


Instant messaging client gives the opportunity to recognize gut microbiota and dysbiosis-related disease: An investigation study on WeChat APP

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Abstract

Objectives: Gut microbiota and dysbiosis are closely related to the occurrence and development of various diseases. It is necessary to popularize gut microbiota-related knowledge to the public. And the instant messaging client on smartphones supplies a perfect tool to achieve this goal. Hence, we will describe the current status of gut microbiota education spread by WeChat official accounts.

Methods: The keywords of “gut microbiota,” “fecal microbiota transplantation (FMT),” and “probiotics” were searched in the articles published from January 2015 to August 2020 on the WeChat official accounts. And the data were analyzed based on the 10 common gut dysbiosis-related diseases.

Results: A total of 3061 WeChat official accounts have published 11,239 articles on gut microbiota dysbiosis-related diseases, with a rising trend in the total article numbers and the total pageviews. The keywords of “gut microbiota” dominate 50.61%, and the articles on inflammatory bowel disease had the largest proportion. Additionally, articles on the keyword “gut microbiota” also included cancer and obesity, articles on the keyword “FMT” mainly consist of *Clostridium difficile* infection and psychological disease, and the keyword “probiotics” was mainly related to obesity and irritable bowel syndrome disease. The top three total pageviews were on inflammatory bowel disease, obesity, and cancer.

Conclusion: This study indicates the current research hotspots and public concerns on the gut microbiota, and WeChat as an instant messaging client plays an important role in promoting the scientific popularization of gut microbiota.

Keywords

Gut microbiota, fecal microbiota transplantation, probiotics, WeChat official account, diseases, instant messaging client

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Introduction

Gut microbiota has become one of the research hotspots in recent years and has attracted increasing attention in science, health care, and public fields. Gut microbiota dysbiosis caused by diet, environment, antibiotic use, and infection plays an important role in the pathophysiology of various diseases, including inflammatory bowel disease (IBD), *Clostridium difficile* infection (CDI), irritable bowel syndrome (IBS), psychological disease, nervous system disease, hepatic disease, cardiovascular disease (CVD), cancer, diabetes, and obesity.^{1–4} Probiotics and fecal microbiota transplantation (FMT) are used for gut dysbiosis related-diseases by reconstructing the composition and function of gut microbiota.⁴ FMT has shown an effective role in the treatment of recurrent CDI,⁵ ulcerative colitis,⁶ Crohn's disease,⁷ hepatic diseases,⁸ psychological diseases,⁹ and nervous system diseases.¹⁰ As the research field expands, the studies and the utilization concerning FMT and probiotics are increasing widely.¹¹ However, FMT was still novel and unfamiliar to the public,^{12–14} though the washed microbiota transplantation¹⁵ as Nanjing consensus recommended methodology of FMT in 2019¹⁶ has been widely used to replace the manual FMT in China. Instant Messaging client provides a new pathway of medical education on gut microbiota and its related intervention strategies for the public.

With the boom of the Internet and smartphones, the push of medical-related information and health care services through mobile phone applications is sharply increasing.^{17–20} One of the most popular smartphone applications in China is WeChat, a free application that provides sending text, voice, videos, photos subscription, and other functions.²¹ As of December 2020, the combined number of monthly active users of WeChat grew to 1.225 billion, up 5% year on year.²² WeChat has been used as a medium to change lifestyles, showing potential positive effects on public medical education and management of diseases.^{23–27} Almost 50% of WeChat users follow between 10 and 20 official accounts as per the latest data, over 80% of WeChat users access official accounts, and more than half of them spend 10–30 min of this on browsing official accounts.²² The WeChat official accounts (WOAs) (<https://en.wikipedia.org/wiki/WeChat>) are used by individuals, media, enterprises, governments, or other organizations. It provides a new way of information dissemination for the public, including knowledge and other information about gut microbiota, FMT, and probiotics. The main function of WOAs is to convey information to users on the WeChat side which is similar to newspapers, magazines, as well as “Facebook Instant Articles.” Our study aimed to provide evidence to evaluate public interest in gut microbiota dysbiosis-related diseases and treatment strategies through the instant messaging client, which could drive researchers to grasp the trend of efforts more accurately.

