Gluten-free diet on video platforms: Retrospective infodemiology study

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Abstract

Background: Video platform is an important approach for individuals to access and adopt health information. Online information on gluten-free diet (GFD) videos remains underinvestigated.

Methods: GFD videos were identified by hashtag-based searching strategy. Videos' basic information, engagement metrics, and content were recorded. Mann-Kendall test was performed to examine time trends of submitting videos and engagement metrics. Video quality was evaluated by the DISCERN instrument and the HONcode.

Results: A total of 822 videos were included in the analysis, with the majority focusing on gluten-free food recipes. The number of videos related to GFD was showing an upward trend. Engagement metrics varied between platforms and video types, with non-recipe videos receiving higher user engagement. The average DISCERN score was 50.20 out of 80 and the average HONcode score was 1.93 out of 8. Videos submitted by health professionals demonstrated better quality compared to those submitted by patients or general users.

Conclusion: There was a rise in the number of videos related to GFD on Chinese video platforms. The overall quality of these videos was poor, most of them were not rigorous enough. Highlighting using social media as a health information source has the potential risk of disseminating one-sided messages and misleading. Efforts should be made to enhance the transparency of advertisements and establish clear guidelines for information sharing on social media platforms.

Introduction

Gluten, a mixture of proteins found in wheat, barley, and rye, has garnered increasing attention due to a rise in adverse reactions associated with its consumption, including celiac disease (CD), non-coeliac gluten sensitivity, and wheat allergy (WA).[1,2] The critical medical treatment and the only available treatment for CD and gluten-related disorders (GRDs) patients is a lifelong elimination of gluten from the diet,[2–4] known as the gluten-free diet (GFD). However, there has been a noticeable increase in the number of individuals adopting a GFD despite the absence of diagnosed GRDs. Media coverage and research outcomes have contributed to a belief that a GFD is "healthful" and offers beneficial effects for various health conditions.[5–7] This kind of trend also seems to extend to countries with rice-based staple diets like China despite the prevalence of CD in the Asia-Pacific region being predicted to be low.[8,9]

Recently, the interest in GFD on the internet appears to increase independently of interest in its indications.[7] The

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increasing presence of social media in sharing information has transformed the traditional means of accessing healthcare-related knowledge. Many individuals now turn to social media platforms for health-related information and advice related to their health conditions.[10] A study revealed that about 70% of mobile-based (e.g. smartphone) users used internet platforms as a source of health information in China.[11] However, since the advent of these platforms such as TikTok became an essential source of information, it has opened the door to rapid and unregulated dissemination of medical information, with potential implications such as marketing of unproven treatments without proper disclosures or discussion of risks.[12,13] Health and diet are among the most common categories of misinformation on the internet, and, in particular, restrictive and popular dietary patterns are forms of dietary misinformation that are regularly dispersed.[14] Considering the popularity of these platforms among younger generations, there is a significant risk of spreading misleading information that can lead to adverse outcomes.

Previous studies have examined the content of diet information on media platforms and the influence of these platforms on diet.[15–17] Studies done in China have examined short videos as sources of information for various conditions such as diabetes,[18] chronic obstructive pulmonary disease (COPD),[19] and inflammatory bowel disease (IBD).[20] However, little attention has been given to GFD. As a country where rice is one of the staple foods and where evidence suggested a growing number of people developing allergies to wheat in the last decade,[21,22] analysis of information on media platforms is needed.

TikTok and BiliBili are two of the largest video-sharing platforms in China, offering users unrestricted access to a vast array of health-related videos, including those focusing on GFD, without the need for registration or payment. In this study, we aim to examine the trends, content, and quality of information on these two platforms, as well as the engagement these videos receive based on their characteristics and content.

Methods

Search strategy

We identified three hashtags or keywords related to the GFD on TikTok, and two hashtags or keywords on BiliBili, which are two of the most popular video platforms in China (Table s1). A web crawler tool was utilized to conduct the video search on 15 May (BiliBili) and 17 May (TikTok) of 2023. The search captured all accessible videos using a guest account without the need to log in. During the search period, non-essential browser cookies were disabled, and no filter was applied.

All videos containing the designated hashtags or keywords in their titles or introductions, as identified by the guest account, were included for further viewing and eligibility screening. Videos were excluded if they were (a) not in video form (e.g. pictures); (b) not related to the human GFD; (c) not in Chinese or English, and lacked Chinese English subtitles; (d) purely product advertisement or product share; (e) without audio or text information in the video (e.g. chewing sound video); or (f) not related to GFD. Duplicate videos uploaded by different accounts on the same platform were counted as different videos. (Figure 1)
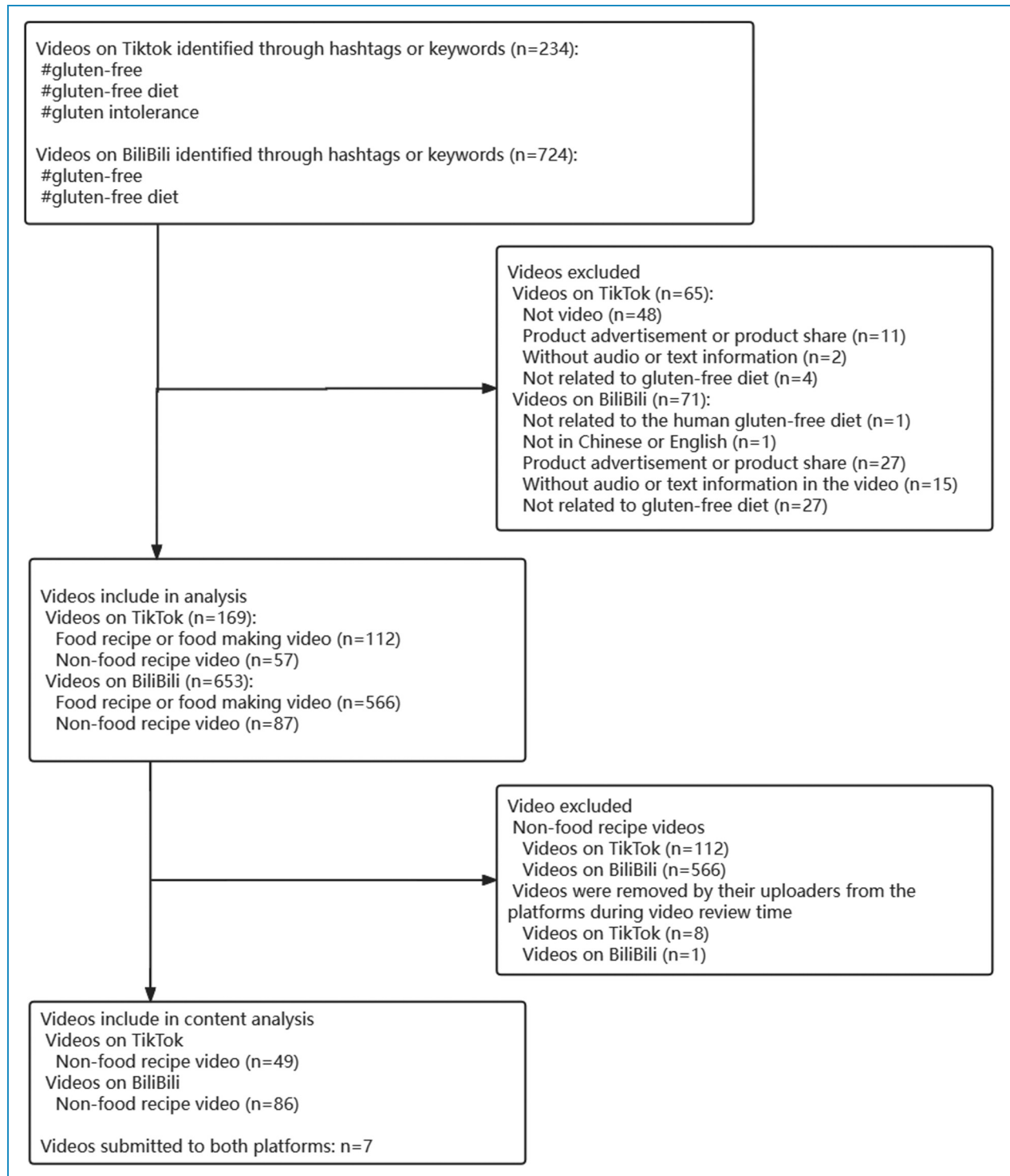
Data collection

