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Covid-19 and "Immune Boosting" on the Internet: A Content Analysis of Google Search Results

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ABSTRACT

Objective: The spread of misinformation has accompanied the coronavirus pandemic, including topics such as immune boosting to prevent COVID-19. This study explores how immune boosting is portrayed on the Internet during the COVID-19 pandemic.

Design: Content Analysis

Methods: We compiled a dataset of 227 webpages from Google searches in Canada and the US using the phrase "immune boosting" AND "coronavirus". We coded webpages for typology and portrayal of immune boosting and supplements. We recorded mentions of microbiome, whether the webpage was selling or advertising an immune boosting product or service, and suggested strategies for boosting immunity.

Results: No significant differences were found between webpages that appeared in the searches in Canada and the US. The most common types of webpages were from news (40.5%) and commercial (24.7%) websites. The concept of immune boosting was portrayed as beneficial for avoiding COVID-19 in 85.5% of webpages and supplements were portrayed as beneficial in 40% of the webpages, but commercial sites were more likely to have these portrayals. The top immune boosting strategies were vitamin C (34.8%), diet (34.8%), sleep (34.4%), exercise (30.8%), and zinc (26.9%). Less than 10% of the webpages provide any critique of the concept of immune boosting.

Conclusions: Pairing evidence-based advice for maintaining one's health (e.g., healthy diet, exercise, sleep) with the phrase immune boosting and strategies lacking in evidence may inadvertently help to legitimize the concept, making it a powerful marketing tool. Results demonstrate how the spread of misinformation is complex and often more subtle than blatant fraudulent claims.

Keywords: misinformation, COVID-19, coronavirus, immune boosting, Internet

ARTICLE SUMMARY

Strengths and Limitations of the Study

- The study includes a large dataset of webpages that appear in Google searches in Canada and the US during a critical period in the pandemic.
- Data analysis identifies and characterizes a common coronavirus-related prevention strategy in a range of online contexts.
- Inter-rater reliability of coding was high with strong to almost perfect agreement.
- Dataset represented English-language webpages only based on a specific query conducted at two points in time in two regions.

INTRODUCTION

The coronavirus pandemic has been accompanied by the spread of misinformation on topics that include the marketing of and speculation on possible cures, treatments and preventative strategies. Some scholars have noted that this "infodemic" – as the World Health Organization called it – has already resulted in considerable harm.[1-4] Specifically, this infodemic is associated with deaths, delayed treatment, wasted resources, and substantive concerns that it adds to an already confused and chaotic information environment.[5-7]

Boosting the immune system is a common theme associated with many of the products and practices presented as strategies to avoid or help fight COVID-19. Indeed, a Google Trends analysis reveals that searches for phrases like "immune boost" and "immune boosting" spiked in early February, 2020, as concern about the impact of the virus started to intensify. However, the concept of immune boosting is misleading and scientifically inaccurate.[8,9] The immune system is fantastically complex and researchers are still exploring how various nutrients impact its performance, with overly active immune systems potentially leading to autoimmune diseases and anaphylaxis. Some early research studies have also suggested that an exaggerated immune response is implicated in respiratory failure in patients with COVID-19.[10] There is no evidence that any product or practice – aside from a vaccine – will provide extra or enhanced "immune boosting" protection against COVID-19.

Despite this reality, celebrities, wellness gurus and supplement companies have been making claims about the need and ways to boost our immune system.[11] These popularisations are entangled with the general public's belief that supplements improve a body's immune system,[12,13] resulting in immune boosting becoming commonly associated with pop culture representations of COVID-19. Additionally, there is some evidence that the kinds of COVID-19 information that people are exposed to affects their health-related behaviours and attitudes.[14,15] As such, the public responses to the pandemic in Canada and the US warrant further exploration of how misinformation may impact on perceptions of how to prevent and protect against COVID-19.[16,17] This study therefore focuses on how immune boosting and supplements are being portrayed with respect to COVID-19 in Canada and the US.

METHODS

Data Collection

Following Macedo et al.,[18] we conducted searches on Google Chrome®, the most widely used search engine,[19] using the phrase "boost immunity" AND "coronavirus" on April 1, 2020 in Winnipeg, Canada to compile a dataset of URLs for analysis. To limit personalization of the search results, we did not link the browser to an existing Google account, and we deleted cookies and erased the browser history. We conducted advanced searches, which allowed us to select regional

settings. We first conducted a search with the region set to Canada, then deleted all cookies and erased the browsing history, and conducted the same search the region set to the US.

We transferred the URLs from each search result to an MS Excel spread sheet, noting the country and result number. Google Chrome automatically omits similar results, so we collected all of the URLs for each search until we reached the automatically generated message "In order to show you the most relevant results, we have omitted some entries very similar to the [#] already displayed. If you like, you can repeat the search with the omitted results included." After, visiting and reading each webpage, we excluded 35 URLs because they were irrelevant (i.e. not about immune boosting and/or coronavirus), behind a paywall, or inaccessible (i.e. broken links). The resulting data set consisted of 227 webpages.

Content Analysis

We analyzed the webpages using a coding framework similar to previous studies conducted by our team.[20-24] Only the content on the webpage linked to the URL was coded. We first coded the typology of the websites in which the webpages appeared (Table 1). Webpages were then coded for how immune boosting and supplements were portrayed, whether an immune boosting product or service was being sold or advertised on the webpage, and whether the microbiome or gut health was mentioned. For webpages that portrayed immune boosting as beneficial to preventing COVID-19, we recorded the suggested immune boosting strategies, that is, the actions people can take to boost their immune systems. Webpages that suggested taking vitamins and minerals (e.g., Vitamin C, Zinc) through food and/or supplements were coded for those specific vitamins or minerals, not food or supplement. Similarly, we recorded an immune boosting strategy as "supplements and vitamins" when the webpage made a general reference to these types of products or in reference to taking a multivitamin or supplement with multiple immune boosting ingredients.

Table 1: Examples of website typologies used in this study

Typology	Example
News	https://www.express.co.uk
	https://www.cbc.ca/news
Commercial	https://delightyoga.com
	https://www.previnex.com
Magazine	https://www.yogajournal.com
	https://www.womensrunning.com
Blog	https://www.romper.com
	https://www.sassymamasg.com

Health Portal	https://www.medicaldaily.com
	https://www.healthing.ca
Non-profit organization	https://www.goodgrub.org
	https://www.zmescience.com
Professionals	https://health.clevelandclinic.org
	https://discoveries.childrenshospital.org
Scientific journals	https://www.ncbi.nlm.nih.gov
	https://www.e-jer.org/journal
Government body or governing body	https://www.who.int
	http://www.bccdc.ca
Other	https://newsthump.com
	https://www.sycamorespringssl.com

Two coders analyzed the entire data set of URLs. To determine reliability of coding, a third coder coded the subjective items in a sample of 45 URLs, roughly ~20% of the data set. Inter-coder reliability was calculated for these items. Cohen's kappa for typology of the website, portrayal of immune boosting, and portrayal of supplements were calculated at 0.886, 0.900, 0.962 respectively, demonstrating strong to almost perfect agreement.[25] An audit of the immune boosting strategies was conducted by the third coder to determine accuracy. Disagreements were discussed between two coders, CR and AM, until agreement was reached.

Statistical Analysis

Data were analyzed using descriptive statistics in SPSS 25. We used the Chi-square test to compare website typologies and portrayals, to compare results from the search in Canada and the search in the US, and to compare the whole data set to the top 20 search results generated by each search, since these results have a higher chance of being read.[26]

Ethics Approval

Ethical approval was not sought because this research did not involve human participants.

Patient and Public Involvement

This research was done without patient or public involvement. Patients or members of the public were not invited to comment on the study design and were not consulted to interpret the results. Patients or members of the public were not invited to contribute to the writing or editing of this document for readability or accuracy.