Methods

Study design and data collection

A retrospective study was conducted to evaluate the public interest in microbiota-related topics in China. We searched WOA articles by the keywords “FMT,” “gut microbiota,” and “probiotics” and 10 gut dysbiosis-related diseases between January 2015 and August 2020. The 10 diseases included IBD, cancer, obesity, psychological disease, IBS, diabetes mellitus, CDI, hepatic diseases, nervous system diseases, and cardiovascular diseases. The keywords and articles were in Chinese. We recoded the code of the official account (some WOAs had their English IDs while others were translated), the type of disease, the page views, the number of “Wows,” the type of article, the form of article, the push time, and relevance to the keywords. Articles were distributed into six groups, including article interpretation, popular science, report, promotion, recruitment, and others (Table 1).

Statistical analysis

For each article, we coded the categorical data in the features frame. The element in the type of article and the type of disease were coded in order. The relevance to the keyword was transformed into dichotomous variables in form of an article. Next, the pageviews, the types of articles, and the types of diseases of every year were described. We then investigated associations between the features of the articles and readers' participation. Correlation and multivariate regression analysis between the pageviews and the number of articles, the push time, the keywords, the type of disease, and the number of “Wows” were conducted. A nonparametric test was used to compare groups on the pageviews and keywords under different diseases, and a chi-square test was used to compare groups on pageviews and article types under different diseases. SPSS statistical software (SPSS Inc., Chicago, USA) was used for the statistical analysis, and $P < 0.05$ was considered as the statistically significant level.

Results

Trends change in the concern of gut microbiota-related diseases

In recent 5 years, the number of articles related to the 10 diseases (see study design) published by WOAs were on a steady rise ($N = 11,239$, Figure 1). Articles related to IBD accounted for the highest percentage every year, with a total of 23.60% (2652/11,239) over the past 5 years. Beyond this, IBD-related articles dominated keywords of gut microbiota, FMT, and probiotics. The following were cancer, diabetes, CDI, psychological disease, IBS, obesity,

Table 1. Features frame with definitions.

Item	Definition
Official account	The WeChat official account that the article comes from
Pageview	The amounts of readings of the articles
Wow	The article has been liked and was pushed to the relevant location where the WeChat users could see their friends' recommendations
Push time	The time when the article was published
Keyword	Gut microbiota, fecal microbiota transplantation and probiotics
Type of article	
Article interpretation	Articles including interpretation and analysis of articles or studies
Popular science	Articles including popular science knowledge
Report	Articles including character interviews, case reports, news, and conference reports
Promotion	Articles including business, lectures, conference information, etc.
Recruitment	Articles including information about donor or patient recruitment
Other	Other types of articles
Form of article	
Text only	Articles containing text only or text and pictures
Text and videos	Articles containing text and videos or text, pictures, and videos
Type of disease	
1. IBD	Articles covering the diseases of inflammatory bowel disease (IBD)
2. CDI	Articles covering the disease of <i>Clostridium difficile</i> infection (CDI)
3. IBS	Articles covering the diseases of irritable bowel syndrome (IBS)
4. Psychological disease	Articles covering the diseases of psychology
5. Nervous system disease	Articles covering the diseases of the nervous system
6. Hepatic disease	Articles covering the diseases of the liver
7. CVD	Articles covering the diseases of cardiovascular
8. Cancer	Articles covering the diseases of various cancers
9. Diabetes	Articles covering the diseases of diabetes
10. Obesity	Articles covering the diseases of obesity
Relevance to the keyword	Whether the content of the article was relevant to the keywords and disease types