Engagement metrics, including likes, favorites, shares, and comments on TikTok, and likes, favorites, coins, comments, and views on BiliBili, were extracted during the video searching period (15 May 2023 for BiliBili and 17 May 2023 for TikTok). We extracted the numbers of likes, collections, shares, and comments on TikTok, as well as the numbers of likes, collections, received coins, comments, and views on BiliBili. Hashtags used in each video were also recorded in the video searching period, along with the characteristics of the video's uploader. Misspelled variations, synonyms, and variation hashtags were consolidated into specific hashtags for analysis. Videos were categorized into two groups based on their content: food recipe share or food-making videos and non-food recipe videos. Non-food recipe videos were included in the content evaluation and quality analysis. Eight videos on TikTok (submitted by 1 account) and one video on BiliBili were deleted by their uploaders on the platforms during the review process. For these deleted videos, their engagement and hashtags collected in the video searching period were included in the analysis, but they were excluded from the video content and quality evaluation (Figure 1).

For non-recipe videos, we further check the introduction and self-report profile verification of their upload account. Uploaders were divided into five categories: (a) self-report physicians or surgeons; (b) self-report dietitians; (c) self-report PhD or MD; (d) self-report patients who adhere to GFD (including individuals with various diseases, not limited to patients with indications such as CD) or relatives of patients who adhere to GFD; and (e) general public users.

Video evaluating

The quality of non-recipe videos was examined by the Health on the Net Foundation Code (HONcode)[23] and the Quality Criteria for Consumer Health Information (DISCERN) instrument.[24] Criteria of DISCERN and HONcode can be found in Tables s2 and s3. Two qualified registered dietitians independently evaluated and scored the quality of the videos, with any disagreements resolved through discussion and/or involvement of senior researchers.

Videos on Tiktok identified through hashtags or keywords (n=234):
#gluten-free
#gluten-free diet
#gluten intolerance

Videos on BiliBili identified through hashtags or keywords (n=724):
#gluten-free
#gluten-free diet

Videos excluded
Videos on TikTok (n=65):
  Not video (n=48)
  Product advertisement or product share (n=11)
  Without audio or text information (n=2)
  Not related to gluten-free diet (n=4)
Videos on BiliBili (n=71):
  Not related to the human gluten-free diet (n=1)
  Not in Chinese or English (n=1)
  Product advertisement or product share (n=27)
  Without audio or text information in the video (n=15)
  Not related to gluten-free diet (n=27)

Videos include in analysis
Videos on TikTok (n=169):
  Food recipe or food making video (n=112)
  Non-food recipe video (n=57)
Videos on BiliBili (n=653):
  Food recipe or food making video (n=566)
  Non-food recipe video (n=87)

Video excluded
Non-food recipe videos
  Videos on TikTok (n=112)
  Videos on BiliBili (n=566)
Videos were removed by their uploaders from the platforms during video review time
  Videos on TikTok (n=8)
  Videos on BiliBili (n=1)

Videos include in content analysis
Videos on TikTok
  Non-food recipe video (n=49)
Videos on BiliBili
  Non-food recipe video (n=86)

Videos submitted to both platforms: n=7

Figure 1. Flowchart of the video search strategy.

Data analysis

The descriptive presentation of the data was done using a narrative summary. T-test, ANOVA test and Wilcoxon rank sum test were used to examine differences in information accuracy and characteristics of normal and non-normal distribution variables, respectively. We carried out the Mann-Kendall test to examine trends of submitting videos related to GFD, as well as trends of audience interest in these videos. This non-parametric test allowed us

to detect any monotonic trends, whether increasing or decreasing, in the data. Additionally, time series analyses were performed to investigate the temporal and seasonal patterns of GFD-related videos.

Data were analyzed by R software. p-values were two-sided, and statistical significance was set at $p < 0.05$.

Result

Descriptive characteristics

A total of 958 videos were initially screened, comprising 234 videos from TikTok and 724 videos from BiliBili. After applying the inclusion and exclusion criteria, 822 videos (169 from TikTok and 653 from BiliBili) were included in the analysis. There were more food recipe-sharing or food-sharing videos than non-food recipe videos on both video platforms ($p < 0.05$). 678 videos were categorized as food recipe videos (videos that teach how to make gluten-free food), while 144 were non-food recipe videos.

The median value of likes, comments, favorites, and shares for all kinds of videos on TikTok up to the data collecting day was 56, 7, 14, and 8, respectively. On BiliBili, the median number of likes, comments, favorites, received coins, and views for videos were 6, 0, 7, 0, and 283, respectively. Videos on TikTok generally had more engagement metrics than videos on BiliBili ($p < 0.05$). Compared to food recipe videos, non-food recipe videos on BiliBili had more likes, comments, favorites, received coins, and views ($p < 0.05$). There was no statistically significant difference in engagement metrics between non-food recipe videos and food recipe videos on TikTok ($p > 0.05$) (Table 1).