RESULTS

The search in Canada yielded 171 websites and the search in the US yielded 173 websites, with 117 URLs overlapping, 54 URLs being unique to the Canadian search, and 56 being unique to the US search. No significant differences were found in the results between Canada and the US for website typology (X^2 (9, N = 344) = 5.35, p = .803), portrayal of immune boosting (X^2 (2, N = 344) = 1.24, p = .538), and portrayal of supplements (X^2 (2, N = 344) = 0.98, p = .614). Similarly, no significant differences were found between the whole data set and the webpages that appeared in the top 20 search results for website typology (X^2 (9, N = 252) = 8.65, p = .470), portrayal of immune boosting (X^2 (2, N = 252) = 4.76, p = .094), and portrayal of supplements (X^2 (2, N = 252) = 0.033, p = .984). Since no significant differences were observed between the search results for the two regions, we present the results from analysis of the whole data set of 227 unique URLs. For results associated with the top 20 search hits, we include the webpages that appear in the top 20 search results of at least one of the regional searches, for a total of 25 webpages.

The two primary types of websites were news and commercial websites (Table 2). News sites made up over 50% of the websites that appeared in the top 20 search results, while commercial sites only made up 16%. In many cases, the typology of websites was difficult to discern, as evidenced by the high number of websites coded as "other", and many sites exhibited characteristic features of more than one typology, for example, a news-style website that was advertising a specific immune boosting supplement. Therefore, we also coded whether the webpage was selling or advertising a specific product or service related to immune boosting. About 20% of the webpages (n=48) were selling or advertising a specific product.

Table 2. Typology of Websites

Typology	**All websites (n=227)**	**Top 20 results (n=25)**
News	92 (40.5%)	13 (52%)
Commercial	56 (24.7%)	4 (16%)
Other	20 (8.8%)	1 (4%)
Magazine	19 (8.4%)	2 (8%)
Blog	15 (6.6%)	1 (4%)
Health Portal	12 (5.3%)	1 (4%)
Non-profit organization	4 (1.8%)	2 (5%)
Professionals	4 (1.8%)	0
Scientific Journals	3 (1.3%)	0
Government or governing body	2 (0.9%)	1 (4%)

We coded the webpages for whether the concept of immune boosting was portrayed as neutral, unscientific, or beneficial for preventing COVID-19 (Table 3). Over 85% of webpages portrayed the concept of immune boosting as beneficial, with less than 10% of the webpages critiquing the concept of immune boosting. We also coded each webpage for portrayal of supplements as a way to boost immunity (Table 4). Almost half of the webpages did not refer to supplements and were coded as neutral, but 40% of the webpages portrayed supplements as beneficial to boosting immunity, highlighting that when supplements were mentioned it was largely in a positive fashion.

Table 3. Portrayal of immune boosting

	All websites	**Top 20 results**
Neutral	12 (5.3%)	4 (16%)
Unscientific	21 (9.3%)	3 (12%)
Beneficial	194 (85.5%)	18 (72%)

Table 4. Portrayal of supplements

	All websites	**Top 20 results**
Neutral	109 (48%)	12 (48%)
Unscientific	27 (11.9%)	3 (12%)
Beneficial	92 (40%)	10 (40%)

We included the microbiome or gut health within our coding framework as it was frequently mentioned in relation to immune boosting. Over 30% (n=70) of websites mentioned the microbiome or gut health, which was generally intertwined within the narrative of immune boosting, and emphasised its importance for overall health. For example, one webpage states, "Yogurt is considered a probiotic that is essential to your immune system's health. It directly affects your gut, helping the good bacteria to thrive. Your gut health is directly associated with your immune system. Therefore, a healthy gut means a healthy immune system."[27]

To assess the degree to which different types of webpages represent the concept of immune boosting, we compared website typology with the portrayal of immune boosting and supplements, mention of the microbiome or gut health, and whether the webpage was selling or advertising an immune boosting product or service. Commercial websites were significantly more likely to portray immune boosting (X^2 (2, N = 227) = 7.57, p = .023) and supplements (X^2 (2, N = 227) = 8.97, p = .011) as beneficial and were more likely to be selling or advertising a product (X^2 (1, N = 227) = 63.64, p = <.0001) than the others. There was no significant difference in whether different types of websites mentioned microbiome or gut health (X^2 (9, N = 227) = 14.08, p = .119).

We coded 82 different strategies that were suggested as a way to boost immunity. Figure 1 shows the strategies that appeared in more than 10% of the total dataset of

webpages. The most common strategies, Vitamin C (*n*=79) and diet (*n*=79), appeared in almost 35% of the webpages. In contrast, the most common strategies in the top 20 search results are sleep (*n*=11), diet (*n*=10), and exercise (*n*=9), which appeared in 44%, 40%, and 36% of these websites respectively.

DISCUSSION

Our study highlights the dominance of the concept of immune boosting during this global pandemic. A large portion of the webpages (85.5%) portray immune boosting as beneficial, providing no critical scientific content and explicitly or implicitly suggesting the efficacy of boosting the immune system. In comparison to previous studies that find a large presence of commercial websites,[18,28] less than a quarter of the websites in our dataset (24.7%) are commercial, and only 20% of webpages were selling a specific immune boosting product or service. However, 40% of webpages portrayed supplements, such as vitamins, as beneficial for boosting immunity, which indirectly supports a hugely popular multi-billion dollar industry[29,30] with largely no scientific basis to support the "immune boost" claim.[8,9] Similarly, while others found that commercial websites were somewhat hidden further down in search results,[18,28] there were only minor variations in the types of websites and how the webpages portrayed immune boosting and supplements between the whole data set and the webpages that appeared in the top 20 of search results.

Despite many of the webpages citing supplements as beneficial to boosting the immune system, diet, sleep, exercise, and stress reduction are some of the most common strategies suggested. Eating a balanced diet, getting sufficient sleep, exercising regularly, and reducing one's stress levels are well known to be strategies for maintaining health under any circumstances. However, the explanations from webpages for how these strategies prevent COVID-19 are framed as not just for health, but for boosting immunity. This suggests that the concept of "immune boosting" has taken on a broader meaning and seems to be deployed to attract interest in the products or ideas being put forth. The phrase is now ubiquitous and has likely taken on a "health halo",[31] not unlike other wellness terms that lack clear definition or health benefits, such as "natural", or "gluten-free".[32,33] The microbiome or gut health were also mentioned as an important part of boosting immunity in 30.8% of the webpages. This is an example of using the rhetoric around an emerging area of science to legitimize unproven approaches to health – a tactic that has been deployed in other contexts.[34,35]

The reification of the phrase "immune boosting" when paired with solid advice for maintaining one's health (e.g., healthy diet, exercise, sleep) and with language from genuine areas of science, such as microbiome research, may inadvertently help to legitimize the concept, making it a more potent marketing tool. Diet, sleep, and exercise are among the top 5 strategies suggested in commercial webpages and the microbiome is mentioned in 39.3% of commercial webpages, which means that immune boosting strategies that lack evidence are often described on par, or in

association, with sound advice for maintaining health with little to indicate the difference to readers. This framing forms one of the core kinds of misinformation portrayed by the immune boosting narrative. It is often an implied, rather than explicit, form of misinformation – where the context and associations to other health actions or relevant science suggest efficacy and benefit. Perhaps more troubling are the advertisements of products and services intertwined within this immune boosting narrative. Policy responses – including regulatory action – will need to grapple with these less overt forms of health misinformation.

CONCLUSION

The results from our study demonstrate how the spread of misinformation is complex and often more subtle than blatant fraudulent claims. The public is increasingly going online for health information[36] and questions persist around the kinds of inaccurate information the public is absorbing and the impacts it may be having on health-related decisions and actions. It is unknown, for example, whether large numbers of the North American public have felt that strengthening their immune system has allowed them to participate in less social distancing. Also unclear is whether immune boosting ideas have clashed with the messaging from public health experts. This study demonstrates, however, that in the case of pandemic like COVID 19 conflictive messaging exists online and presents significant challenges for the public seeking scientifically accurate information and advice.