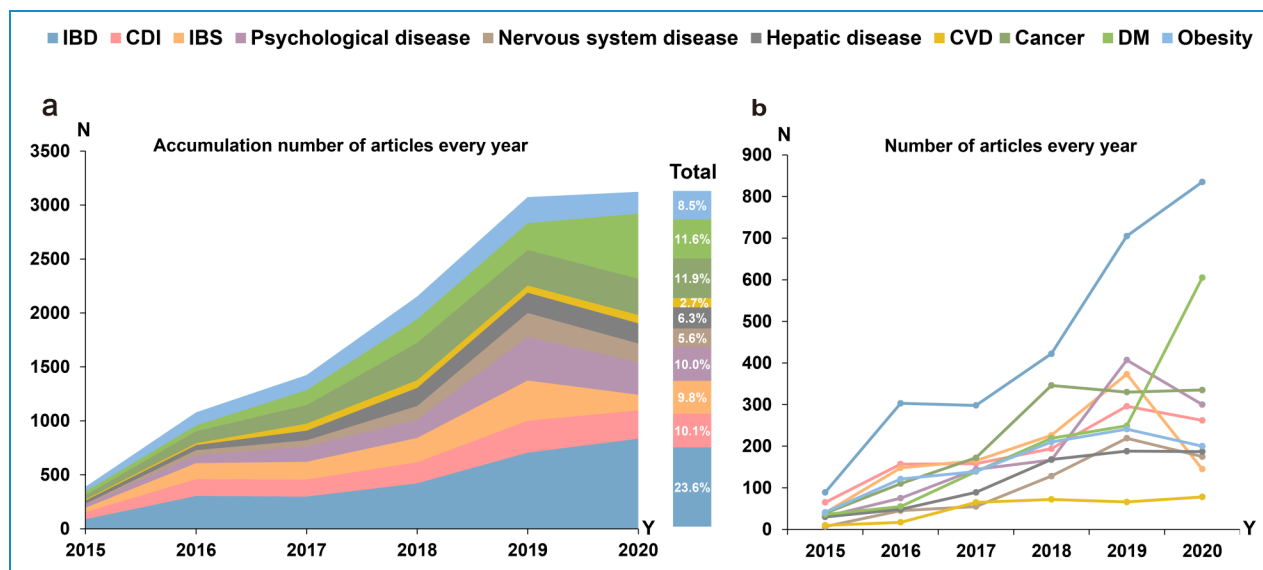


Figure 1. Articles related to 10 gut dysbiosis related-diseases published on WeChat official account. (a) The total articles of 10 diseases every year from 2015 to 2020.08. (b) The number of articles about each disease every year from 2015.01 to 2020.08. IBD: inflammatory bowel disease; CDI: *Clostridium difficile* infection; IBS: irritable bowel syndrome; CVD: cardiovascular disease.

hepatic disease, nervous system disease, and CVD (Figure 1(a)). Compared with previous years, the number of articles related to diabetes surged to second place in the first half of 2020, while that regarding IBS plummeted to ninth in the first half of 2020. Although there was a certain increase in the annual articles about hepatic diseases, nervous system diseases, and CVD, they remained the diseases with the lowest number of publications (Figure 1(b)). The number of articles with the keywords of “gut microbiota” was the most, accounting for 50.61% (5688/11,239), while “FMT” and “probiotics” accounted for 22.41% (2519/11,239) and 26.98% (3032/11,239), respectively. Apart from IBD, the total number of articles with regard to diseases and “gut microbiota” were mainly cancer (13.92%) and obesity (10.81%) in recent years. When it comes to “FMT,” the number of articles on CDI ranked second every year, totally accounting for 18.66% (470/2519). The attention on psychological diseases and cancer treated by FMT exceeded other diseases year by year, and the total number of articles ranked third and fourth. As for the keyword “probiotics,” the articles from 2015 to 2020 were mainly about IBD, diabetes, IBS, and Cancer. In 2020, articles on diabetes increased by 5.7 times compared with last year, surpassing IBD to become the first (Figure S1).

Pageviews reflected the increasing attention on dysbiosis-related diseases

From 2015 to 2020, the total pageviews of articles related to the above 10 diseases reported by WOAs showed an upward trend year by year. The articles on IBD

($N=5,865,235$), obesity ($N=5,698,742$), cancer ($N=5,222,583$) ranked the top three in terms of total pageviews. On average, the top three pageviews of each article were about obesity ($N=5986.07$), nervous system diseases ($N=4373.33$), and psychological diseases ($N=4151.41$). Pageviews of IBD-related articles have ranked first on “FMT” and “probiotics” over the past 5 years. Although the total pageviews of IBD-related articles were the largest, the number of articles was also large, so the average pageviews of each article were the least (Figure 2(a)). Each year, the total pageviews of obesity on the three keywords ranked top five. The average pageviews of obesity-related articles on “FMT” and “gut microbiota” were in the first place respectively, and the “probiotics” was in the second place (Figure 2). In addition to 2017, articles with three keywords and psychological disease also ranked among the top five in terms of total pageviews (Figure 2(a)). The pageviews of CDI-related articles mainly focused on the keywords of “FMT” and “gut microbiota,” and the average pageviews among the three keywords were similar (Figure 2(b)). Whether in total or in three keywords, total and average pageviews of cancer were both in the top five since 2017 (Figure 2). CVD and nervous system disease-related articles had lower pageviews, mainly focused on “gut microbiota” and “probiotics.” Since 2018, the cumulative pageviews of hepatic disease increased obviously, mainly focusing on “gut microbiota” and “probiotics.” With regard to IBS, pageviews concentrated mainly on the keyword of “gut microbiota” and the average pageviews ranked second on the keyword “FMT.” Average pageviews of diabetes-related articles were mainly on the keywords of “FMT” (Figure 2(b)).