Popularity of videos related to the gluten-free diet

Popularity of submitting videos. Uploaders' interests in GFD varied between the two platforms. The first video related to GFD on TikTok was released in October 2018, focusing on the introduction of gluten and GFD, while the first video on BiliBili was a food-making video reposted from YouTube, released in November 2015. Figure 2 shows the number of videos uploaded over time. Throughout most of the observed period, there were more food recipe videos than non-food recipe videos. Results of time series analysis suggested that the peak periods for submitting and releasing GFD videos were June and August, and there were fewer videos released in November and December (Table s4). Time series analysis revealed that there was an increasing interest in submitting videos about GFD. The result of the Mann-Kendall test showed both the number of food recipes (Z was 3.1 for TikTok and 5.4 for BiliBili, respectively; S was 36 and 122 for BiliBili, respectively.) and non-food recipe videos (Z was 4.4 for TikTok and 4.3 for BiliBili, respectively. S was 319 and 189 for BiliBili,

Table 1. Characteristics of videos on TikTok and BiliBili.

Characteristics[a]	TikTok			BiliBili			
	food recipe videos (n = 112)	Non-food recipe videos (n = 57)	p	All (n = 169)	food recipe videos (n = 566)	Non-food recipe videos (n = 87)	p	All (n = 653)	p
Likes, median (IQR)[b]	55 (10, 153)	61 (13, 177)	0.597	56 (12, 160)	4 (1, 22)	24 (8, 68)	<0.001	6 (1, 7)	<0.001
Comments, median (IQR)	7 (2, 32)	9 (1, 28)	0.674	7 (2, 29)	0 (0, 3)	4 (0, 12)	<0.001	0 (0, 4)	<0.001
Favorites, median (IQR)	14 (2, 62)	14 (2, 58)	0.983	14 (2,62)	5 (1, 39)	20(7, 71)	<0.001	7 (1, 2)	0.0167
Shares, median (IQR)	6 (1 28)	10 (1, 62)	0.204	8 (1, 35)	–	–	–	–	–
Coins, median (IQR)	–	–	–	–	5 (0, 13)	0 (0, 4)	<0.001	0 (0, 4)	–
Views, median (IQR)	–	–	–	–	1216 (416, 3128)	228 (63, 957)	<0.001	283 (73, 1235)	–

Note: [a]numbers of likes, comments, favorites, shares, coins and views over 10,000 were counted per 1000.
[b]IQR: interquartile range, presented as (P25, P75).
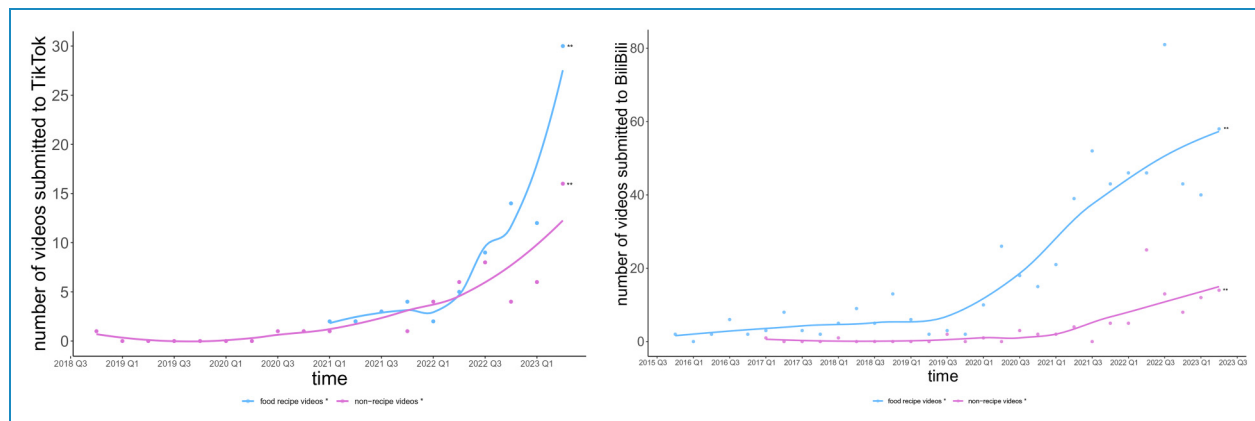
Figure 2. Trends of submitting videos related to GFD. (a) Trends of submitting videos to TikTok; (b) trends of submitting videos to BiliBili. Notes: *: Mann-Kendall test *p* < 0.05, **: The number of videos submitted in May 2023 was estimated by using the double numbers of videos submitted to platforms during 1 May 2023 and the data collection days (TikTok: 17 May 2023, BiliBili: 15 May 2023). GFD: gluten-free diet

respectively.) showed a significant increasing trend (*p* < 0.05) (Table s5).

Popularity of engagement metrics. The trends in engagement metrics varied between platforms and video types. Mann-Kendall test suggested that almost all engagement metrics (only excluded comments on TikTok) of food recipe videos had decreasing trends over time (Z < 0, *p* < 0.05), which means that the earlier the videos were released, the more viewer engagements they got. The median number of likes decreased from 130 in 2020 to 12 in 2023. However, this trend was not observed consistently for non-recipe videos (*p* < 0.05). While all engagement metrics of non-recipe videos on TikTok showed decreasing trends (Z < 0, *p* < 0.05), no significant statistical trend was found on BiliBili (*p* > 0.05) (Table s6).

To further explore the differences in engagement between the two types of videos over the years, we examined the engagement metrics by year. The results suggest that non-recipe videos were more likely to receive higher viewer engagement compared to food recipe videos. The median number of likes for non-recipe videos in 2022 was 209(TikTok) and 22, while 130 (TikTok) and 3 (BiliBili) for recipe videos. The biggest difference was found in the number of views. The median number of views for non-recipe videos was 1303 (year 2020), 1955 (year 2021), 1276 (year 2022), and 561 (year 2023), while such number for recipe videos were 443 (year 2020), 152 (year 2021), 117 (year 2022), and 188 (year 2023) (Table s7).

Hashtags and keywords of gluten-free diet videos

Hashtags and keywords used to describe gluten-free videos, as well as their relationships, are shown in Figures 3 and 4.