Data Sharing

The data set is available upon request.

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Author Contributions

CR, ARM, and TC conceived of the study. CR compiled the dataset and CR, ARM, and BC analyzed the data. All authors were involved in interpreting the data, drafting the manuscript, revising the manuscript critically for intellectual content, and approving the final version to be published and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors have no conflicts of interest to declare.

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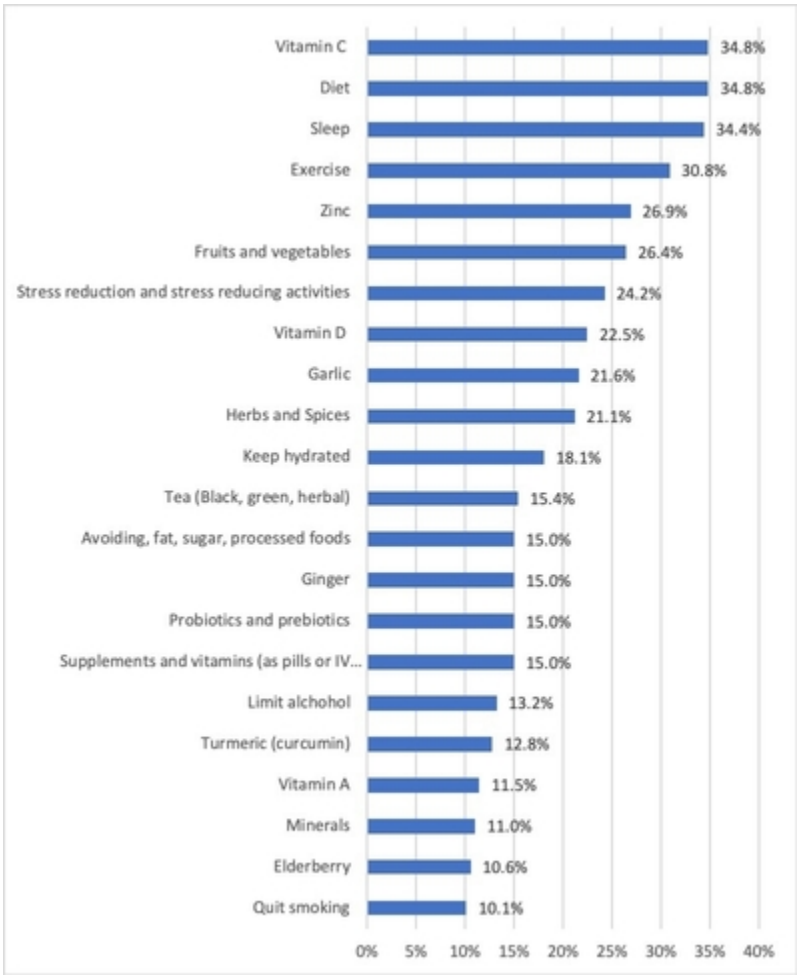
Figure 1. Immune Boosting Strategies (>10% of webpages)



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16x20mm (600 x 600 DPI)

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Covid-19 and "Immune Boosting" on the Internet: A Content Analysis of Google Search Results

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ABSTRACT

Objective: The spread of misinformation has accompanied the coronavirus pandemic, including topics such as immune boosting to prevent COVID-19. This study explores how immune boosting is portrayed on the Internet during the COVID-19 pandemic.

Design: Content Analysis

Methods: We compiled a dataset of 227 webpages from Google searches in Canada and the US using the phrase "boost immunity" AND "coronavirus". We coded webpages for typology and portrayal of immune boosting and supplements. We recorded mentions of microbiome, whether the webpage was selling or advertising an immune boosting product or service, and suggested strategies for boosting immunity.

Results: No significant differences were found between webpages that appeared in the searches in Canada and the US. The most common types of webpages were from news (40.5%) and commercial (24.7%) websites. The concept of immune boosting was portrayed as beneficial for avoiding COVID-19 in 85.5% of webpages and supplements were portrayed as beneficial in 40% of the webpages, but commercial sites were more likely to have these portrayals. The top immune boosting strategies were vitamin C (34.8%), diet (34.4%), sleep (34.4%), exercise (30.8%), and zinc (26.9%). Less than 10% of the webpages provide any critique of the concept of immune boosting.

Conclusions: Pairing evidence-based advice for maintaining one's health (e.g., healthy diet, exercise, sleep) with the phrase immune boosting and strategies lacking in evidence may inadvertently help to legitimize the concept, making it a powerful marketing tool. Results demonstrate how the spread of misinformation is complex and often more subtle than blatant fraudulent claims.

Keywords: misinformation, COVID-19, coronavirus, immune boosting, Internet

ARTICLE SUMMARY

Strengths and Limitations of the Study

- The study includes a large dataset of webpages that appear in Google searches in Canada and the US during a critical period in the pandemic.
- Data analysis identifies and characterizes a common coronavirus-related prevention strategy in a range of online contexts.
- Inter-rater reliability of coding was high with strong to almost perfect agreement.
- Dataset represented English-language webpages only based on a specific query conducted at two points in time in two regions.

INTRODUCTION

The coronavirus pandemic has been accompanied by the spread of misinformation on topics that include the marketing of and speculation on possible cures, treatments and preventative strategies. Some scholars have noted that this "infodemic" – as the World Health Organization called it – has already resulted in considerable harm.[1-4] Specifically, this infodemic is associated with deaths, delayed treatment, wasted resources, and substantive concerns that it adds to an already confused and chaotic information environment.[5-7]

Boosting the immune system is a common theme associated with many of the products and practices presented as strategies to avoid or help fight COVID-19. Indeed, a Google Trends analysis reveals that searches for phrases like "immune boost" and "immune boosting" spiked in early February, 2020, as concern about the impact of the virus started to intensify. However, the concept of immune boosting is misleading and scientifically inaccurate.[8,9] The immune system is fantastically complex and researchers are still exploring how various nutrients impact its performance, with overly active immune systems potentially leading to autoimmune diseases and anaphylaxis. Some early research studies have also suggested that an exaggerated immune response is implicated in respiratory failure in patients with COVID-19.[10] There is no evidence that any product or practice – aside from a vaccine – will provide extra or enhanced "immune boosting" protection against COVID-19.

Despite this reality, celebrities, wellness gurus and supplement companies have been making claims about the need and ways to boost our immune system.[11] These popularisations are entangled with the general public's belief that supplements improve a body's immune system,[12,13] resulting in immune boosting becoming commonly associated with pop culture representations of COVID-19. Additionally, there is some evidence that the kinds of COVID-19 information that people are exposed to affects their health-related behaviours and attitudes.[14,15] As such, the different public responses to the pandemic in Canada and the US warrant further exploration of how misinformation may impact on perceptions of how to prevent and protect against COVID-19.[16,17] This study therefore focuses on how immune boosting and supplements are being portrayed with respect to COVID-19 in Canada and the US.

METHODS

Data Collection

Following Macedo et al.,[18] we conducted searches on google.com using the Google Chrome® browser, the most widely used search engine,[19] using the phrase "boost immunity" AND "coronavirus" on April 1, 2020 in Winnipeg, Canada to compile a dataset of URLs for analysis. To limit personalization of the search results, we did not link the browser to an existing Google account, and we deleted cookies and erased the browser history. We conducted advanced searches, which allowed us to

select regional settings. We first conducted a search with the region set to Canada, then deleted all cookies and erased the browsing history, and conducted the same search the region set to the US.

We transferred the URLs from each search result to an MS Excel spread sheet, noting the country and result number. Google Chrome automatically omits similar results, so we collected all of the URLs for each search until we reached the automatically generated message "In order to show you the most relevant results, we have omitted some entries very similar to the [#] already displayed. If you like, you can repeat the search with the omitted results included." After, visiting and reading each webpage, we excluded 35 URLs because they were irrelevant (i.e. not about immune boosting and/or coronavirus), behind a paywall, or inaccessible (i.e. broken links). The resulting data set consisted of 227 webpages.

