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RESEARCH PAPER

Portrayals of 2v, 4v and 9vHPV vaccines on Chinese social media: a content analysis of hot posts on Sina Weibo

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ABSTRACT

Rather than receive the effective 2vHPV vaccines that are readily available in China, Chinese women usually wait to receive 4v and 9vHPV vaccines, which are difficult to acquire. This means that Chinese women miss the opportunity for optimal protection from cervical cancer. As social media platforms are the main channel by which Chinese women learn about HPV vaccines, this study aimed to explore how HPV vaccines are described on social media, and in particular how they discuss or distinguish 2 v, 4 v and 9vHPV vaccines. The Octopus Web crawler tool was used to capture hot Weibo posts from 2013–2021, and 1,164 valid data were obtained. Results suggested that there are very few posts with great influence on Weibo about HPV vaccines among 9 years and much of them are created by "lay people." HPV-related topics lacked persistent popularity, comprised highly repetitive content and the spread of information was geographically diverse. There were significant differences in the media descriptions of different kinds of HPV vaccines. Price was mentioned more often in the descriptions of 2vHPV vaccines, whereas appointments were referred to most often in the descriptions of 9vHPV vaccines. There was little media attention paid to the safety and effectiveness of HPV vaccines. Chinese media should develop better collaborations with public health professionals, pay more attention to the originality of their news coverage of HPV vaccines and strive to promote HPV vaccination. Such collaboration will help news media to better understand the key points of HPV information that need to be disseminated.

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Introduction

Although HPV vaccine hesitancy is a global emerging concern,[1] opposition to HPV vaccines in China is less intense than that in Western countries,[2] with most Chinese women showing a supportive attitude toward HPV vaccination.[3] Currently, four types of HPV vaccines are available in China: the 2vHPV vaccine Cervarix® (USD85/dose), the domestic 2vHPV vaccine Cecolin® (USD48.2/dose), the 4vHPV vaccine Gardasil® (USD117/dose)[4] and the 9vHPV vaccine Gardasil®9 (USD190.3/dose).[5] The most common reasons why Chinese women fail to receive HPV vaccination are their unwillingness to receive a 2vHPV vaccine and the difficulty they experience in obtaining an appointment to receive a 4vHPV or 9vHPV vaccine.[6]

The insufficient supply of HPV vaccines in China is a problem.[7] The government has put forward restrictions on the age for vaccination of different vaccines to overcoming this problem: 2vHPV vaccines are suitable for women aged 9–45, 4vHPV vaccines are suitable for women aged 20–45, and 9vHPV vaccines are suitable for women aged 16–26. Currently, only women can be vaccinated with HPV vaccines in China.[8] Chinese women of a certain age can make appointments for HPV vaccination in a hospital,[9] but may have to wait for up to 2 years to be seen if they choose 4 v or 9vHPV vaccines.[10] 4v and 9vHPV vaccines can only be imported, and the insufficient global production of HPV vaccines leads to a huge shortage in China. Chinese women gain access to 4v and 9vHPV vaccination through HPV Vaccine Lottery. Since 2020, 4v and 9vHPV vaccines have basically been out of stock. HPV vaccination is given in three doses, and hospitals need to give priority to those who have been vaccinated to guarantee the whole process of vaccination. Therefore, the first doses of 4v and 9vHPV vaccines are almost unavailable.[11] Affected by the Covid-19 epidemic, HPV Vaccine Lottery was suspended in many places. For example, in May 2020, 183,815 women in Shenzhen participated in the first 9vHPV Vaccine Lottery after the epidemic, and only 3,150 doses were available, meaning that the success rate was only 1.7%.[12] The difficulty in booking 4v and 9vHPV vaccines persists this year. According to medical staff at a hospital in Beijing, 4vHPV vaccination has been queued up until the end of October. In Hubei Province, there were only 400 doses of 4vHPV vaccines available in July, and 9vHPV vaccination was closed to women who had not been inoculated with the first dose.[13] Due to the supply problems and strict age limitations, some women, especially those aged older than 26, even choose to travel to Hong Kong for vaccination.[14] Under such circumstances, some women are still waiting blindly for 4 v and 9vHPV vaccines.[11]