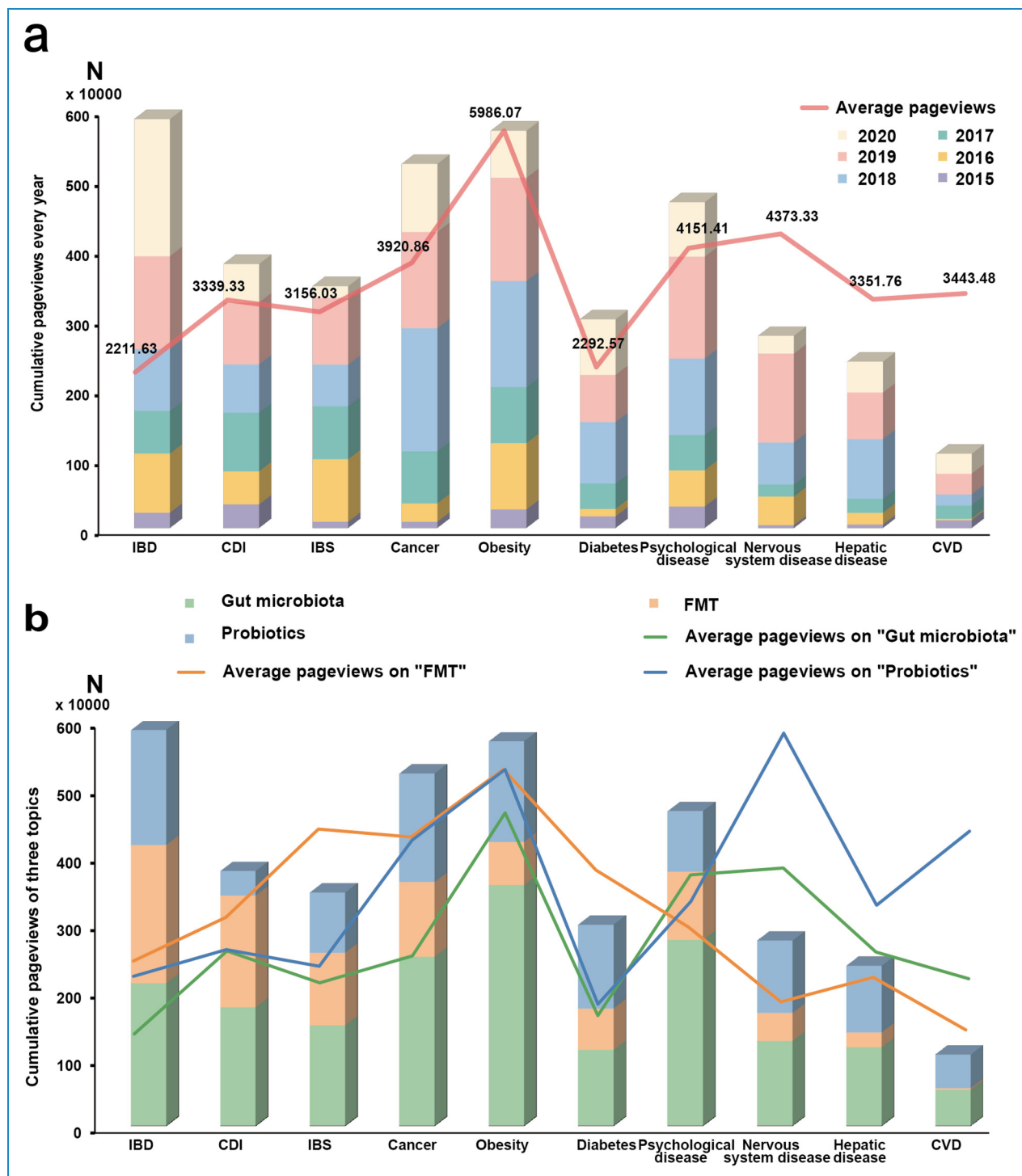


Figure 2. Cumulative pageviews and pageviews per article. (a) Cumulative pageviews of articles related to each disease and average pageviews per article from 2015.01 to 2020.08. (b) The total pageviews and the average pageviews of articles on keywords of "Gut microbiota," "FMT," "Probiotics" from 2015 to 2020.08. CDI: *Clostridium difficile* infection; IBD: inflammatory bowel disease; IBS: irritable bowel syndrome; CVD: cardiovascular disease; FMT: fecal microbiota transplantation.