Content Analysis

We conducted a modified content analysis of the webpages [20] using a coding framework similar to previous studies conducted by our team that includes both deductive and inductive category development.[21-25] Only the content on the webpage linked to the URL was coded. We first coded the typology of the websites in which the webpages appeared using a modified version of Macedo et al.'s typology (see Table A in the supplementary materials) [18]. Webpages were then coded for how immune boosting and supplements were portrayed, whether an immune boosting product or service was being sold or advertised on the webpage, and whether the microbiome or gut health was mentioned. For webpages that portrayed immune boosting as beneficial to preventing COVID-19, we recorded the suggested immune boosting strategies, that is, the actions people can take to boost their immune systems. Webpages that suggested taking vitamins and minerals (e.g., Vitamin C, Zinc) through food and/or supplements were coded for those specific vitamins or minerals, not food or supplement. Similarly, we recorded an immune boosting strategy as "supplements and vitamins" when the webpage made a general reference to these types of products or in reference to taking a multivitamin or supplement with multiple immune boosting ingredients.

Two coders analyzed the entire data set of URLs. To determine reliability of coding, a third coder coded the subjective items in a sample of 45 URLs, roughly ~20% of the data set. Inter-coder reliability was calculated for these items. Cohen's kappa for typology of the website, portrayal of immune boosting, and portrayal of supplements were calculated at 0.886, 0.900, 0.962 respectively, demonstrating strong to almost perfect agreement.[26] An audit of the immune boosting strategies was conducted by the third coder to determine accuracy. Disagreements were discussed between two coders, CR and AM, until agreement was reached.

Statistical Analysis

Data were analyzed using descriptive statistics in SPSS 25. We used the Chi-square test to compare website typologies and portrayals, to compare results from the search in Canada and the search in the US, and to compare the top 20 search results

generated by each search with the remaining webpages in the data set, since the top 20 search results have a higher chance of being read.[27]

Ethics Approval

Ethical approval was not sought because this research did not involve human participants.

Patient and Public Involvement

This research was done without patient or public involvement. Patients or members of the public were not invited to comment on the study design and were not consulted to interpret the results. Patients or members of the public were not invited to contribute to the writing or editing of this document for readability or accuracy.

RESULTS

The search in Canada yielded 171 websites and the search in the US yielded 173 websites, with 117 URLs overlapping, 54 URLs being unique to the Canadian search, and 56 being unique to the US search. For results associated with the top 20 search hits, we include the webpages that appear in the top 20 search results of at least one of the regional searches, for a total of 25 webpages.

The two primary types of websites were news and commercial websites (Table 1). While there were no significant differences found between the webpages that appeared in the top 20 search results and the webpages in the rest of the data set (X^2 (9, N = 227) = 13.06, p = .160), news sites made up over 50% of the websites that appeared in the top 20 search results, while commercial sites only made up 16%. No significant differences were found in the results between Canada and the US for website typology (X^2 (9, N = 344) = 5.35, p = .803). In many cases, the typology of websites was difficult to discern, as evidenced by the high number of websites coded as "other", and many sites exhibited characteristic features of more than one typology, for example, a news-style website that was advertising a specific immune boosting supplement. Therefore, we also coded whether the webpage was selling or advertising a specific product or service related to immune boosting. About 20% of the webpages (n=48) were selling or advertising a specific product.

Table 1. Typology of Websites

Typology	All websites	Top 20 results	Canada	USA
News	92 (40.5%)	13 (52%)	76 (44.4%)	70 (40.5%)
Commercial	56 (24.7%)	4 (16%)	40 (23.4%)	43 (24.9%)
Other	20 (8.8%)	1 (4%)	9 (5.3%)	18 (10.4%)
Magazine	19 (8.4%)	2 (8%)	16 (9.4%)	14 (8.1%)
Blog	15 (6.6%)	1 (4%)	13 (7.6%)	9 (5.2%)

Health Portal	12 (5.3%)	1 (4%)	8 (4.7%)	8 (4.6%)
Non-profit organization	4 (1.8%)	2 (5%)	3 (1.8%)	4 (2.3%)
Professionals	4 (1.8%)	0	2 (1.2%)	4 (2.3%)
Scientific Journals	3 (1.3%)	0	2 (1.2%)	2 (1.2%)
Government or governing body	2 (0.9%)	1 (4%)	2 (1.2%)	1 (0.6%)

We coded the webpages for whether the concept of immune boosting was portrayed as neutral, whether the website noted the lack of evidence for the concept of immune boosting, or whether the website stated that immune boosting was beneficial for preventing COVID-19 (Table 2). Over 85% of webpages portrayed the concept of immune boosting as beneficial, with less than 10% of the webpages critiquing the concept of immune boosting and its lack of evidence. There was a significant difference between the top 20 search results and the remaining data set (X^2 (2, N = 227) = 6.93 p = .031) with 72% of webpages in the top 20 search results and 87.1% of the remaining webpages in the data set portraying immune boosting as beneficial. There were no significant differences between webpages that appeared in the searches in Canada and the US (X^2 (2, N = 344) = 1.24, p = .538).

Table 2. Portrayal of immune boosting

	All websites	**Top 20 results**	**Canada**	**USA**
Neutral	12 (5.3%)	4 (16%)	11 (6.4%)	8 (4.6%)
Notes Lack of Evidence	21 (9.3%)	3 (12%)	18 (10.5%)	14 (8.1%)
States Beneficial	194 (85.5%)	18 (72%)	142 (83%)	151 (87.3%)

We also coded each webpage for portrayal of supplements as a way to boost immunity (Table 3). Almost half of the webpages did not refer to supplements and were coded as neutral, but 40% of the webpages portrayed supplements as beneficial to boosting immunity, highlighting that when supplements were mentioned it was largely in a positive fashion. There were no significant differences between the top 20 search results and the rest of the data set (X^2 (2, N = 227) = 0.041, p = .980) nor between the Canada and US search results (X^2 (2, N = 344) = 0.98, p = .614).

Table 3. Portrayal of supplements

	All websites	**Top 20 results**	**Canada**	**USA**
Neutral	109 (48%)	12 (48%)	85 (49.7%)	77 (44.5%)
Notes Lack of Evidence	27 (11.9%)	3 (12%)	19 (11.1%)	20 (11.6%)
States Beneficial	92 (40%)	10 (40%)	67 (39.2%)	76 (43.9%)

We included the microbiome or gut health within our coding framework as it was frequently mentioned in relation to immune boosting. Over 30% (n=70) of webpages mentioned the microbiome or gut health, which was generally intertwined within the narrative of immune boosting, and emphasised its importance for overall health. For example, one webpage states, "Yogurt is considered a probiotic that is essential to your immune system's health. It directly affects your gut, helping the good bacteria to thrive. Your gut health is directly associated with your immune system. Therefore, a healthy gut means a healthy immune system."[28]

To assess the degree to which different types of webpages represent the concept of immune boosting, we compared website typology with the portrayal of immune boosting and supplements, mention of the microbiome or gut health, and whether the webpage was selling or advertising an immune boosting product or service. We focused on news and commercial websites given their prevalence in the dataset and due to low case counts for the other types of websites, Commercial webpages were significantly more likely to portray immune boosting (X^2 (2, N = 148) = 11.56, p = .003) and supplements (X^2 (2, N = 148) = 14.77, p = .001) as beneficial compared to news webpages (Table 4). In addition, 58.9% (*n*=33) of commercial webpages and 5.4% (*n*=5) of news webpages were selling or advertising a product, which was statistically significant (X^2 (1, N = 148) = 52.20, p = <.0001). Finally, 39.3% (*n*=22) of commercial webpages and 25% (*n*=23) of news webpages mention the microbiome or gut health, which was not statistically significant (X^2 (1, N = 148) = 3.36, p = .067).

