that were selected were “immunity booster,” “immunity boosting foods,” and “immunity boosting drinks.”

### Website Selection

To prevent customized results, all the cookies were deleted along with the browser history. Then, the selected keywords were typed into Google’s search box one by one and the top 20 websites in the order of their appearance during search were taken for rating. All the websites having irrelevant content; requiring sign in or payment; having non-functional links; with content not in English language; duplicates; or containing books, journal articles, etc., were excluded from the study. A total of 60 websites were thus retrieved for rating.

Similarly, for accessing websites from DuckDuckGo, the cookies and browser history were deleted and then the keywords were typed into DuckDuckGo search box and 60 websites were retrieved for rating (20 for each keyword). Thus, a total of 120 websites were retrieved for rating and analysis.

### Rating of the Websites

The URLs of all the eligible websites from both the search engines were copied on a Microsoft Excel sheet and given to three independent raters for rating using DISCERN tool. The original DISCERN tool has 15 questions and one for overall rating. For the purpose of this study, three questions were removed from the original questionnaire as they were not relevant to this study topic.

Each quality criteria described in the tool, in the form of tool questions gets a rating on a 5-point Likert scale, where “1” denotes that the given quality criteria are missing in the publication, ratings from “2 to 4” mean that the quality criteria have been partially

fulfilled to a certain extent, and “5” signifies that the quality criteria have been completely fulfilled.<sup>[18]</sup>

### Content Analysis

Analysis of the content of all the websites was performed to examine various important aspects of immunity boosting for an infection. However, some websites out of all were specific for coronavirus infection. Based on the information available in all of the websites used for rating, the websites were classified as whether portraying immunity boosting as beneficial, not beneficial, or neutral. Websites were also analyzed for assessing whether they were promoting any type of nutritional supplements for boosting the immune health, here, the coding was done as “yes” or “no” where yes implied that the website talked about or promoted any supplement and no implied that either the website did not have any information on supplements or supplements were described as unnecessary. Since balanced intake of nutrients in appropriate amounts is the key to long-term health, websites were given a code “yes” if they had any cautionary message regarding appropriate consumption or limited consumption of immunity boosting products/food items/nutrients, if they mentioned the tolerable upper limit of any immunomodulatory nutrient and they were given a code “no” if they did not have any such cautionary message or information to warn or inform the readers about possible detrimental effects of overconsumption of the immunity boosters. The websites were also analyzed for methods or strategies for boosting the immune system along with mention of any possibly harmful factors which can negatively affect immunocompetence of an individual. These were also listed down to find out the most frequently promoted immunity boosting strategy on web. Similarly, various nutrients, bioactive compounds, foods, and drinks (in the form of the main nutrient or bioactive compound present in them) that were being recommended to be beneficial in enhancing immune function were also recorded.

### Correlation of DISCERN Score with Order of Appearance of Websites during Web Search

Visibility of any website on a search engine depends on the algorithms used for ranking and ordering, as per the ranking position that has been calculated.<sup>[20]</sup> Websites with higher ranking on search engine results page (SERP) are more likely to be viewed by the consumers.<sup>[9]</sup> To determine whether the sequence in which the websites appeared on search was dependent on the quality of the information on the website, Spearman’s correlation test was applied to each set of links for every topic on each search engine.

### Statistical Analysis

Statistical analysis was performed using SPSS version 22 and GraphPad Prism 7. Descriptive statistics were calculated as means, standard deviations, and percentages. Inter-rater reliability was computed using intraclass correlation coefficient (two-way mixed model) which measures the degree of agreement or disagreement among the raters in the form of kappa.<sup>[21]</sup> Univariate analysis of variance (ANOVA) was computed to determine if there was any significant difference in the quality of websites retrieved from the search engines Google and DuckDuckGo. Spearman’s correlation was used to assess the correlation between the DISCERN score given to each website by the three raters with the order of

appearance of websites during web search. For content analysis, data were expressed as means and percentages. Ethical clearance for this study was obtained from the Institutional Ethics Committee of Lady Irwin College, University of Delhi, before data collection from the participants.