Although the 4v and 9vHPV vaccines have broader antiviral effects than 2vHPV vaccine, their limited availability – due to their high price, the strict age limitations on who can receive them and

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the difficulty in securing a vaccination appointment that is not years away – is a concern. As such, it is fortunate that 2vHPV vaccines are relatively widely available in China, especially as the domestically produced 2vHPV vaccine Cecolin® was approved for sale in 2020 at a lower price than Cervarix®.[3] However, Chinese women tend to decline to receive 2vHPV vaccination, as there have been doubts aired on these vaccines' efficacy and quality. Thus, women develop vaccine hesitancy while waiting a long time for appointments to receive the far less available 4 v and 9vHPV vaccines.

In fact, 2vHPV vaccines are considered safe and effective for the prevention of HPV infection in Chinese women. The genotypic distribution of high-risk HPV types varies geographically,[15] and the HPV genotypes detected in Chinese women have varied over time. In a 2002 survey of the prevalence of cervical cancer, it was found that the prevalence of HPV 16 and HPV 18 was 79.6% and 7.5%, respectively, whereas that of HPV 52 and HPV 58 was less than 4%.[16] Similar studies in various regions of China have found different results. Some have revealed a decline in the prevalence of HPV 18,[15] while HPVs 16, 52 and 58 have been frequently proposed as the most common HPV genotypes in Chinese women.[17,18] Investigations have also emphasized the high health risks of HPV 16 infection,[19,20] as it has the highest risk of leading to high-grade cervical lesions.[21] HPVs 16 and 18 account for approximately 70% of cases of cervical cancer in the world.[22] According to recent domestic research, Chinese people are more inclined to be infected with HPVs 16 and 18, and 2vHPV vaccine can prevent up to 84.5% of cases of cervical cancer.[23] Thus, although HPVs 16 and 18 are not the only genotypes present in Chinese women, 2vHPV vaccines can give these women good protection against cervical cancer.

Although consulting doctors can provide women with the most appropriate HPV vaccination regimens,[24] there remains a shortage of family doctors and a lack of supporting policies in China.[25] Nowadays, social media are the primary channel by which the public obtain information on HPV vaccines and general health issues.[26] Everyone can release information and interact with the public via social media platforms.[27] It is thus not uncommon for social media exposure to affect HPV vaccination rates.[28] Many researchers have highlighted the significant role played by social media platforms, such as Twitter[29] and Facebook,[30,31] and the popular Chinese social platforms Sina Weibo,[32] Zhihu,[33] and WeChat,[34] in affecting HPV vaccination rates. The increasing use of digital communication channels has profoundly influenced the process of health communication,[35] and exposure to vaccine information on social media platforms may alter women's perceptions of HPV vaccines and their willingness to be vaccinated.[28] Incomplete or unbalanced information presented in social media will lead to public misunderstanding of health issues and influence vaccination behavior. For example, Agergaard et al.,[31] highlighted the important role Facebook played in HPV controversy as media increasingly reported on negative events in HPV vaccination without scientific evidence. HPV-related misinformation flourishing in social media may lead to vaccine hesitancy and ill-informed decisions.

Research on the relationship between social media construction of HPV vaccines and people's perceived knowledge of HPV vaccines is not limited. However, to the best of our knowledge, there has been no study to compare the information on 2v, 4 v and 9vHPV vaccines disseminated on social media. The reality is that 2vHPV vaccines are both effective and sufficient, while 4 v and 9vHPV vaccines are in short supply. Receiving a 2vHPV vaccine as soon as possible instead of waiting to receive 4 v and 9vHPV vaccines will assist in the promotion of HPV vaccines and in ensuring that women receive adequate and timely protection against cervical cancer. Inaccurate and biased information on different types of HPV and HPV vaccination on social media may hinder 2vHPV vaccination. Therefore, the aim of the present study was to examine how social media describe HPV vaccination, and in particular how they discuss or distinguish 2v, 4 v and 9vHPV vaccines. Specifically, the following research questions were raised.

RQ1: Who are the content creators of HPV-related hot posts?