Keywords with high centrality and frequency generally represented popular words associated with these videos. Gluten-free and GFD were the two central words for these videos. The top 10 hashtags in terms of occurrence frequency on Tiktok were: gluten-free (64), gluten-free diet (63), Hashimoto's thyroiditis (HT) (15), anti-inflammatory diet (13), low carb diet (13), food intolerance (12), gluten (11), gluten-free, egg free and milk free(9), healthy diet (9) and ketogenic diet (7). The top 10 hashtags on BiliBili were food (424), food making (375), gluten-free (145), food vlog (133), lose weight (130), life (129), instructions (109), daily (106), healthy diet (98) and bake (97). Hashtags of videos were clustered into seven and six categories for TikTok and BiliBili. Clusters and 2 occurrence frequency hashtag samples are shown in Table 2.

Relationships and clusters for hashtags of each type of video are shown in Figure s2-s4. Hashtags used in food recipe videos often indicated that the recipes were related to losing weight (hashtags like #slimming diet, #low calorie, #fitness, etc.), food for allergic people (hashtags like #food intolerance and #allergic), food for HT patients (hashtags like #Hashimoto's thyroiditis), and the ketogenic diet (hashtags like #ketogenic) (Figures s1 and s3). Besides, as a video platform allows for the submission of videos originally released on other platforms under the authorship of the original producer, the hashtag #youtube was found in videos released on BiliBili, indicating the original source of videos (Figure s3). Hashtags of non-recipe videos usually indicated that their video was related to HT, the popularization of health and losing weight (only on BiliBili). One other therapeutic diet mentioned in these hashtags was ketogenic diet, and three other kinds of diet mentioned were low carb diet, vegetarian, vegan, and anti-inflammatory diet (Figures s2 and s4).
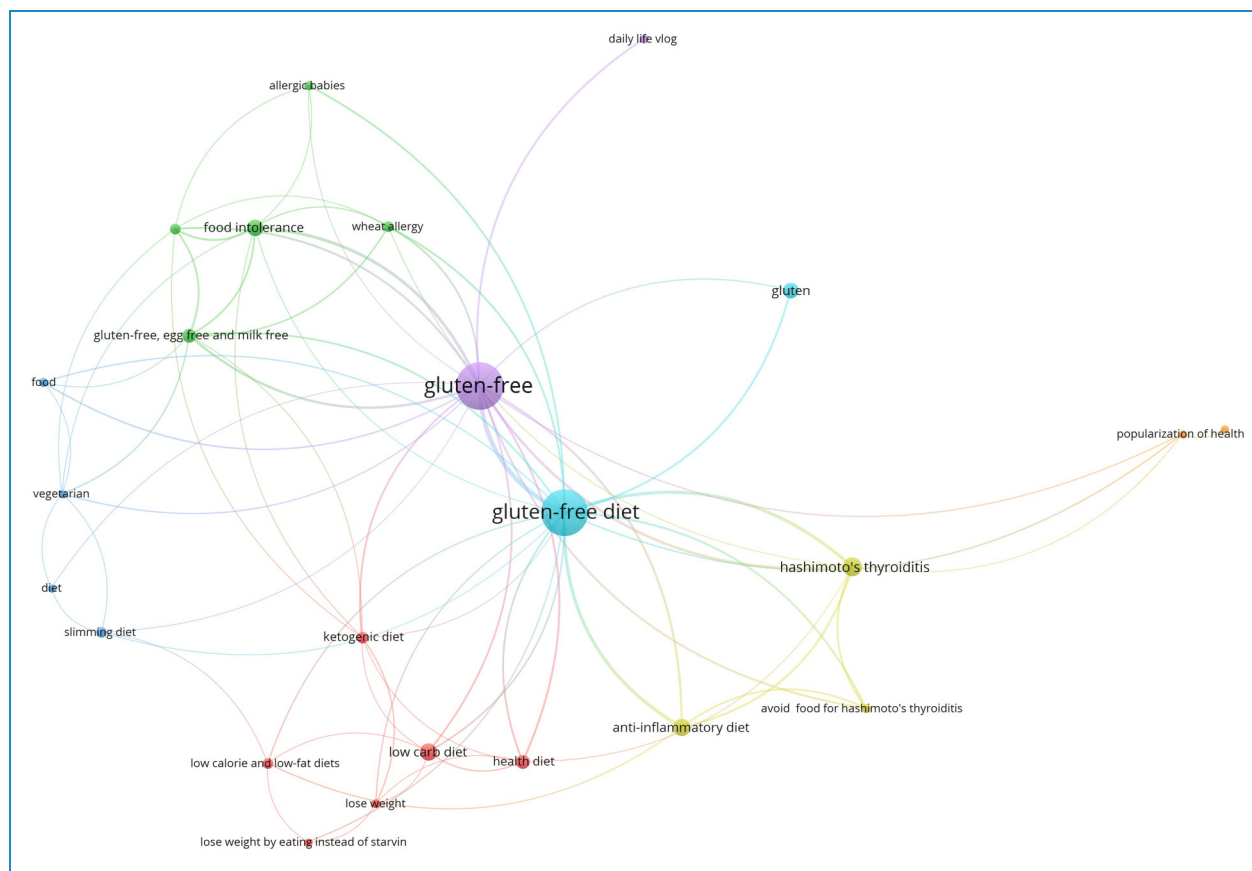
Figure 3. Hashtags network map of gluten-free videos on TikTok.

Descriptive characteristics of non-food recipe videos

49 videos on TikTok and 86 videos on BiliBili (including seven videos submitted to both platforms) were classified as non-food recipe videos. Videos on TikTok submitted by self-reported patients who adhered to GFD or their relatives were more likely to receive likes, comments and favorites compared to other uploader categories, but the difference was not statistically significant. In contrast, videos on BiliBili submitted by self-reported physicians/surgeons, PhD/MD received more likes, comments, and favorites ($p < 0.05$), and had a larger number of views by users. (Table 3)

Video content assessment

There was no statistical difference in video quality between the two platforms ($p > 0.05$). The average DISCERN score for video quality assessment was 48.98 out of 80 and 50.88 out of 80 for Tiktok and BiliBili, respectively, indicating an overall low quality of information in the videos. Among the uploader categories, videos submitted by self-reported physicians/surgeons had the highest average scores (56.20 and 59.67), followed by those submitted by self-reported dietitians (53.00 and 52.80). Videos submitted by general public

users (TikTok) and self-reported PhD/MD (BiliBili) had the lowest DISCERN scores (Table s8).