We explored the factors that affected the cumulative pageviews. Chi-square test and Kruskal–Wallis test were used to compare the association between keywords and

pageviews (Supplemental Table 1). Compared with "probiotics," the public paid more attention to "FMT," then followed by "gut microbiota." Hence, we conducted a Pearson

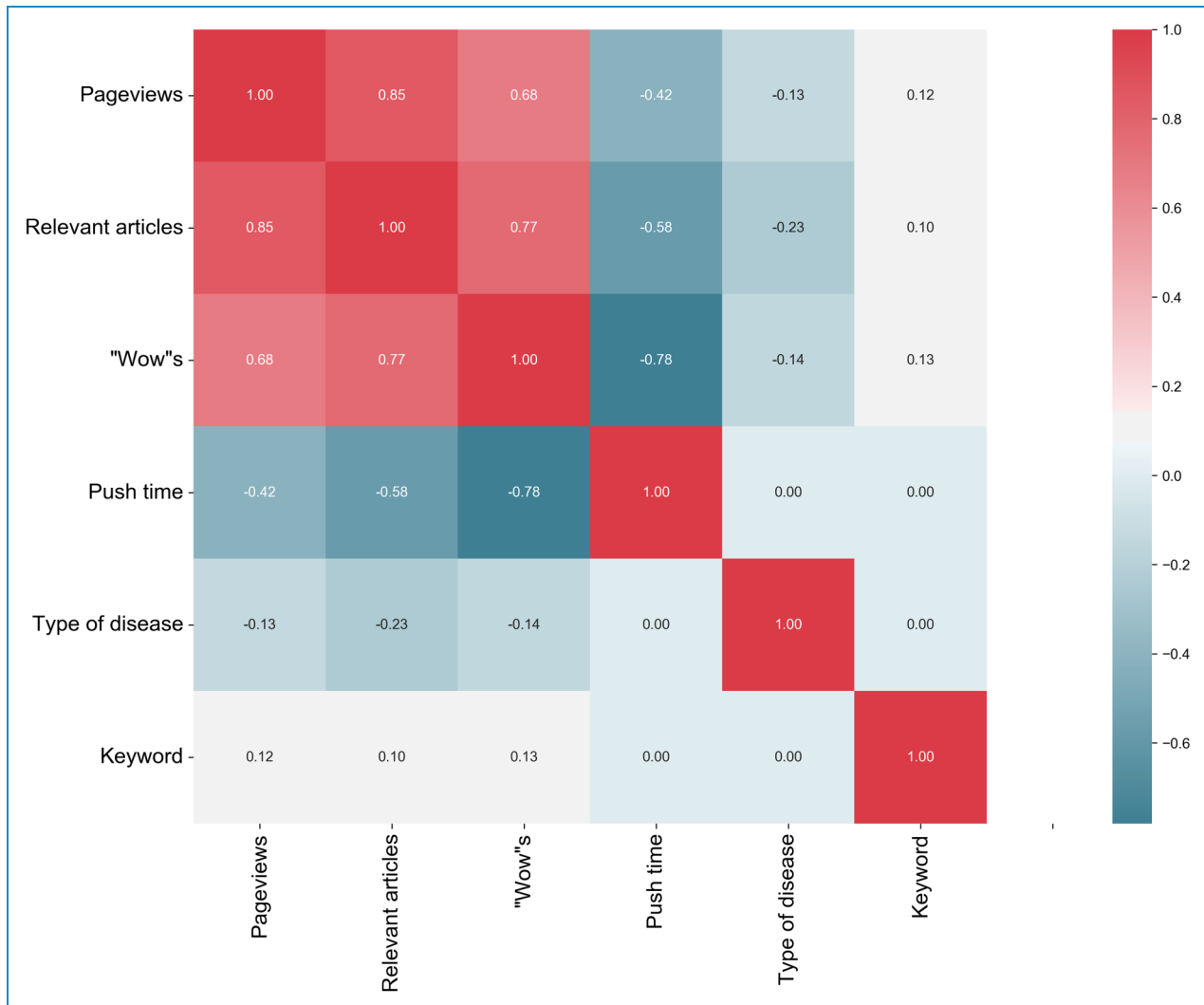


Figure 3. Linear correlation analysis associated with cumulative pageviews. Push time, the length of statistical time from the time of publication.