RQ2: How are HPV-related hot posts distributed in space and time?

RQ3: What are the main HPV-related topics?

RQ4: Are there any differences in media descriptions of epidemiological information on the 3 kinds of HPV vaccines?

Materials and methods

Data collection and coding

Sina Weibo, which has more than 500 million users[36] and is the most popular social media platform in China,[32] is an important source of health information for Chinese. Hot posts on Sina Weibo, in contrast to common posts, tend to be microblogs whose popularity is indicated by their large numbers of retweets, likes and comments, and such hot posts thus have a significant influence on and are indicative of the topics that Chinese netizens discuss on Weibo on a given day.[37] Provided enough popularity, the content creators of hot posts can be anyone of governments, news media, individuals, or non-governmental organizations. Therefore, hot posts are rather representative of public opinion.[38]

Sina Weibo enables users to retrieve textual content from a defined time period that contains specific keywords. Based on previously adopted methodology,[39] the Octopus Web crawler tool was used to capture hot Weibo posts that included the keywords "cervical cancer vaccine" (this is actually a misunderstanding of the concept of HPV vaccination, but a preliminary investigation revealed that much of the relevant news on Weibo had used these words), "HPV vaccine," "2vHPV," "4vHPV," "9vHPV" and "human papillomavirus." The retrieved items included the name of the creator, the post date, the post content, the number of retweets, the number of likes and the number of comments. 1,731 raw data were obtained, which covered all the hot Weibo posts about HPV in the entire history. The raw data were first organized in an Excel sheet, and duplicate data that had been retrieved by different keyword searches were removed with the function "delete duplicate values." A manual method was then used to exclude irrelevant data. Finally, 1,164 valid data were analyzed.

A content analysis was conducted, with variables including content creators, post date, geographic information, and content categories. The posts were categorized into four categories: "security," "effectiveness," "affordability" and "appointment." An inductive thematic analysis was conducted to contextualize the data, and the disseminative effect of each trending theme was integrated.

As human- and machine- learning coding has been widely used in media content research,[40] we combined machine coding with manual coding in the encoding process by using DiVoMiner[1], an analysis platform developed by Zhuhai Hengqin BoYi Data Technology Co., Ltd. DiVoMiner uses machine-learning and manual-correction coding methods, enabling the entire process of content analysis to be performed online.[41] First, two coders independently coded 150 posts. Upon completion of manual coding, DivoMiner was used to code the remaining posts. Then, the implementation of Wang and Guo's encoding approach[42] resulted in 192 (16.3%) of the 1,164 data being randomly extracted via DiVoMiner, and these were encoded manually again. The Krippendorf's alpha exceeded 0.7, indicating that the machine coding had good reliability. Finally, the machine-coded data were imported into IBM SPSS Statistics 19 for descriptive statistics and chi-square testing to compare the content of posts. The flow diagram of data collecting and coding is shown in Figure 1.

Results

RQ1: content creators of hot posts

Table 1 shows that more than half of the hot posts about HPV were created by news media organizations (55.7%), with far fewer by government agencies (2%) or health professional organizations (9.9%), such as doctor-published "we-media," hospital official accounts, and organizations focused on promoting immunization or science, and the remainder by individual social media users (32.4%). This means that among the posts about HPV and its vaccination, much of the content with great influence on social media is created by "lay people."

Also, we found that even after removing duplicate posts (i.e., those that had the same creator and content), a large amount of repeated content remained. For example, the statement *"It is not recommended to receive a SARS-CoV-2 vaccine and an HPV vaccine at the same time"* (Appendices), which was initially released by CCTV news, a government media organization in China, was paraphrased or directly quoted a total of 32 times, by various creators. This phenomenon was common in the 1,164 microblogs we collected, and typically involved local news media directly quoting or summarizing government media news releases.

RQ2: temporal and spatial distribution of hot posts

There are very few hot posts on Sina Weibo about HPV vaccines, and thus no time limitations were set for data extraction. The time-range of collected microblog data is from 5 July 2013 to 25 February 2021. The distribution of the 1,164 hot posts in each year is shown in Table 2.