When considering reliability and treatment choices, videos submitted by self-reported physicians/surgeons had the highest scores (30.00 and 26.33), while those submitted by general users (26.1) and PhD/MD (20.50) had the lowest scores (Table s8). In terms of specific questions addressing the sources of support and information (question 4: sources of information, question 5: information produced time, question 7: details of additional sources), the scores were around 2, indicating the videos delivered poorly in providing specific and evidence-based information or references. Regarding reliability, the scores of question 6 (Is it balanced and unbiased) and question 8 (does it refer to areas of uncertainty) appeared different. Compared to other videos, videos submitted by physicians/surgeons and dietitians were more likely to be more balanced and unbiased, and were less likely to be involved in areas of uncertainty (Figure 5).

The quality of videos was also assessed by the HONCode. The average for video quality assessment was 1.96 and 1.93 out of 80 for TikTok and BiliBili, respectively. Videos submitted by physicians/surgeons (2.80 and 3.67 for Tiktok and BiliBili, respectively) and dietitians
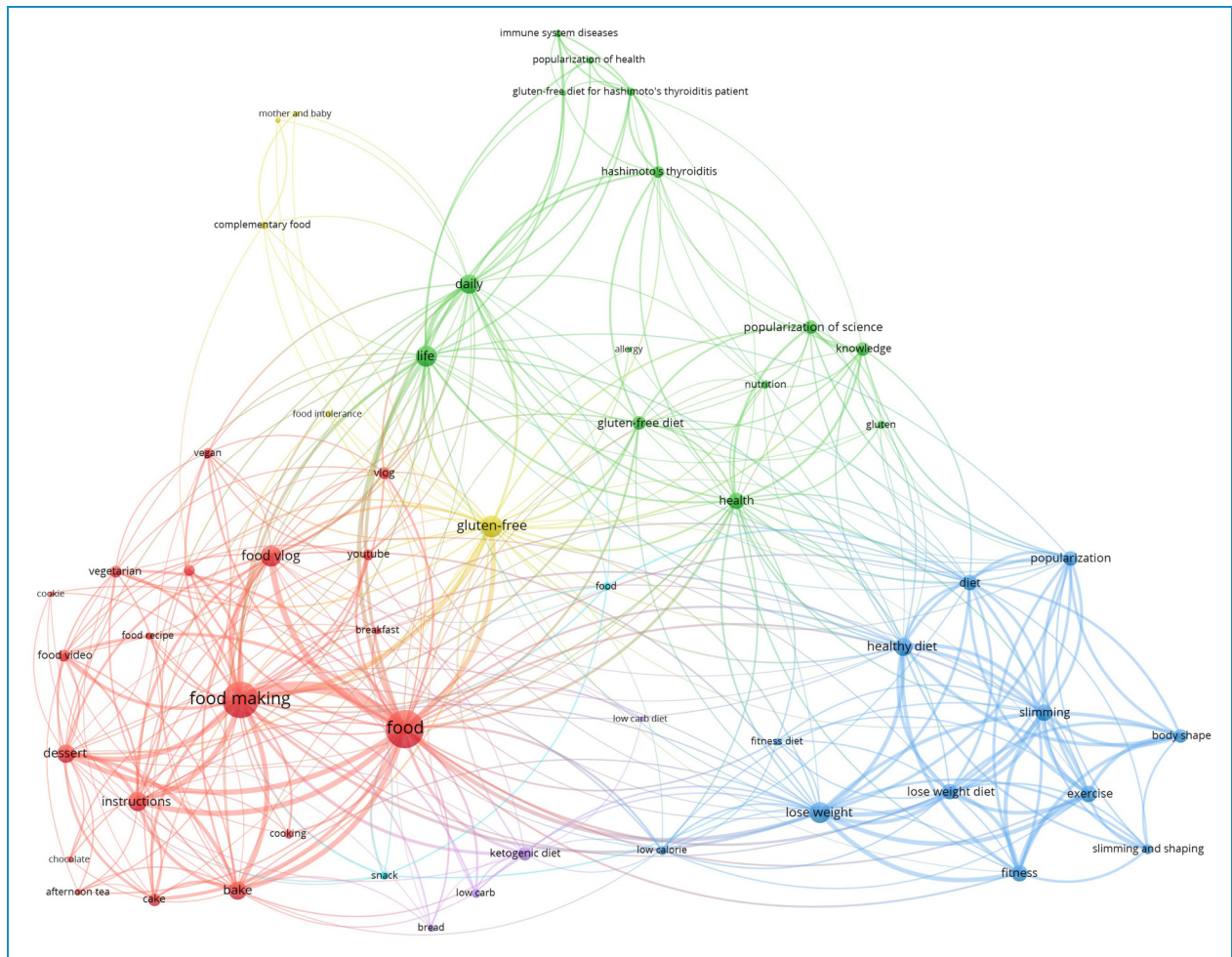
Figure 4. Hashtags network map of gluten-free videos on BiliBili.

(2.62 and 3.0 for Tiktok and BiliBili, respectively) had the highest and the second highest score. However, in contrast to the ranking based on the rank of the DISCERN scores, videos submitted by self-reported patients or relatives had the lowest HONCode score (Table s8). Videos submitted by physicians, surgeons, and dietitians had higher quality in authority and advertisement, while videos submitted by patients paid more attention to the user's practice. No videos met the criteria of financial disclosure and confidentiality due to the policy of video platforms and the lack of disclosure statements (Figure 6).

We extracted the information in the video regarding the recommendation of GFD to viewers without CD or WA. 0% of physicians/surgeons recommended GFD to ordinary people or people with other diseases. Conversely, only 1 (1.6%) video of patients who adhered to GFD or relatives of patients did not recommend GFD to ordinary people or people with other diseases. 22.2% of dietitians recommended GFD to ordinary people while 33% of dietitians did not recommend it (Table s9).

We observed that 21 videos contained food products, of which 19 of them contained products with clear brand labels (Table s9). Diseases mentioned by patients were also extracted. Self-reported diseases among patient accounts included HT, allergic constitution, gastroesophageal reflux disease, Sjogren's syndrome, multiple sclerosis (MS), autism, hair loss, and acne. Foods mentioned to substitute for wheat included quinoa, buckwheat, corn, oats, brown rice, millet, colored rice, rice, legume, and tubers.

Discussion

Principal findings

In this study, we investigated the trends and content of GFD videos in China. Our findings revealed an increasing trend of submitting videos related to GFD over the past 5 years. High-frequency hashtags or keywords related to GFD videos including gluten-free, food making, healthy diet, slimming, and HT. The majority of these videos were

Table 2. Clusters and hashtags of videos.