## RESULTS

### Quality Rating

The question wise average rating given to all the websites on Google and DuckDuckGo is presented in Table 1. Overall, the average question ratings ranged from 2.01 to 3.82 indicating amoderate or fair quality with no rating being in the extremities, that is, 1 or 5. The number and percentage of total websites on Google and DuckDuckGo which were of low, moderate, and high quality are shown in Table 2. The websites with low-quality information were the ones that got a total score of <26 (or <40%), those which got between 26 and 51 (or 40–79%) were classified as moderate quality websites, and the websites which got a DISCERN score of more than 51 out of 65 (>79%) were classified as high-quality websites. The comparison of the average scores given to Google and DuckDuckGo, for each search term, is shown in Table 3.

The inter-rater reliability computed using Intraclass correlation coefficient (ICC) was 0.592 (95% CI = 0.496–0.680) for single measures, which indicate fair degree of agreement among the three raters. The ICC value for average measure came out to be 0.813, which is an indicator of excellent agreement among the raters.<sup>[21]</sup>

Spearman's rank correlation coefficient was used to assess the correlation between a website's position in the search results and its quality of information. Table 4 shows the results of the Spearman's correlation coefficient, which indicates non-significant associations between a website's rank in the search results and its quality. Greater correlation was seen in case of websites from DuckDuckGo when compared to Google.

### Content Analysis

Almost 47% of websites depicted immunity boosting as beneficial, 4% depicted it as not beneficial, and 49% were neutral about it.

Only 14% of the websites had any warning to prevent people from overconsumption of the immunity boosting products being recommended. Similarly, only 11% of the websites recommended nutrient supplements for immunity boosting. Percentage of websites recommending various strategies to boost the immune system on Google and DuckDuckGo is shown in Figure 1. Percentage of websites on Google and DuckDuckGo recommending various nutrients and bioactive compounds for boosting the immune system is shown in Figure 2.

The most frequently recommended vitamin and mineral were Vitamin C (or citrus fruits) and zinc. Other minerals deemed as beneficial were selenium, magnesium, calcium, iron, and potassium. Protein and fats such as MCFAs and omega 3 were the main macronutrients linked to a better functioning immune system. The bioactive compounds associated with immune health were gingerol (or ginger), curcumin (or turmeric), allicin (or garlic), epigallocatechin gallate (EGCG), piperine, and antioxidants or compounds with potential antioxidant function, such as anthocyanins, theobromine, and flavonoids. Other spices which contain certain compounds which were said to have the potential to increase immunity of a person against pathogenic microbes are cumin seeds, coriander seeds, cinnamon, nutmeg, clove, star anise, fennel seeds, cardamom, etc. Among the herbs, Tulsi or Holy Basil (*Ocimum tenuiflorum*), giloy or heart-leaved moonseed (*Tinospora cordifolia*), Ashwagandha or Indian Ginseng (*Withania somnifera*), licorice (*Glycyrrhiza glabra*), thyme leaves (*Thymus vulgaris*), ginseng (*Panax ginseng*), oregano (*Origanum vulgare*), Green Chiretta or Nilavembu (*Andrographis paniculata*), etc., were recommended. Some websites also mentioned honey and prebiotics and/or probiotics such as kefir and yogurt as immunity boosters.

## DISCUSSION

The present study was done to analyze the quality and content of online information related to immunity boosting. The purpose of this study was to assess the health information on websites from Google and DuckDuckGo.

The moderate ratings (2.97 and 3.08) received by the websites indicate that the information on these websites was of "fair quality" which means that it is useful information source but with some

**Table 1:** Average ratings given to websites on Google and DuckDuckGo

Q. No.	Discern questions	Average discern scores					
		Google		DuckDuckGo		Total	
		Mean	SD	Mean	SD	Mean	SD
1	Are the aims clear?	3.6	0.39	3.67	0.15	3.64	0.99
2	Does it achieve its aims?	3.56	0.61	3.62	0.34	3.59	0.99
3	Is it relevant?	3.79	0.25	3.84	0.37	3.82	0.84
4	Is it clear what sources of information were used to compile the publication (other than the author or producer)?	2.06	0.04	2.44	0.46	2.25	1.42
5	Is it clear when the information used or reported in the publication was produced?	2.39	0.52	2.62	0.71	2.51	1.39
6	Is it balanced and unbiased?	3.43	0.35	3.62	0.24	3.53	1.23
7	Does it provide details of additional sources of support and information?	1.97	0.76	2.13	0.96	2.056	1.21
8	Does it refer to areas of uncertainty?	2.49	0.34	2.53	0.34	2.51	1.40
9	Does it describe how each immunity enhancement method works?	3.42	0.36	3.57	0.32	3.49	1.01
10	Does it describe the benefits of using these immunity enhancement methods?	3.58	0.11	3.68	0.20	3.63	1.00
11	Does it describe the risks of using these immunity enhancement methods?	1.98	0.26	2.04	0.15	2.01	1.11
12	Is it clear that there may be more than 1 possible method to enhance immunity?	3.07	0.33	3.12	0.3	3.09	1.34
13	Based on the answers to all of the above questions, rate the overall quality of the publication as a source of information	3.18	0.26	3.27	0.19	3.22	0.93