Of the three hot posts on HPV vaccines in 2013 (Appendices), two comprised basic knowledge on HPV and were posted on the we-media accounts of doctors, and the other was news coverage about an HPV-positive woman in Hubei province, China. There was no hot post on HPV in 2014, and the two hot posts in 2015 both reported the news that *"A British middle school student has invented condoms that will change color in the presence of a sexually transmitted disease."* Since 2016, topics in hot Weibo posts on HPV have become more common. Figure 2 shows the number of hot posts retrieved for each month from July 2016 to February 2021, and marks several key time nodes of news reports.

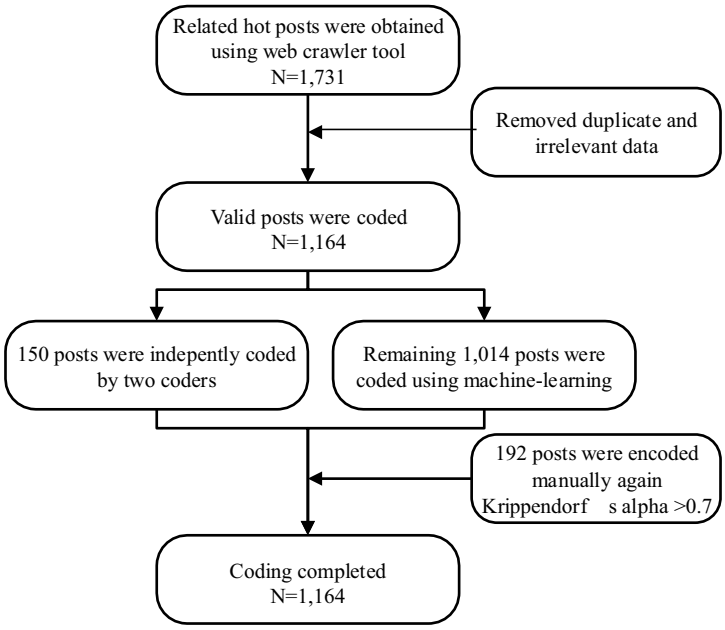

Figure 1. Data collection and coding process. 1,731 raw data were obtained, and 1,164 data were valid. First, two coders independently coded 150 posts, and DivoMiner was used to code the remaining posts. Then, 192 (16.3%) of the 1,164 data were randomly extracted via DiVoMiner, and these were encoded manually again. The Krippendorf's alpha exceeded 0.7, indicating that the machine coding had good reliability.

Table 1. Numbers of collected hot posts by various creators.

Creators	Number
News media	648
Government agencies	24
Professional organizations	115
Other publishers (Individuals)	377

Table 2. Numbers of collected hot posts by year.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number	3	0	2	16	231	11	86	686	129

The 2vHPV vaccine Cervarix®, produced by GlaxoSmithKline (GSK), was approved in mainland China in July 2016,[43] followed by the 4vHPV vaccine Gardasil®, produced by Merck Sharp & Dohme (MSD), in May 2017.[44] However, these milestones did not receive significant coverage on Weibo. In August 2017, Cervarix® vaccinations were officially started,[45] and there were significantly more hot posts on HPV in this month than in previous months. Gardasil® became available on the Chinese market in November 2017,[46] which resulted in a peak of HPV-related posts. The 9vHPV vaccine Gardasil®9, produced by MSD, was approved in mainland China in April–May 2018, and was officially introduced to the market within 8 days, which was much more rapid than the introduction of Cervarix® and Gardasil®.[47] However, the introduction of Gardasil®9 did not result in many posts on Weibo; it appears that no attention was paid to it. In summary, until the approval of the 2vHPV and first domestically produced HPV vaccine Cecolin®, produced by Xiamen Innovax Biotech Co., Ltd., at the end of 2019,[48] there was little interest in HPV-related topics on Weibo.

The marketing of Cecolin® was widely discussed on Weibo. In 2020, Cecolin® vaccination began in various regions of China, and there was extensive discussion of this and related topics on Weibo. At the end of 2020, a Chinese immunologist suggested that women should not be given vaccines against severe acute respiratory syndrome coronavirus 2 and an HPV vaccine simultaneously, which led to the greatest number of hot Weibo posts on HPV vaccination.