Clusters	Hashtags
TikTok	
Clusters 1	low carb diet; ketogenic diet
Clusters 2	food intolerance; gluten-free
Clusters 3	slimming diet; food
Clusters 4	hashimoto's thyroiditis; anti-inflammatory diet
Clusters 5	gluten-free; vlog
Clusters 6	gluten-free diet; gluten
Clusters 7	popularization of health; popularization of medical
BiliBili	
Clusters 1	low carb diet; ketogenic diet
Clusters 2	food intolerance; gluten-free
Clusters 3	slimming diet; lose weight
Clusters 4	hashimoto's thyroiditis; daily
Clusters 5	food making; vlog
Clusters 6	snack; food

gluten-free food recipe videos (678/822, 82.5%). Non-recipe videos took up less than 20% of the total videos, with most of them being uploaded by self-reported GFD-adhering patients and general users. The overall quality of non-food recipe videos, as assessed by DISCERN and HONcode, was found to be unsatisfactory. Videos submitted by health professionals (self-report physicians, surgeons, and dietitians) videos had better quality than other videos.

Trend analysis

Previous studies using Google Trends found sustained popularity of the gluten-free network since 2013–2014.[7,14] In China, the first video about GFD was released in 2015. The number of GFD videos in China experienced a rapid increase after 2019, suggesting that there was more interest in GFD recently. This trend may partly relate to the increasing reports of WA and IBD in China.[21,25,26] However, the surge in disease prevalence alone cannot explain the disproportionate growth in interest towards GFD. The timing of video uploads and the types of videos may suggest an alternative pathway for the

dissemination of GFD information among the Chinese population. Between 2015 and 2017, all uploaded and released videos primarily focused on gluten-free food making, predominantly in English or other languages. Some of these videos had the hashtag Youtube, indicating the original source of the videos. The first non-recipe video was released in 2017, aiming to explain GFD. This indicated a possibility that the concept of gluten-free was first introduced to the general public through overseas cooking recipes on the internet, aligning with studies on popular sources of gluten-free information done in other country.[27] After the introduction of gluten-free recipes, the Chinses population may start to pay attention to gluten and GFD around 2017–2018, leading to the current popularity of GFD as a dietary choice.

Audience engagement analysis

On the platform that provides the number of views, we found that food recipe videos garnered significantly higher views compared to non-recipe videos. This may be attributed to food recipe videos often having more hashtags or keywords, which facilitate discoverability through other hashtags. Conversely, when considering engagement metrics, which partially reflect video popularity,[28] non-recipe videos exhibited higher user engagement. This indicated that non-recipe videos were more likely to be added to users' personal favorites and shared. Compared to other users, videos submitted by self-report physician, surgeon, PhD and MD were more favored by viewers. This signifies a shift from the traditional approach where doctors prescribed GFD to patients, as short video platforms offer a space for the proliferation of GFD content from various sources.

Quality analysis

To our knowledge, our study is the first to examine the quality of GFD videos in China. DISCERN and HONcode instruments showed that the quality of videos varied. The overall quality did not fully meet the criteria of an accurate and impartial information source. Our study consisted of other studies that found an overall poor quality of health-related videos on platforms such as YouTube and TikTok.[20,29,30] According to the video upload and promotion policies of these platforms, there was no restriction on the content that was published and no scientific supervision on the quality of published videos. The lack of content restrictions and scientific oversight on these platforms may contribute to the suboptimal quality of published videos.

In the analysis of videos based on authors' type, we found that physicians/surgeons made the highest quality videos, consistent with findings from other studies.[29,30] Videos from general users and PhD/MD had the lowest

Table 3. Characteristics of non-food recipe videos.

Characteristics[a]	Physicians/ surgeons	Dietitians	PhD/MD	Patients/relatives	General users	p
TikTok	N = 5	N = 13	N = 0	N = 7	N = 24	
Likes, median (IQR)[b]	81 (18, 132)	47 (5, 249)	–	98 (69, 157)	96 (22, 348)	0.697
Comments, median (IQR)	15 (3, 19)	6 (1, 23)	–	19 (15, 46)	12 (3, 40)	0.650
Favorites, median (IQR)	7 (5, 62)	23 (1, 78)	–	35 (20, 73)	19 (3, 50)	0.663
Share (IQR)	10 (8, 79)	14 (1, 77)	–	16 (10, 82)	26.50 (2, 78)	0.912
Duration (IQR)	72 (59, 112)	70 (44, 117)	–	189 (134, 249)	100 (42, 186)	0.090
BiliBili	N = 3	N = 5	N = 2	N = 37	N = 39	
Likes, median (IQR)	178 (112, 807)	13 (3, 26)	661.50 (331, 992)	27 (18, 46)	13 (2, 64)	0.029
Comments, median (IQR)	28 (16, 126)	0 (0, 1)	113.50 (57, 170)	6 (2, 14)	1 (0, 9)	0.023
Favorites, median (IQR)	38 (37, 96)	9 (0, 20)	92 (46, 138)	24 (13, 75)	13 (1, 65)	0.099
Coins, median (IQR)	38 (21, 39)	0 (0, 6)	90.50 (45, 136)	5 (4, 9)	2 (0, 14)	0.095
Views, median (IQR)	3017 (2,527, 11,509)	563 (218, 755)	12,541 (6,312, 18,771)	1359 (831, 2220)	594 (219, 3062)	0.042
Duration (IQR)	276 (250, 284)	257 (203, 362)	216 (144, 289)	133 (110, 186)	282 (109, 746)	0.016

aAccounts of videos that invited physicians, dietitians or PhD were counted by their submission account, not the main characters of videos.
bIQR: Interquartile range, presented as (P25, P75).

quality by DISCERN, and videos from patients or relatives of patients who adhere to GFD had the lowest quality by HONcode.

Videos submitted by physician/surgeon had the highest score on aim, justifiability, description of treatment, and decision-making. Contrary to expectations and other studies,[29,30] we found that videos submitted by health professionals, including physicians and surgeons, scored lowest on references and sources of information, whereas videos submitted by patients or general users scored highest on the sources of information. This discrepancy might be caused by health professionals being more likely to translate professional knowledge obtained from serval sources into content that is easier for the public to understand during science popularization, resulting in the difficulty in tracing their references. Meanwhile, it is worth noting that though lots of videos submitted by patients or general users provided the source of their content, seldom were research papers or randomized controlled trial outcomes. Most of their source were popular books translated or published without peer review, some of these self-help

books had also been reported in other studies done in other countries.[31] Our results underscored the need for developing policies for video submission and review of health information on social media, as well as the standardization of popular science content. In addition, providing instruction to health professionals on the content they need to share and the appropriate methods for sharing information may help to promote the production of higher quality videos.