Table 4. Comparison of news and commercial website portrayals

	Immune Boosting		Supplements	
	News	Commercial	News	Commercial
Neutral	5 (5.4%)	0	51 (55.4%)	18 (32.1%)
Notes Lack of Evidence	18 (19.6%)	2 (3.6%)	16 (17.4%)	5 (8.9%)
States Beneficial	69 (75%)	54 (96.4%)	25 (27.2%)	33 (58.9%)

We coded 83 different strategies that were suggested as a way to boost immunity. Figure 1 shows the strategies that appeared in more than 10% of the total dataset of webpages. The most common strategies – Vitamin C (*n*=79), sleep (*n*=78), and diet (*n*=78) – appeared in almost 35% of the webpages. In contrast, the most common strategies in the top 20 search results are sleep (*n*=11), diet (*n*=10), and exercise (*n*=9), which appeared in 44%, 40%, and 36% of these websites respectively.

DISCUSSION

Our study highlights the dominance of the concept of immune boosting during this global pandemic with no major differences in how the concept is portrayed in Canada and the USA. A large portion of the webpages (85.5%) portray immune boosting as beneficial, providing no critical scientific content and explicitly or

implicitly suggesting the efficacy of boosting the immune system. In comparison to previous studies that find a large presence of commercial websites,[18,29] less than a quarter of the websites in our dataset (24.7%) are commercial, and only 20% of webpages were selling a specific immune boosting product or service. It is possible that Google may have modified their search rank algorithms during the pandemic to foreground established media sources and institutions over commercial discourse, but to our knowledge there has been no official statement from Google addressing this. However, 40% of webpages portrayed supplements, such as vitamins, as beneficial for boosting immunity, which indirectly supports a hugely popular multi-billion dollar industry[30-32] with largely no scientific basis to support the "immune boost" claim.[8,9] Similarly, while others found that commercial websites were somewhat hidden further down in search results,[18,28] there were only minor variations in the types of websites and how the webpages portrayed immune boosting and supplements between the whole data set and the webpages that appeared in the top 20 of search results.

Despite many of the webpages citing supplements as beneficial to boosting the immune system, diet, sleep, exercise, and stress reduction are some of the most common strategies suggested. Eating a balanced diet, getting sufficient sleep, exercising regularly, and reducing one's stress levels are well known to be strategies for maintaining health under any circumstances. However, the explanations from webpages for how these strategies prevent COVID-19 are framed as not just for health, but for boosting immunity. This suggests that the concept of "immune boosting" has taken on a broader meaning and seems to be deployed to attract interest in the products or ideas being put forth. The phrase is now ubiquitous and has likely taken on a "health halo",[33] not unlike other wellness terms that lack clear definition or health benefits, such as "natural", or "gluten-free".[34,35] The microbiome or gut health were also mentioned as an important part of boosting immunity in 30.8% of the webpages. This is an example of using the rhetoric around an emerging area of science to legitimize unproven approaches to health – a tactic that has been deployed in other contexts.[36,37]

The reification of the phrase "immune boosting" when paired with solid advice for maintaining one's health (e.g., healthy diet, exercise, sleep) and with language from genuine areas of science, such as microbiome research, may inadvertently help to legitimize the concept, making it a more potent marketing tool. Diet, sleep, and exercise are among the top 5 strategies suggested in commercial webpages and the microbiome is mentioned in 39.3% of commercial webpages, which means that immune boosting strategies that lack evidence are often described on par, or in association, with sound advice for maintaining health with little to indicate the difference to readers. This framing forms one of the core kinds of misinformation portrayed by the immune boosting narrative. It is often an implied, rather than explicit, form of misinformation – where the context and associations to other health actions or relevant science suggest efficacy and benefit. Perhaps more troubling are the advertisements of products and services intertwined within this

immune boosting narrative. Policy responses – including regulatory action – will need to grapple with these less overt forms of health misinformation.

Limitations

Our study has some limitations. First, we made all efforts to limit the personalization of google searches and to approximate searches in different regions, but IP address masking was not possible and some localized results may have appeared in search results. Second, the searches were conducted in a single day at two points in time. Subsequent searches at different points in time during the pandemic may have yielded a different data set. The data set also includes only English-language websites.

CONCLUSION

The results from our study demonstrate how the spread of misinformation is complex and often more subtle than blatant fraudulent claims. The public is increasingly going online for health information[38] and questions persist around the kinds of inaccurate information the public is absorbing and the impacts it may be having on health-related decisions and actions. It is unknown, for example, whether large numbers of the North American public have felt that strengthening their immune system has allowed them to participate in less social distancing. Further research is required on the impact of immune boosting messages on public perceptions and subsequent health-related behaviours. Also unclear is whether immune boosting ideas have clashed with the messaging from public health experts. This study demonstrates, however, that in the case of pandemic like COVID 19 conflictive messaging exists online and presents significant challenges for the public seeking scientifically accurate information and advice.

Data Sharing

The data set is available here: https://doi.org/10.6084/m9.figshare.12783644 .

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Author Contributions

CR, ARM, and TC conceived of the study. CR compiled the dataset and CR, ARM, and BC analyzed the data. All authors were involved in interpreting the data, drafting the

manuscript, revising the manuscript critically for intellectual content, and approving the final version to be published and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Figure 1. Immune Boosting Strategies (>10% of webpages)

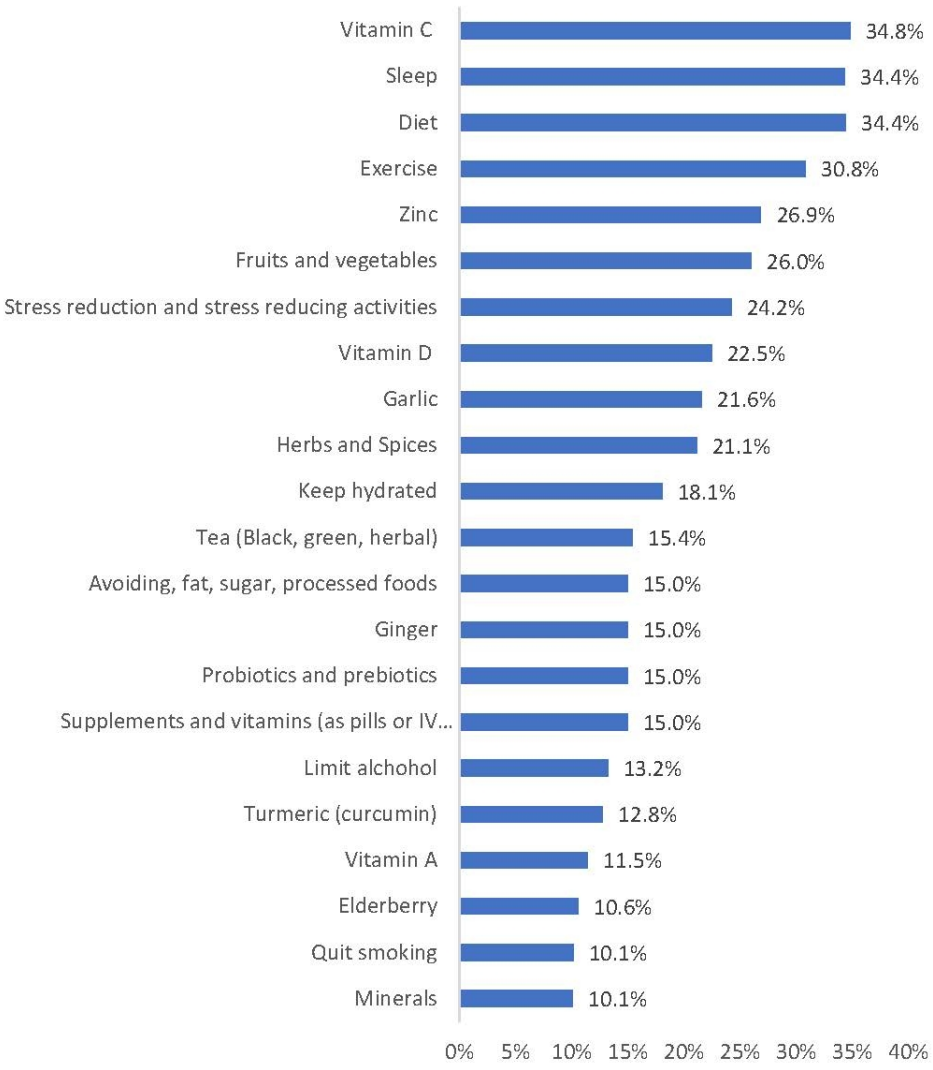

Figure 1. Immune Boosting Strategies (>10% of webpages)