Red: Below average values (mean<2.5); Green: Above average values (mean>2.5)

shortcomings.<sup>[18]</sup> DISCERN questions assessed clarity of aims and whether those aims were achieved, balanced information, description of how each immunity enhancement method works, the benefits of using these immunity enhancement methods, mention of other possible methods to enhance immunity, relevance of the information, and overall quality received above average (>2.5) scores. DISCERN questions assessed sources of information, when the information was produced, details of additional information sources, areas of uncertainty, and risks associated with using the immunity enhancement methods received below average (<2.5) scores. Overall, majority of the websites were of moderate quality receiving a rating in the range of 26–51 ( $n = 103, 85.83\%$ ), followed by 10.83% websites, which were classified as high quality. The sum of total scores received by each website, that is, 65 were divided into three parts, similar to the criteria used in another study in which those websites which received less than 40% of the total were categorized as low quality, those between 40 and 79% of the total score were moderate quality, and those above it were classified as high-quality website.<sup>[3]</sup> The results of this study are similar to the findings of several previous studies assessing online health information quality using DISCERN.<sup>[7,8,10,12,22]</sup> In another study, when the information on childhood epilepsy on Google was assessed by lay subjects around 79% of the websites were classified as fair (or moderate), less than 20 were poor, and around 2% belonged to good category.<sup>[3]</sup>

A study on 109 people showed that more than 91% of the people do not go beyond first page in search results when looking for information on internet, while 50% do not go below the third website.<sup>[8]</sup> The findings of this study showed that there was no statistically significant relationship between a website's ranking in the search results and the quality of information based on DISCERN quality criteria, although weak to moderate negative association was seen for most of the topics on both Google and DuckDuckGo. These findings were similar to the results of another study which

assessed the quality of nutrition related information on Google and Yahoo using DISCERN and EQIP score.<sup>[9]</sup>

Less than half of the websites (47%) depicted immunity boosting as beneficial, while only 4% considered it as not beneficial. Majority of websites (86%) did not have any information about the amount of immunity boosting products that should to be consumed or the harm that could be caused due to overconsumption of these immunity boosting products. Merely 11% of the websites recommended the use of these supplements for boosting immunity.

Diet, exercise, appropriate sleep, and reducing stress were the most commonly recommended strategies by the websites. Evidences indicate that poor diet, comprised energy rich and micronutrient deficit food items, chronic stress, sedentary lifestyle, obesity, sleep deprivation, pollution, smoking, and excessive alcohol consumption, leads to compromised immune function thereby increasing their risk of getting infected. Reactive oxygen species (ROS) produced in and due to pollution can lead to imbalance of the oxidant-antioxidant ratio in the body thereby leading to oxidative stress. Chronic stress and excessive alcohol consumption can lower the immune response. Sleep is important for immunological memory and its deprivation can lead to dysregulation of NK cells and cytokines.<sup>[23]</sup>

A large number of nutrients and bioactive compounds have been recommended as having immunity boosting effects. In their review papers, Maggini *et al.*<sup>[23]</sup> and Monnerat *et al.*<sup>[24]</sup> discuss about several *in vitro* and *in vivo* evidences about the key roles played by micronutrients in the innate and adaptive immunity immune system. Vitamin C functions as an antioxidant, thereby protecting lymphocytes from oxidative stress along with playing key role in functioning and production of cells such as T cells, natural killer cells, and leukocytes. Vitamin A is of vital importance in the performance of B and T cells along with helping in proper functioning of the cells responsible for innate immunity. Antibodies production and the activity of NK cells are also dependent on Vitamin B6, which also helps in regulation of inflammation. Studies have shown the potential effects of Vitamin B7 in immune responses and in enhancement of T CD4 lymphocyte response. Folate deficiency can depress the immune response to the antigen. Vitamin B 12 regulates helper and cytotoxic T cells proportion along with contributing to antibodies metabolism. Vitamin D affects macrophage differentiation and reduces pro-inflammatory cytokines production along with improving anti-inflammatory cytokines levels in the body. The anti-inflammatory and antioxidant functions of Vitamin E protect the T cells in addition to improving the activity of NK cells and proliferation of lymphocytes. Zinc is an important antioxidant protecting against both ROS (reactive oxygen species) and RNS (reactive nitrogen species). Inflammatory cytokines production and regulation are affected by iron, which also generates ROS, thereby killing the pathogens affecting immune system. Magnesium protects the DNA from oxidative damage while selenium affects the functioning of natural killer cells and leukocytes.<sup>[23,24]</sup>