correlation analysis. The cumulative pageviews were positively correlated with the number of cumulative relevant articles ($r=0.85$, $P < 0.001$) and the number of cumulative "Wows" ($r=0.68$, $P < 0.001$), but negatively correlated with the push time ($r = -0.42$, $P < 0.001$) (Figure 3). A multiple linear regression analysis ($R^2 = 0.580$, $F = 48.008$, $P < 0.001$) among the cumulative pageviews and the factors was performed. The types of disease were coded in order, and the positive regression coefficient between cumulative pageviews and the type of disease indicated a potential trend that the public paid more and more attention to parenteral diseases (Table 2).

WOAs with a large number of posts

From 2015 to 2020, a total of 3061 WOAs published articles regarding "FMT," "gut microbiota," and "probiotics." The top five official accounts with the largest number of articles were

"Digestive World," "Rexinchang Biotechnology Research Institute," "Medlive-Gastroenterology," "Gut-Microbes-Health," and "Micro-ecology." There were 23 WOAs with a total of more than 50 posts (Figure 4(a)). Among the 948 official accounts with the keyword of "FMT," "Digestive World," "Gut- Health," and "MedLive-Gastroenterology" reached the highest number of posts, which were 90, 82, and 73, respectively (Figure 4(b)). There were 2009 official accounts concerning the keywords of "gut microbiota," where "Rexinchang Biotechnology Research Institute," "Digestive World," and "Micro-ecology" had the largest number of posts, with 159, 140, and 125, respectively (Figure 4(c)). As for the keyword "probiotics," 1496 official accounts have published the related articles, of which "Medlive-Gastroenterology," "Observation Room of Jun-Qing," and "Digestive World" ranked top for 57, 55, and 55, respectively (Figure 4(d)).

Table 2. Multiple linear regression analysis associated with the cumulative pageviews.

Variables	B	95% CI	P-value
Type of disease	8177.113	1137.324–15216.902	0.023
Length of push time	5597.401	–99911.487–76714.818	0.431
Keyword	5945.151	–179532.633–29842.935	0.624
Number of relevant articles per year	2102.758	1702.564–2502.951	<0.001
Number of “Wows” per year	29.398	5.790–53.005	0.015

Length of push time, the length of statistical time from the time of publication. The number of relevant articles per year, the cumulative number of articles published in each year from January 2015 to August 2020. The number of “Wows” per year, the cumulative number of “Wows” in each year from 2015 to August 2020. $P < 0.05$ was considered statistically significant. Keywords, gut microbiota, fecal microbiota transplantation, and probiotics.

Approximately 1028 (33.6%) official accounts have published a total of 2652 (23.60%) IBD-related articles, with the largest number of official accounts and the largest total number of articles. The official accounts of the top three posts were “Digestive World” (115 articles), “Rexinchang Biotechnology Research Institute” (92 articles), and “IBD Academic Information Officer” (85 articles). While 202 official accounts have published CVD-related articles, with the least number of official accounts and the least total number of articles (Supplemental Table 2).

Association between types of articles and keywords

Correlation between types of articles and keywords was explored in this study (Table 3). On the one hand, the composition of types of articles among the three keywords was generally different on the whole ($P < 0.001$, Fisher exact test). Compared with “FMT” and “gut microbiota,” popular science articles accounted for a high proportion of “probiotics.” No matter which form of the disease, the main composition of every keyword was the popular science and the article interpretation. Although both popular science and article interpretation occupied the most in the articles related to three keywords. Besides, “FMT” and “gut microbiota” had a larger percentage of reports and recruitments while the number of promotion of articles was relatively more in “probiotics.” Especially,

the types of articles on “probiotics” were more varied than that on others.

On the other hand, the composition of types of articles was also not identical for every type of disease. The articles of popular science and interpretation were the major composition of each keyword in whichever type of disease. Recruitment articles could be seen more in the IBS, IBD, and nervous system diseases under the keyword “FMT.” Although the articles of interpretation were less than the articles of popular science in number, its composition in “gut microbiota” was more than that in other keywords in most of the diseases, such as diabetes, IBD, cancer, hepatic diseases, and CVD.