133x162mm (200 x 200 DPI)

Supplementary Materials

Table A: Examples of website typologies used in this study

Typology	Example
News	https://www.express.co.uk
	https://www.cbc.ca/news
Commercial	https://delightyoga.com
	https://www.previnex.com
Magazine	https://www.yogajournal.com
	https://www.womensrunning.com
Blog	https://www.romper.com
	https://www.sassymamasg.com
Health Portal	https://www.medicaldaily.com
	https://www.healthing.ca
Non-profit organization	https://www.goodgrub.org
	https://www.zmescience.com
Professionals	https://health.clevelandclinic.org
	https://discoveries.childrenshospital.org
Scientific journals	https://www.ncbi.nlm.nih.gov
	https://www.e-jer.org/journal
Government body or governing body	https://www.who.int
	http://www.bccdc.ca
Other	https://newsthump.com
	https://www.sycamorespringssl.com

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Covid-19 and "Immune Boosting" on the Internet: A Content Analysis of Google Search Results

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ABSTRACT

Objective: The spread of misinformation has accompanied the coronavirus pandemic, including topics such as immune boosting to prevent COVID-19. This study explores how immune boosting is portrayed on the Internet during the COVID-19 pandemic.

Design: Content Analysis

Methods: We compiled a dataset of 227 webpages from Google searches in Canada and the US using the phrase "boost immunity" AND "coronavirus" on April 1, 2020. We coded webpages for typology and portrayal of immune boosting and supplements. We recorded mentions of microbiome, whether the webpage was selling or advertising an immune boosting product or service, and suggested strategies for boosting immunity.

Results: No significant differences were found between webpages that appeared in the searches in Canada and the US. The most common types of webpages were from news (40.5%) and commercial (24.7%) websites. The concept of immune boosting was portrayed as beneficial for avoiding COVID-19 in 85.5% of webpages and supplements were portrayed as beneficial in 40% of the webpages, but commercial sites were more likely to have these portrayals. The top immune boosting strategies were vitamin C (34.8%), diet (34.4%), sleep (34.4%), exercise (30.8%), and zinc (26.9%). Less than 10% of the webpages provide any critique of the concept of immune boosting.

Conclusions: Pairing evidence-based advice for maintaining one's health (e.g., healthy diet, exercise, sleep) with the phrase immune boosting and strategies lacking in evidence may inadvertently help to legitimize the concept, making it a powerful marketing tool. Results demonstrate how the spread of misinformation is complex and often more subtle than blatant fraudulent claims.

Keywords: misinformation, COVID-19, coronavirus, immune boosting, Internet

ARTICLE SUMMARY

Strengths and Limitations of the Study

- The study includes a large dataset of webpages that appear in Google searches in Canada and the US during a critical period in the pandemic.
- Data analysis identifies and characterizes a common coronavirus-related prevention strategy in a range of online contexts.
- Inter-rater reliability of coding was high with strong to almost perfect agreement.
- Dataset represented English-language webpages only based on a specific query conducted at two points in time in two regions.

- IP address masking was not possible and some localized results may have appeared in search results for the two regions.

INTRODUCTION

The coronavirus pandemic has been accompanied by the spread of misinformation on topics that include the marketing of and speculation on possible cures, treatments and preventative strategies. Some scholars have noted that this "infodemic" – as the World Health Organization called it – has already resulted in considerable harm.[1-4] Specifically, this infodemic is associated with deaths, delayed treatment, wasted resources, and substantive concerns that it adds to an already confused and chaotic information environment.[5-7]

Boosting the immune system is a common theme associated with many of the products and practices presented as strategies to avoid or help fight COVID-19. Indeed, a Google Trends analysis reveals that searches for phrases like "immune boost" and "immune boosting" spiked in early February, 2020, as concern about the impact of the virus started to intensify. However, the concept of immune boosting is misleading and scientifically inaccurate.[8,9] The immune system is fantastically complex and researchers are still exploring how various nutrients impact its performance, with overly active immune systems potentially leading to autoimmune diseases and anaphylaxis. Some early research studies have also suggested that an exaggerated immune response is implicated in respiratory failure in patients with COVID-19.[10] There is no evidence that any product or practice – aside from a vaccine – will provide extra or enhanced "immune boosting" protection against COVID-19.

Despite this reality, celebrities, wellness gurus and supplement companies have been making claims about the need and ways to boost our immune system.[11] These popularisations are entangled with the general public's belief that supplements improve a body's immune system,[12,13] resulting in immune boosting becoming commonly associated with pop culture representations of COVID-19. Additionally, there is some evidence that the kinds of COVID-19 information that people are exposed to affects their health-related behaviours and attitudes.[14,15] As such, the different public responses to the pandemic in Canada and the US warrant further exploration of how misinformation may impact on perceptions of how to prevent and protect against COVID-19.[16,17] This study therefore focuses on how immune boosting and supplements are being portrayed with respect to COVID-19 in Canada and the US.

METHODS

Data Collection

Following Macedo et al.,[18] we conducted searches on google.com using the Google Chrome® browser, the most widely used search engine,[19] using the phrase "boost immunity" AND "coronavirus" on April 1, 2020 in Winnipeg, Canada to compile a

dataset of URLs for analysis. To limit personalization of the search results, we did not link the browser to an existing Google account, and we deleted cookies and erased the browser history. We conducted advanced searches, which allowed us to select regional settings. We first conducted a search with the region set to Canada, then deleted all cookies and erased the browsing history, and conducted the same search the region set to the US.

We transferred the URLs from each search result to an MS Excel spread sheet, noting the country and result number. Google Chrome automatically omits similar results, so we collected all of the URLs for each search until we reached the automatically generated message "In order to show you the most relevant results, we have omitted some entries very similar to the [#] already displayed. If you like, you can repeat the search with the omitted results included." After, visiting and reading each webpage, we excluded 35 URLs because they were irrelevant (i.e. not about immune boosting and/or coronavirus), behind a paywall, or inaccessible (i.e. broken links). The resulting data set consisted of 227 webpages.

Content Analysis

We conducted a modified content analysis of the webpages [20] using a coding framework similar to previous studies conducted by our team that includes both deductive and inductive category development.[21-25] Only the content on the webpage linked to the URL was coded. We first coded the typology of the websites in which the webpages appeared using a modified version of Macedo et al.'s typology (see Table A in the supplementary materials) [18]. Webpages were then coded for how immune boosting and supplements were portrayed, whether an immune boosting product or service was being sold or advertised on the webpage, and whether the microbiome or gut health was mentioned. For webpages that portrayed immune boosting as beneficial to preventing COVID-19, we recorded the suggested immune boosting strategies, that is, the actions people can take to boost their immune systems. Webpages that suggested taking vitamins and minerals (e.g., Vitamin C, Zinc) through food and/or supplements were coded for those specific vitamins or minerals, not food or supplement. Similarly, we recorded an immune boosting strategy as "supplements and vitamins" when the webpage made a general reference to these types of products or in reference to taking a multivitamin or supplement with multiple immune boosting ingredients.

Two coders analyzed the entire data set of URLs. To determine reliability of coding, a third coder coded the subjective items in a sample of 45 URLs, roughly ~20% of the data set. Inter-coder reliability was calculated for these items. Cohen's kappa for typology of the website, portrayal of immune boosting, and portrayal of supplements were calculated at 0.886, 0.900, 0.962 respectively, demonstrating strong to almost perfect agreement.[26] An audit of the immune boosting strategies was conducted by the third coder to determine accuracy. Disagreements were discussed between two coders, CR and AM, until agreement was reached.