Another divergence between videos submitted by health professionals and other types of users was the areas of uncertainty. Health professionals were more willing to recommend GFD to those with allergies or gastrointestinal symptoms. Patients and relatives of patients who adhere to GFD, however, were more willing to expand the indications of GFD to diseases with controversial effects, such as HT and MS.[32–35] This difference in recommendations highlighted the need for clearer guidelines and evidence-based information to address areas of uncertainty surrounding GFD.

Additionally, financial disclosure and advertisement policy were another two weaknesses of these videos.
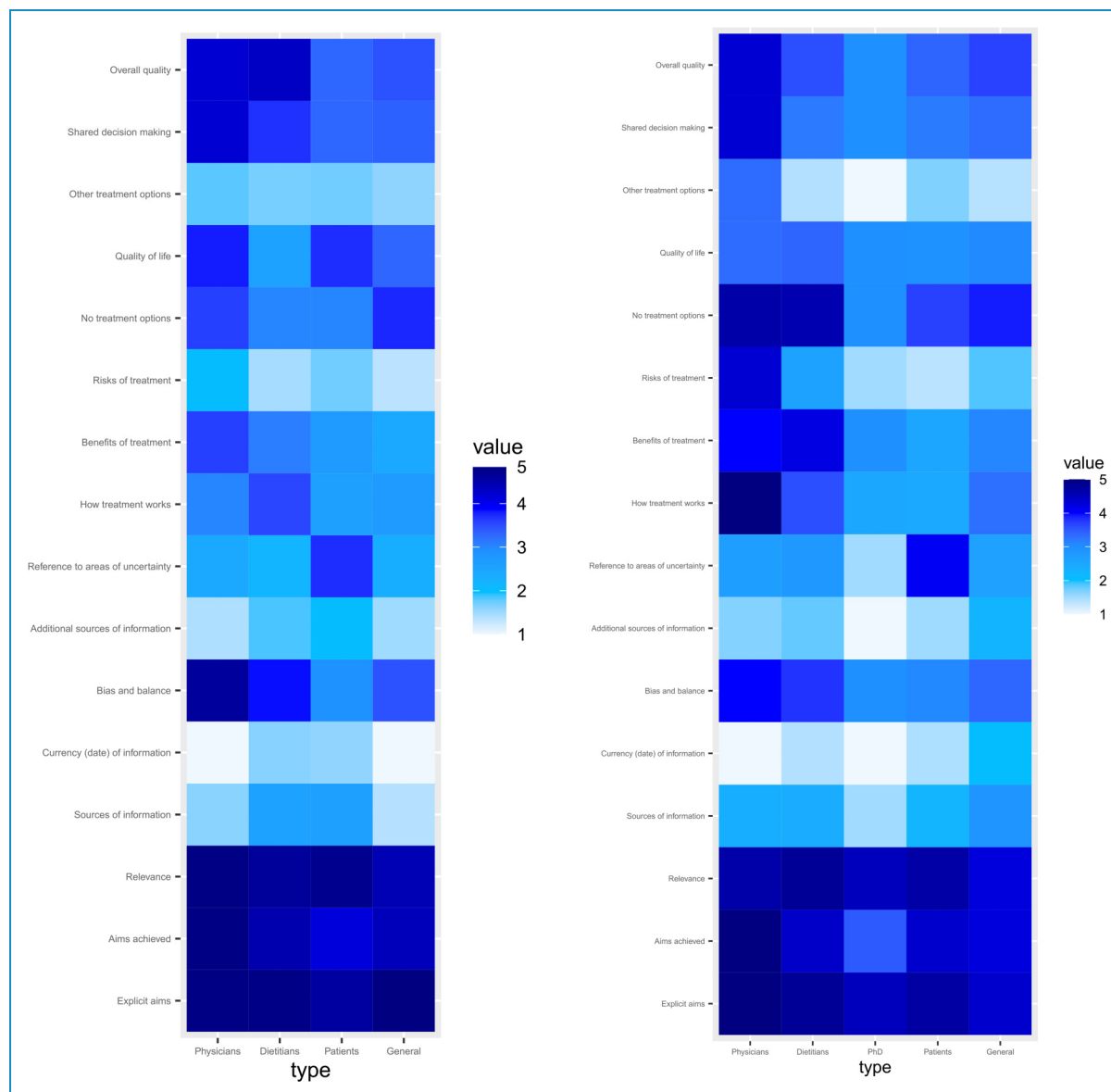
Figure 5. DISCERN scores for videos submitted by different account. (a) DISCERN scores for videos on TikTok; (b) DISCERN scores for videos on BiliBili.

Some videos prominently featured specific products without any statement of financial support. Lack of supervision on potential advertisements on social media might explain this finding. Clarifying advertising policies of video platforms may be an urgent issue to be addressed.

Content analysis

We found that hashtags and keywords chosen by uploaders to describe their videos covered a wide range of fields. The majority of food recipe videos focused on bakery food instructions, which may be attributed to the fact that baking often involves the use of flour, a gluten-containing ingredient. People who adhered to GFD may have a great demand for alternatives to traditional flour-based products.[1,3] Meanwhile, it is important to note requirements for body shape including slimming and fitness formed another cluster of hashtags. Unfortunately, gluten-free packaged foods frequently contain a greater density of sugar and fat,[36] which may lead to a poor effect on their claim.