Discussion

Bacterial genome sequencing has been widely applied, promoting the rapid research growth of gut microbiota, FMT, and probiotics since 2011, especially in recent 5 years.^{28–30} Messaging makes WeChat since 2011 in China a commonly used daily application. There’s a common phenomenon for Chinese people to obtain health-related knowledge through WOAs. Researchers can send messages conveniently through WeChat public and personal accounts to convey information about the gut microbiota and disease, such as “Cell” to push some findings to followers through WOA. In our research, the pageviews of the articles published by some official accounts were relatively large, even as high as 1,000,000. These popular official accounts can help researchers promote their research to a wider audience. This study is the first to explore the focus of public attention on microbiota-related diseases and the author’s promotion trend through WeChat. Our results showed that in the past 5 years, the public had paid more and more attention to microbiota-related diseases, among which there were the most articles on the keyword of “gut microbiota.” The public showed the highest interest in the keyword of “gut microbiota” and the diseases of IBD, obesity, and cancer. Besides, IBD had the largest number of articles and the total number of articles on each keyword. However, the average amount of pageviews per article was the least. Therefore, in this information world, the author should not only convey health information but also need to attract readers as much as possible. The high average pageviews per article and linear regression results suggested that the public is increasingly concerned about the interaction between microbiota and parenteral diseases. There were fewer promotional types of articles on the keyword “FMT” and more recruitments than other keywords, possibly because donors are an integral part of the FMT process.³¹ As a relatively new measure for reconstructing gut microbiota, FMT had received a similar number of articles and pageviews as probiotics, which can be seen that people’s attention to FMT was high.