Bioactive compounds which are mainly found in plant-based

**Table 2:** Proportion of websites with low-, medium-, and high-quality information on Google and DuckDuckGo

Search engine	Low		Moderate		High	
	n	%	n	%	n	%
Google	2	3.33	53	88.33	5	8.33
DuckDuckGo	2	3.33	50	83.33	8	13.33
Total	4	3.33	103	85.83	13	10.83

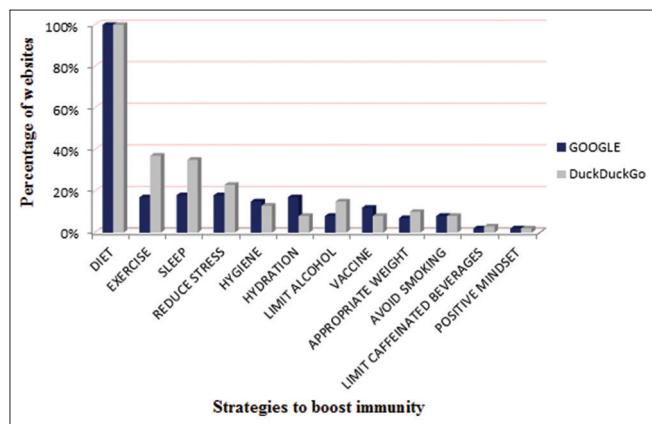
**Table 3:** Comparison of the quality of websites on Google and DuckDuckGo based on their DISCERN scores for each search term

Search engine	n	Google (Mean±SD)	DuckDuckGo (Mean±SD)	F	P-value
Total	60	2.97±0.59	3.08±0.64	1.08	0.30
Immunity booster	20	3.08±0.62	3.50±0.58	4.94	0.03 <sup>a</sup>
Immunity boosting foods	20	3.13±0.45	2.95±0.57	1.15	0.29
Immunity boosting drinks	20	2.69±0.62	2.79±0.57	0.30	0.58

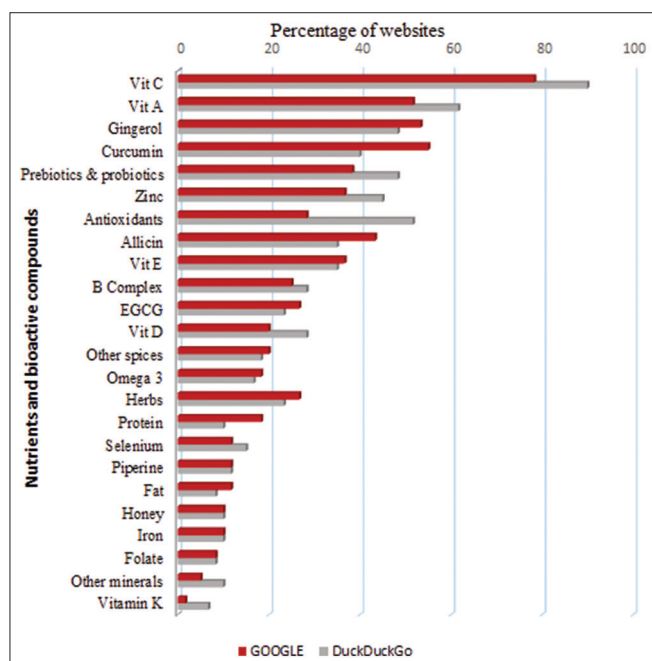
<sup>a</sup>Level of significance  $\alpha < 0.05$