As shown in Table 3, Weibo users in Northeast China paid the least attention to HPV-related topics, whereas users in Central and Southern China showed much more interest. The number of hot posts in East China was far higher than that in other regions, which may be because Xiamen Innovax Biotech Co., Ltd., the producers of Cecolin®, are located in this region.

RQ3: inductive thematic analysis and disseminative effect analysis

The findings of the inductive thematic analysis, *the main HPV-related topics* are shown in Table 4. The most frequent theme was about 4 v and 9vHPV vaccination appointments (11.0%, n = 128). Domestic 2vHPV vaccination (10.4%, n = 119) and imported 4vHPV vaccination (8.9%, n = 104) were also extensively covered in hot Weibo posts. Other trending themes in large proportion were about interference between SARS-CoV -2 vaccines and HPV vaccines (8.1%, n = 94) and imported 2vHPV vaccination (6.1%, n = 71) (See Table 4 for more trending themes and the corresponding quotations).

We also integrated the disseminative effect of each trending theme following the suggestion of Cha et al[49] that the disseminative effect of microblogs can be represented as a sum of

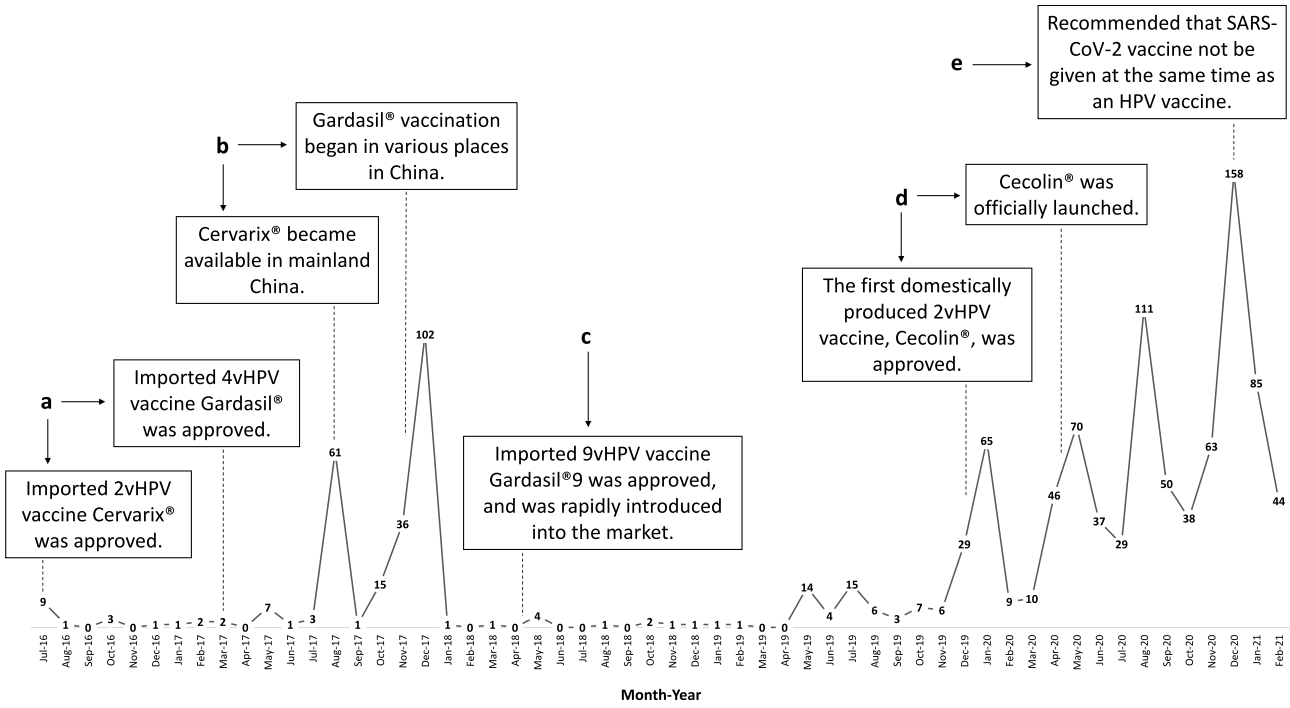

Figure 2. Number of collected hot posts per month and key time points of human papillomavirus vaccine news coverage in China. (a) The approval of imported 2vHPV vaccine Cervarix® and 4vHPV vaccine Gardasil® did not receive significant coverage on Weibo. (b) More hot posts appeared when Cervarix® became available, and a peak of hot posts resulted from the start of Gardasil® vaccination. (c) No attention was drawn neither when imported 9vHPV vaccine was approved nor launched. (d) The approval and official launch of domestic 2vHPV vaccine Cecolin® were both widely discussed on Weibo. (e) The interference between SARS-CoV-2 vaccines and HPV vaccines led to the greatest number of hot Weibo posts on HPV vaccination.

Table 3. Numbers of collected hot posts by region mentioned in the post content.

Region	Number
Northeast China	21
North China	72
Northwest China	86
Southwest China	94
Central China	117
South China	144
East China	247

retweets, likes and comments. The statistical results are shown in Table 4. Posts about the price of domestic HPV vaccines had the greatest disseminative effect, followed by those about 4v and 9vHPV vaccination appointments, which was mainly due to the difficulty in obtaining a vaccination appointment and the collapse of booking applets.

RQ4: media descriptions of 3 types of HPV vaccines

To address Research Question 4, Chi-square tests were used to evaluate the difference in the descriptions of different types of HPV vaccines, and showed significant differences ($\chi^2 = 64.443^{***}$, $\varphi = 0.176$ and Cramer's $V = 0.125$). Based on the results in Table 5, we found that there were no significant differences between the descriptions of the safety and effectiveness of the three types of HPV vaccines. However, microblogs on 2vHPV vaccines tended to focus on describing their affordability, and microblogs on the 9vHPV vaccine tended to focus on describing appointment availability. This may be attributable to the relatively low price of the domestically produced 2vHPV vaccine and the extreme difficulty in obtaining an appointment to receive the 9vHPV vaccine.