Allergic babies and supplementary foods for babies with allergic constitutions formed a unique cluster. With the increase in the prevalence of allergies in the Chinese population,[22] there may be a growing demand for information and guidance on managing allergies in infants in the
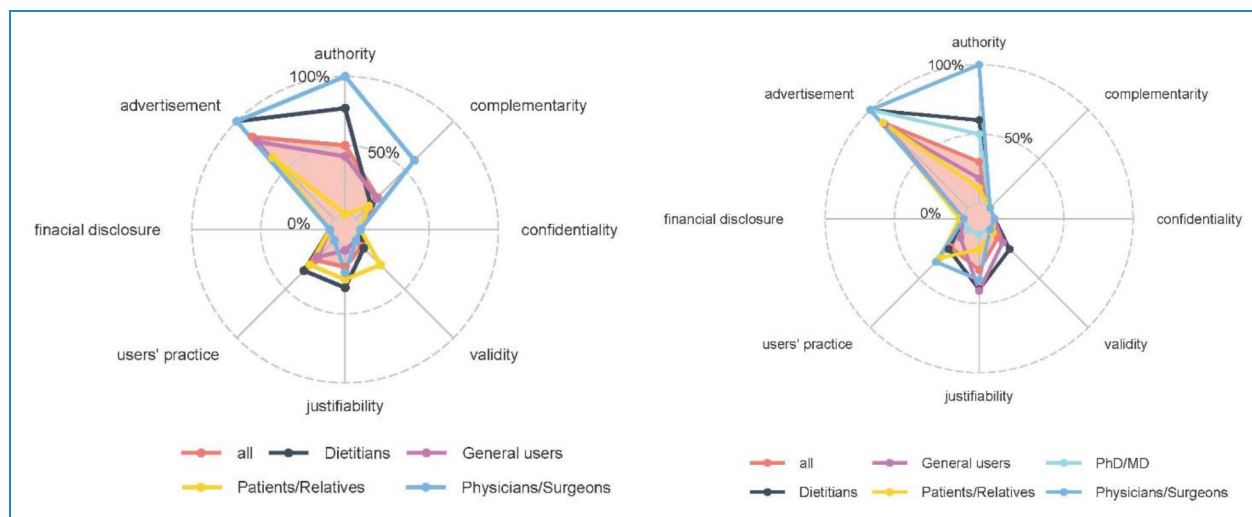
Figure 6. HONCode scores for videos submitted by different account. (a) HONCode scores for videos on TikTok; (b) HONCode scores for videos on BiliBili.

future. In addition to WA, immune system diseases such as HT formed another cluster, indicating a high level of interest in GFD among patients with these conditions.

The ketogenic diet, low carb diet, and anti-inflammation diet were frequently mentioned, probably because these dietary patterns in some situations have the similarities of containing less refined grains and containing more proteins. Vegetarian and vegan diets were also mentioned, likely due to their perception as "healthier" dietary choices among the general public.

Among patients adhering to a GFD, the most frequently reported disease applicable to GFD was WA. Surprisingly, no patients reported that they had CD, which is the primary indication for GFD.[5] This might be because the prevalence of CD in Chinese is low. The disease most commonly reported by patients or relatives of patients was HT. Although HT is not a well-known indication for GFD, some trials showed that GFD could reduce thyroid antibody titers[37] or concentrations of thyrotropin (TSH).[34] However, the literature review showed that recommending GFD to treat HT without CD or gluten allergy is still up for more evidence.[32] Furthermore, a study also found that GFD may impair the beneficial effects of exogenous vitamin D in HT patients.[38] It is worth noticing that celiac sprue and HT are cognate diseases. The prevalence of CD in patients with thyroid autoimmunity was 2 to 5% in the Dutch population.[39] CD, including its atypical form, could increase the demand for thyroxine,[40] and thyroid and coeliac-specific serological tests might represent an epiphenomenon.[39] Therefore, some Hashimoto thyroiditis patients in China may be undiagnosed atypical CD patients at the same time. For these patients, GFD or increasing the T4 dose could achieve target TSH levels.[40]

In terms of alternative foods to replace wheat and other gluten-containing carbohydrates in GFD, quinoa was the most frequently mentioned, followed by buckwheat and colored rice. Contrary to our expectations, refined rice, as the most commonly consumed gluten-free staple food in China, was rarely recommended. This may be because refined rice is widely known as the equivalent of wheat and barley in China. Uploaders of videos may prefer to introduce some less common alternatives. Meanwhile, as a kind of refined grain, refined rice is associated with lots of non-communicable diseases and chronic inflammation.[41–43] Uploaders of videos may also wish to introduce healthier food to the public. It is worth noting that though using whole grains to replace wheat and barley in gluten-free recipes will make the diet healthier, it will misestimate the relationship between GFD and symptom improvement. Meanwhile, these shared "gluten-free diets" are sometimes aligned with the Mediterranean diet, ketogenic diet, or/and anti-inflammatory diets, dietary patterns mentioned later are associated with reducing risk or improving symptoms of various chronic diseases.[44–46] Therefore, symptom improvements experienced by individuals following online gluten-free recipes may be due to changes in their overall dietary patterns rather than the exclusion of gluten alone.

There was a significant disagreement between physicians/surgeons and patients regarding the recommendation of GFD. All of physicians/surgeons didn't recommend GFD to patients without WA diagnosis or gastrointestinal symptoms, while 96.7% (29/30) videos that included recommendation content submitted by patients recommended patients with the same disease or symptom (without allergy testing or diagnosis) try GFD. This conflicting recommendation may lead to confusion among viewers and potentially undermine the authority of physicians and surgeons.

Implications

Our study found an increasing trend of interest in GFD in China. However, while demand for GFD instruction is rapidly rising, information about GFD shared on video platforms in China is of ragged quality and lacks of a statement of reference. The statement of potential advertisement and financial support was also unclear. Although some videos provided unbiased and reliable information about GFD, users seeking information from platforms like TikTok often encountered low-quality videos that failed to deliver adequate information.

Diet-related information shared on social media has the potential to influence users' dietary choices, and algorithms and "echo chambers" may enhance the promotion of popular diets.[14,47] Videos with biased content may lead to confusion and impair informed decision-making. This highlights the importance of submitting correct and high-quality information on social media. Our studies also found that videos submitted by health professionals gained more engagement. Therefore, it is vital for physicians, surgeons and dietitians to establish themselves as authoritative voices of nutrition in the web-based landscape by sharing evidence-based information that can be favored by the ordinary public.

Limitations

Our study has some limitations. Firstly, although we used multiple tools (DISCERN, and HONcode) to evaluate GFD videos, there remain some limitations in assessing the quality of videos and their content. These tools were originally developed for evaluating website information, and their applicability to video content evaluation may have some limitations. Secondly, although we analyzed the number of engagements, we did not evaluate whether engagements were positive or negative. Engagements can sometimes be gained due to dissatisfaction but not praise. Thirdly, our study included videos originally submitted outside of China but reprinted on Chinese platforms. Therefore, our findings may not fully represent the quality of videos produced by Chinese uploaders. Additionally, some accounts reprinted foreign videos to help others learn foreign languages rather than specifically introducing GFD to the public. We did not conduct a deeper analysis of the purposes behind submitting these videos.

Conclusion

There was an increasing interest in GFD over the past 5 years. The overall quality of these videos was poor, lacking references, and transparency regarding potential advertisements. Videos submitted by health professionals demonstrated better quality compared to other uploaders. Policy development of video platforms and education for health professionals on making videos are necessary to promote the production of high-quality videos. Additionally, users should be cautious and critical of information they encounter on social media platforms.

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