**Table 4:** Analysis of correlation between a website's position and its quality on Google and DuckDuckGo

Search term	Google			DuckDuckGo		
	$r_s$	95% CI	P-value	$r_s$	95% CI	P-value
Immunity booster	-0.2289	-0.6184–0.251	0.3318	-0.4281	-0.7384–0.03178	0.0597
Immunity boosting foods	-0.2908	-0.6577–0.1878	0.2136	-0.3422	-0.689–0.132	0.1397
Immunity boosting drinks	0.0391	-0.4221–0.4843	0.8700	-0.1602	-0.5724–0.3166	0.4998



**Figure 1:** Percentage of websites recommending various strategies to boost the immune system



**Figure 2:** Percentage of websites recommending various nutrients and bioactive compounds for immunity boosting

products are known to provide pharmacological benefits. There are certain pathways through which these compounds impact the immune system. Studies have shown that polyphenols such as resveratrol, curcumin, epigallocatechin gallate (EGCG), and gingerol are helpful in reducing inflammation and oxidative stress. These have also been associated with cell count of immune system and its differentiation. Modulation of the cells of the immune system and cytokine production is impacted by polyphenols. The antioxidant and anti-inflammatory functions of curcumin are well known. Along with this, it is also known to protect against microbes such as viruses and bacteria.<sup>[24]</sup> It is known to bind with viral cells, thereby causing a reduction in its infectivity. Similarly, gingerol in ginger has anti-inflammatory property. *In vitro* studies have shown that quercetin and catechin have an influence in the balance of production of pro- as well as anti-inflammatory cytokines. Polyphenols have also been found to be affecting NF-κB signaling pathways by modulating NF-κB. Prebiotic and probiotic also have

immunomodulatory benefits and can interact beneficially to boost the immune system of the host. Probiotics, which are the beneficial microbes, help in immunity boosting by secreting antimicrobials, competitively excluding gastrointestinal pathogens for adhesion sites and nutrition. Prebiotics which are beneficial substrates function in a variety of ways like in maintaining gut barrier integrity, downregulating certain pro-inflammatory markers, and upregulation lymphocytes.<sup>[25]</sup>

These findings support the results of another study, in which analysis of the websites on immunity boosting on Google showed that among the dietary factors considered important for functioning of immune system, use of Vitamin C (34.8%) was the most commonly recommended vitamin followed by Vitamin D. Among the minerals, zinc (26.9%) was the most recommended while 11% mentioned other minerals. Other than these, garlic (21.6%), herbs and spices (21%), ginger (15%), turmeric/curcumin (12.8%), probiotics and prebiotics (15%), etc., were the others recommended.<sup>[26]</sup>

### CONCLUSION

Consumption of a variety of fruits and vegetables, spices, and herbs can ensure intake of these beneficial nutrients and other beneficial compounds. Results of this study show that a variety of food-related components has been promoted which can help in ensuring a nutritionally varied and potentially adequate diet, thereby helping the immune system to function optimally. However, it is also important to consider that the potential of these in proving protection against any infection, particularly COVID, has not been proven. Hence, even though these can potentially enhance immune system and improve immunocompetence of an individual, these should be promoted or considered to be substitutes to cautionary measures to provide protection against the coronavirus such as wearing masks and washing hands. Furthermore, it is alarming that only 14% of the websites assessed had information or warning for adequate consumption. These immunity boosting foods and drinks should be consumed only in appropriate quantities as overdoing it can lead to toxicity or can pose threats to the health of the people.

The limitations of this study are that due to paucity of time and resources, only limited number of websites on both the search engines could be assessed for evaluating the information. Furthermore, this study assessed the information available in English only. Many people prefer to read information in their regional languages and their information quality may be different from that of English language websites. Further studies on other search engines and/or using other quality assessment tools can be undertaken to find out the differences in the quality of web-based information based on search engines.

The findings of this study can be used to educate the consumers of health information about the various possible quality parameters that should be looked for whenever they are searching for any information related to their health. They can be made aware about the major limitations of the health-related information (esp. immunity boosting related) available on internet. Enhancing the capability of the people in assessing the quality of any piece of information which can affect their health before following it blindly will be very important in improving the health of the public. Furthermore, these findings might be useful to the website content creators of health-related information to create websites providing good quality information to the readers.

## ACKNOWLEDGMENTS

The authors would like to express their deepest gratitude to the study participants for their invaluable time and support throughout the study.

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