Discussion

This study is one of the few that has examined social media descriptions of 3 types of HPV vaccination, and particularly the differences among the descriptions of 2v, 4v and 9vHPV vaccines.

News organizations have monopolized HPV-related topics on social media platforms (55.7%), and have made it hard for the voices of professional medical experts (9.9%) and authentic civilians to be heard (32.4%). To some extent, this finding resonated with previous studies, because most of the content about HPV on Facebook, Twitter and Instagram was released by news media or "lay" consumers.[28] However, our finding was not completely consistent with some studies on descriptions of vaccines on social media. Yu and Ma[50] found that in Shandong Vaccine Incident, 53.7% of the content creators on Weibo were individuals. The vaccine incident may have elicited public anger, and resulted in more emotive and contentious comments on social media. Similarly, Luisi[30] also found that in the first decade (2006–2016) after HPV vaccine was approved by the United States Food and Drug Administration (FDA), the content creators of HPV-related posts on Facebook were mainly individuals. One possible reason for the difference is that anti-vaccination movement is more powerful in foreign countries,[51] causing heated discussions among netizens. On the other hand, Chinese news media is the main generator of HPV topics on social media platforms, usually generating objective HPV-related topics. The lack of controversial content fails to trigger public discussion and feedback, which may be a reason for the absence of civilian voices.

We also examined the content generated by different kinds of accounts. On the one hand, these hot posts created by media are highly similar to one another. Because health information acquires scientificity and accuracy, most news media often directly copy the news reports of government media, *People's Daily*, the Chinese Communist Party newspaper, for convenience and for fear of making mistakes if they paraphrase these. On the other hand, the contents created by the government, health professionals and individual accounts were not very different from that of news media. Professional opinions from health professionals and organizations, and publicly available empirical and narrative information from ordinary netizens have not entered the main public discourse on descriptions of HPV vaccines in the present study. In other studies, government agencies are calmer and more restrained, using a discourse of scientific rationality to relieve public anxiety;[50] medical professionals and organizations mainly focus on providing professional advice to promote public understanding of viruses and vaccines;[34] individual accounts usually respond to vaccine incidents and arouse public sympathy through comments and views on hot issues.[52] Without diverse voices, public attention cannot be drawn to important areas of conflict and highly homogeneous media descriptions decrease the diversity and originality of media content, which leads to the public suffering from reading fatigue and having an insufficiently comprehensive knowledge of HPV topics.