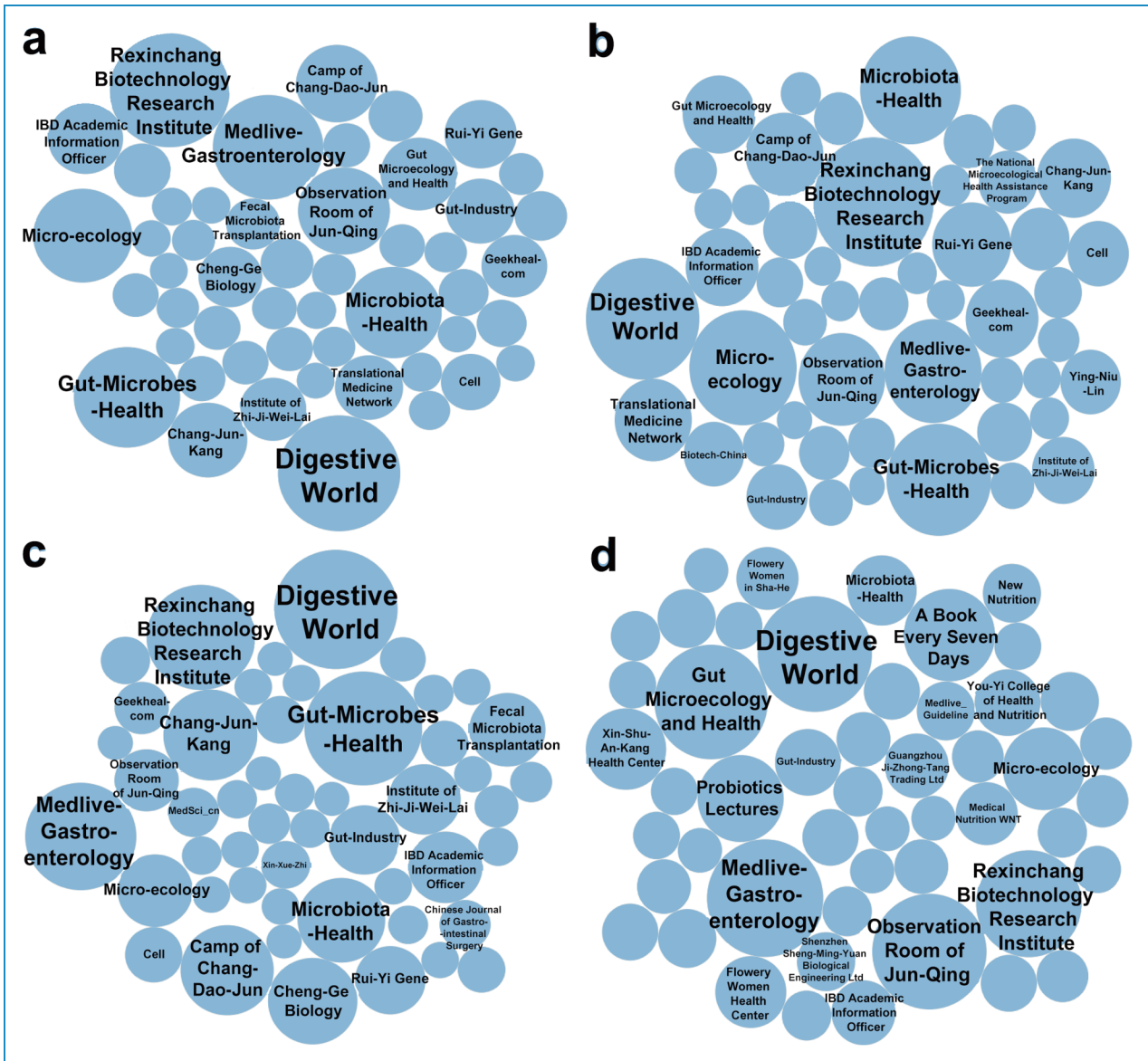


Figure 4. WeChat official accounts with a large number of posts on three keywords. (a) WOAs with a large total number of posts. (b) WOAs with a large total number of posts on the keyword “Gut microbiota.” (c) WOAs with a large total number of posts on the keyword “FMT.” (d) WOAs with a large total number of posts on the keyword “Probiotics.” WOAs: WeChat official accounts; FMT: fecal microbiota transplantation.

Table 3. Types of articles.

	Article interpretation	Popular science	Report	Promotion	Patient recruitment	Donor recruitment	Text and videos	Other
FMT	1421	1267	309	102	154	91	50	21
Gut microbiota	3008	2920	319	203	76	42	84	33
Probiotics	596	2280	63	437	17	0	121	7

An article on the WeChat official account could be composed of several forms. FMT, fecal microbiota transplantation.

The number of “Wows” of articles related to 10 gut dysbiosis-related diseases published by WOAs has increased sharply since 2019, probably due to WeChat launching the function in 2019. During the past 5 years, the top five in the total “Wows” of the articles were CDI (17,601), obesity (14,400), psychological diseases (14,232), IBD (13,951), and cancer (12,486). On average, the top five “Wows” per article were related to psychological disease (61.88), obesity (61.28), nervous system diseases (43.07), cancer (39.14), and CVD (36.73). “Wow” is not consistent with sharing functions completely, which many people are not familiar with. In our opinion, this data had some reference value but not as a reference as the pageviews. It was positively correlated with pageviews and promoted the spread of health information.

Strengths and limitations

The present study had several strengths. Our study was the first to provide evidence to evaluate public interest in topics on gut dysbiosis-related diseases and the promotion trend of the editors of the WOAs. This study confirmed that the WOA was an effective way to deliver information about gut microbiota dysbiosis-related diseases and treatment strategies. The factors affecting pageviews were analyzed, which can be helpful to guide clinicians and medical scientists to better popularize science.

This study had some limitations. First of all, the diseases involved were not comprehensive enough. The gut microbiota also played an important role in the occurrence and development of other diseases, such as aging,³² kidney diseases,³³ and COVID-19.^{34,35} Secondly, we were aimed at WeChat users, not involving other social software information. Other apps, such as Weibo, were also important ways for people to obtain information in China.³⁶ Thirdly, this was a retrospective analysis, the WOAs users could push feeds to subscribers and deleted them at any time, and the numbers of pageviews and “Wows” of official account articles were dynamic, which caused the potential bias of the data collection. Finally, more dimensions need to be used to investigate the impact of the spread of disease-related knowledge on the public through WOAs. For instance, during the COVID-19 quarantine period, WeChat users increased their use intensity. Except for spreading disease-related knowledge, WeChat including WOAs also relatively compensates for the damage to mental health and life satisfaction caused by the lack of offline social contact.^{37,38}

Conclusions

This study confirmed that the WOA was an effective way to obtain information related to microbiota and diseases. Researchers effectively used WeChat public accounts to convey health messages and promote healthy behavior

changes. In the past few years, the public has grown on interests in gut microbiota dysbiosis-related diseases, which would help researchers to grasp the key information of development trends.

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Author contributions: BC, XL, YL, SZ, and XW designed the study and edited the manuscript. YL, SZ, and XW were responsible for the data collection. YL, SZ, and XW participated in the data analysis and wrote the manuscript. QL, YW, YH, and FZ revised the manuscript. All authors read and approved the final manuscript.

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