Statistical Analysis

Data were analyzed using descriptive statistics in SPSS 25. We used the Chi-square test to compare website typologies and portrayals, to compare results from the search in Canada and the search in the US, and to compare the top 20 search results generated by each search with the remaining webpages in the data set, since the top 20 search results have a higher chance of being read.[27]

Ethics Approval

Ethical approval was not sought because this research did not involve human participants.

Patient and Public Involvement

This research was done without patient or public involvement. Patients or members of the public were not invited to comment on the study design and were not consulted to interpret the results. Patients or members of the public were not invited to contribute to the writing or editing of this document for readability or accuracy.

RESULTS

The search in Canada yielded 171 websites and the search in the US yielded 173 websites, with 117 URLs overlapping, 54 URLs being unique to the Canadian search, and 56 being unique to the US search. For results associated with the top 20 search hits, we include the webpages that appear in the top 20 search results of at least one of the regional searches, for a total of 25 webpages.

The two primary types of websites were news and commercial websites (Table 1). While there were no significant differences found between the webpages that appeared in the top 20 search results and the webpages in the rest of the data set (X^2 (9, N = 227) = 13.06, p = .160), news sites made up over 50% of the websites that appeared in the top 20 search results, while commercial sites only made up 16%. No significant differences were found in the results between Canada and the US for website typology (X^2 (9, N = 344) = 5.35, p = .803). In many cases, the typology of websites was difficult to discern, as evidenced by the high number of websites coded as "other", and many sites exhibited characteristic features of more than one typology, for example, a news-style website that was advertising a specific immune boosting supplement. Therefore, we also coded whether the webpage was selling or advertising a specific product or service related to immune boosting. About 20% of the webpages (n=48) were selling or advertising a specific product.

Table 1. Typology of Websites

Typology	All websites	Top 20 results	Canada	USA
News	92 (40.5%)	13 (52%)	76 (44.4%)	70 (40.5%)
Commercial	56 (24.7%)	4 (16%)	40 (23.4%)	43 (24.9%)

Other	20 (8.8%)	1 (4%)	9 (5.3%)	18 (10.4%)
Magazine	19 (8.4%)	2 (8%)	16 (9.4%)	14 (8.1%)
Blog	15 (6.6%)	1 (4%)	13 (7.6%)	9 (5.2%)
Health Portal	12 (5.3%)	1 (4%)	8 (4.7%)	8 (4.6%)
Non-profit organization	4 (1.8%)	2 (5%)	3 (1.8%)	4 (2.3%)
Professionals	4 (1.8%)	0	2 (1.2%)	4 (2.3%)
Scientific Journals	3 (1.3%)	0	2 (1.2%)	2 (1.2%)
Government or governing body	2 (0.9%)	1 (4%)	2 (1.2%)	1 (0.6%)

We coded the webpages for whether the concept of immune boosting was portrayed as neutral, whether the website noted the lack of evidence for the concept of immune boosting, or whether the website stated that immune boosting was beneficial for preventing COVID-19 (Table 2). Over 85% of webpages portrayed the concept of immune boosting as beneficial, with less than 10% of the webpages critiquing the concept of immune boosting and its lack of evidence. There was a significant difference between the top 20 search results and the remaining data set (X^2 (2, N = 227) = 6.93 p = .031) with 72% of webpages in the top 20 search results and 87.1% of the remaining webpages in the data set portraying immune boosting as beneficial. There were no significant differences between webpages that appeared in the searches in Canada and the US (X^2 (2, N = 344) = 1.24, p = .538).

Table 2. Portrayal of immune boosting

	All websites	**Top 20 results**	**Canada**	**USA**
Neutral	12 (5.3%)	4 (16%)	11 (6.4%)	8 (4.6%)
Notes Lack of Evidence	21 (9.3%)	3 (12%)	18 (10.5%)	14 (8.1%)
States Beneficial	194 (85.5%)	18 (72%)	142 (83%)	151 (87.3%)

We also coded each webpage for portrayal of supplements as a way to boost immunity (Table 3). Almost half of the webpages did not refer to supplements and were coded as neutral, but 40% of the webpages portrayed supplements as beneficial to boosting immunity, highlighting that when supplements were mentioned it was largely in a positive fashion. There were no significant differences between the top 20 search results and the rest of the data set (X^2 (2, N = 227) = 0.041, p = .980) nor between the Canada and US search results (X^2 (2, N = 344) = 0.98, p = .614).

Table 3. Portrayal of supplements

	All websites	**Top 20 results**	**Canada**	**USA**
Neutral	109 (48%)	12 (48%)	85 (49.7%)	77 (44.5%)

Notes Lack of Evidence	27 (11.9%)	3 (12%)	19 (11.1%)	20 (11.6%)
States Beneficial	92 (40%)	10 (40%)	67 (39.2%)	76 (43.9%)

We included the microbiome or gut health within our coding framework as it was frequently mentioned in relation to immune boosting. Over 30% (n=70) of webpages mentioned the microbiome or gut health, which was generally intertwined within the narrative of immune boosting, and emphasised its importance for overall health. For example, one webpage states, "Yogurt is considered a probiotic that is essential to your immune system's health. It directly affects your gut, helping the good bacteria to thrive. Your gut health is directly associated with your immune system. Therefore, a healthy gut means a healthy immune system."[28]

To assess the degree to which different types of webpages represent the concept of immune boosting, we compared website typology with the portrayal of immune boosting and supplements, mention of the microbiome or gut health, and whether the webpage was selling or advertising an immune boosting product or service. We focused on news and commercial websites given their prevalence in the dataset and due to low case counts for the other types of websites, Commercial webpages were significantly more likely to portray immune boosting (X^2 (2, N = 148) = 11.56, p = .003) and supplements (X^2 (2, N = 148) = 14.77, p = .001) as beneficial compared to news webpages (Table 4). In addition, 58.9% (*n*=33) of commercial webpages and 5.4% (*n*=5) of news webpages were selling or advertising a product, which was statistically significant (X^2 (1, N = 148) = 52.20, p = <.0001). Finally, 39.3% (*n*=22) of commercial webpages and 25% (*n*=23) of news webpages mention the microbiome or gut health, which was not statistically significant (X^2 (1, N = 148) = 3.36, p = .067).

Table 4. Comparison of news and commercial website portrayals

	Immune Boosting		Supplements	
	News	Commercial	News	Commercial
Neutral	5 (5.4%)	0	51 (55.4%)	18 (32.1%)
Notes Lack of Evidence	18 (19.6%)	2 (3.6%)	16 (17.4%)	5 (8.9%)
States Beneficial	69 (75%)	54 (96.4%)	25 (27.2%)	33 (58.9%)

We coded 83 different strategies that were suggested as a way to boost immunity. Figure 1 shows the strategies that appeared in more than 10% of the total dataset of webpages. The most common strategies – Vitamin C (*n*=79), sleep (*n*=78), and diet (*n*=78) – appeared in almost 35% of the webpages. In contrast, the most common strategies in the top 20 search results are sleep (*n*=11), diet (*n*=10), and exercise (*n*=9), which appeared in 44%, 40%, and 36% of these websites respectively.

DISCUSSION

Our study highlights the dominance of the concept of immune boosting during this global pandemic with no major differences in how the concept is portrayed in Canada and the USA. A large portion of the webpages (85.5%) portray immune boosting as beneficial, providing no critical scientific content and explicitly or implicitly suggesting the efficacy of boosting the immune system. In comparison to previous studies that find a large presence of commercial websites,[18,29] less than a quarter of the websites in our dataset (24.7%) are commercial, and only 20% of webpages were selling a specific immune boosting product or service. It is possible that Google may have modified their search rank algorithms during the pandemic to foreground established media sources and institutions over commercial discourse, but to our knowledge there has been no official statement from Google addressing this. However, 40% of webpages portrayed supplements, such as vitamins, as beneficial for boosting immunity, which indirectly supports a hugely popular multi-billion dollar industry[30-32] with largely no scientific basis to support the "immune boost" claim.[8,9] Similarly, while others found that commercial websites were somewhat hidden further down in search results,[18,28] there were only minor variations in the types of websites and how the webpages portrayed immune boosting and supplements between the whole data set and the webpages that appeared in the top 20 of search results.

Despite many of the webpages citing supplements as beneficial to boosting the immune system, diet, sleep, exercise, and stress reduction are some of the most common strategies suggested. Eating a balanced diet, getting sufficient sleep, exercising regularly, and reducing one's stress levels are well known to be strategies for maintaining health under any circumstances. However, the explanations from webpages for how these strategies prevent COVID-19 are framed as not just for health, but for boosting immunity. This suggests that the concept of "immune boosting" has taken on a broader meaning and seems to be deployed to attract interest in the products or ideas being put forth. The phrase is now ubiquitous and has likely taken on a "health halo",[33] not unlike other wellness terms that lack clear definition or health benefits, such as "natural", or "gluten-free".[34,35] The microbiome or gut health were also mentioned as an important part of boosting immunity in 30.8% of the webpages. This is an example of using the rhetoric around an emerging area of science to legitimize unproven approaches to health – a tactic that has been deployed in other contexts.[36,37]

The reification of the phrase "immune boosting" when paired with solid advice for maintaining one's health (e.g., healthy diet, exercise, sleep) and with language from genuine areas of science, such as microbiome research, may inadvertently help to legitimize the concept, making it a more potent marketing tool. Diet, sleep, and exercise are among the top 5 strategies suggested in commercial webpages and the microbiome is mentioned in 39.3% of commercial webpages, which means that immune boosting strategies that lack evidence are often described on par, or in association, with sound advice for maintaining health with little to indicate the difference to readers. This framing forms one of the core kinds of misinformation

portrayed by the immune boosting narrative. It is often an implied, rather than explicit, form of misinformation – where the context and associations to other health actions or relevant science suggest efficacy and benefit. Perhaps more troubling are the advertisements of products and services intertwined within this immune boosting narrative. Policy responses – including regulatory action – will need to grapple with these less overt forms of health misinformation.

Limitations

Our study has some limitations. First, we made all efforts to limit the personalization of google searches and to approximate searches in different regions, but IP address masking was not possible and some localized results may have appeared in search results. Second, the searches were conducted in a single day at two points in time. Subsequent searches at different points in time during the pandemic may have yielded a different data set. The data set also includes only English-language websites.

CONCLUSION

The results from our study demonstrate how the spread of misinformation is complex and often more subtle than blatant fraudulent claims. The public is increasingly going online for health information[38] and questions persist around the kinds of inaccurate information the public is absorbing and the impacts it may be having on health-related decisions and actions. It is unknown, for example, whether large numbers of the North American public have felt that strengthening their immune system has allowed them to participate in less social distancing. Further research is required on the impact of immune boosting messages on public perceptions and subsequent health-related behaviours. Also unclear is whether immune boosting ideas have clashed with the messaging from public health experts. This study demonstrates, however, that in the case of pandemic like COVID 19 conflictive messaging exists online and presents significant challenges for the public seeking scientifically accurate information and advice.

Data Sharing

The data set is available here: https://doi.org/10.6084/m9.figshare.12783644 .

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Author Contributions

CR, ARM, and TC conceived of the study. CR compiled the dataset and CR, ARM, and BC analyzed the data. All authors were involved in interpreting the data, drafting the manuscript, revising the manuscript critically for intellectual content, and approving the final version to be published and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Figure 1. Immune Boosting Strategies (>10% of webpages)

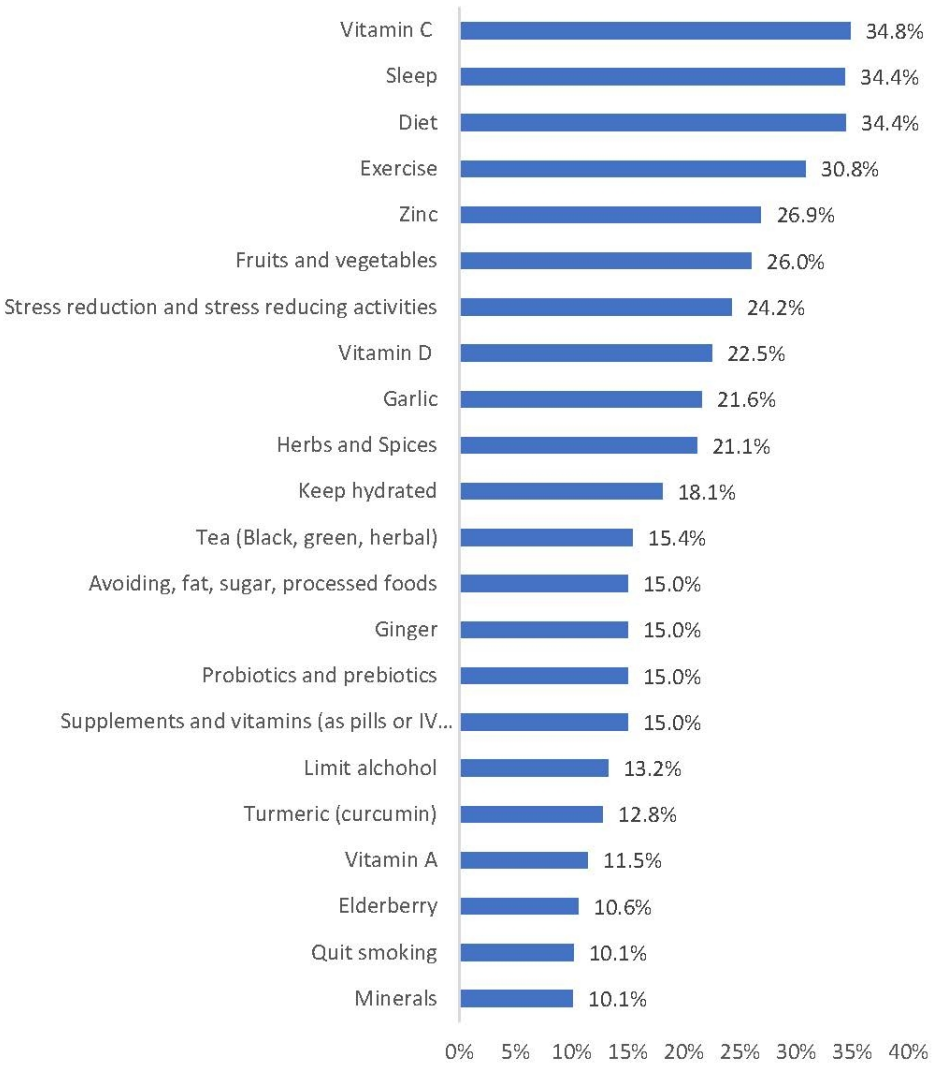

Figure 1. Immune Boosting Strategies (>10% of webpages)

133x162mm (200 x 200 DPI)

Supplementary Materials

Table A: Examples of website typologies used in this study

Typology	Example
News	https://www.express.co.uk
	https://www.cbc.ca/news
Commercial	https://delightyoga.com
	https://www.previnex.com
Magazine	https://www.yogajournal.com
	https://www.womensrunning.com
Blog	https://www.romper.com
	https://www.sassymamasg.com
Health Portal	https://www.medicaldaily.com
	https://www.healthing.ca
Non-profit organization	https://www.goodgrub.org
	https://www.zmescience.com
Professionals	https://health.clevelandclinic.org
	https://discoveries.childrenshospital.org
Scientific journals	https://www.ncbi.nlm.nih.gov
	https://www.e-jer.org/journal
Government body or governing body	https://www.who.int
	http://www.bccdc.ca
Other	https://newsthump.com
	https://www.sycamorespringssl.com