To RQ2, there are very few hot posts on Sina Weibo about HPV vaccines among 9 years. This was also different from previous researches,[53] because HPV-related topics are usually intensely debated on Twitter and Facebook, although these discussions often involve inaccurate claims or biased information without scientific evidence.[28] Since the introduction of the first 2vHPV vaccine in mainland China in 2016, the topics in posts on HPV have been limited and uncreative, covering nothing more than the approval and official launch of vaccines, and have spread only basic knowledge of HPV by taking advantage of related hot news. Moreover, most of these hot posts were not about the efficacy of HPV vaccines, which was in line with previous researches.[54,55] Compared with the efficacy of vaccine itself, social media content tends to pay more attention to explosive events such as vaccination accidents, such as the Changchun Changsheng vaccine incident[54] and the Shandong illegal vaccine sales incident.[55] Besides, social and entertainment content is of most interest to Weibo users,[37] thus the lack of HPV-related hot posts may have led to the public's low awareness of the importance of HPV vaccination and poor understanding of HPV-related topics.

Regional differences were also found in the spread of HPV-related topics. The extent of discussion on HPV-related topics in northern China is less than that in southern China. According to Wang's study,[3] women living in economically developed areas are likely to express attitudes or beliefs about the HPV vaccine because they were considering vaccination, but women living in economically undeveloped areas may not understand the risk posed by cervical cancer, and thus may

Table 4. Trending themes in host posts included in the analysis (N = 1164).

Coverage dates[a]	Trending themes	Quotations	Effect[b]	n (%)
15/05/2018-25/02/2021	4v and 9vHPV vaccination appointments	*"Online appointments can be made for 4v and 9vHPV vaccination, and 2vHPV vaccination appointments can be made at people's nearest vaccination clinic. A total of 2,990 people will be vaccinated with the 4vHPV vaccine, and a total of 2,090 people will be vaccinated with the 9vHPV vaccine. Twelve vaccination units in Shaanxi Province will be available for vaccination."*	325629	128 (11%)
24/04/2020-25/11/2020	Domestic 2vHPV vaccination	*"On 22 August, the first domestically produced cervical cancer vaccine was launched in Shanghai. It has the same ability as the imported vaccine to prevent HPV 16 and 18-related precancerous lesions and persistent infection, but is cheaper."*	238277	119 (10%)
24/05/2017-01/02/2021	Imported 4vHPV vaccination	*"The first 4 v cervical cancer vaccine approved in China was placed on the market a few days ago. 4vHPV vaccination in Yunnan Province will officially begin tomorrow. Women no longer have to go abroad for HPV vaccination. Instead, they can get the prevention of cervical cancer vaccines at home."*	32776	104 (9%)
05/12/2020-13/02/2021	Interference between SARS-CoV-2 vaccines and HPV vaccines	*"Wang Huaqing, the chief expert of the National Immunization Program of the Chinese Center for Disease Control and Prevention, said, 'Because the research and development time of SARS-CoV-2 vaccines has been so short, it is not recommended that SARS-CoV-2 vaccines and HPV vaccines are given at the same time.'"*	325498	94 (8%)
19/07/2016-30/12/2017	Imported 2vHPV vaccination	*"Recently, the first cervical cancer vaccine approved in mainland China, Cervarix, has been placed on the market. Residents can be vaccinated in community hospitals and community health service centers. Is the HPV vaccine effective? Who needs to be vaccinated? How safe is it? What's the difference between 2v, 4v and 9vHPV vaccines?"*	119677	71 (6%)
13/11/2017-15/11/2020	Price of domestic HPV vaccines	*"The price of Cecolin, produced by Xiamen Wantai Canghai Biotechnology Co., Ltd., is 329 yuan per dose. Girls aged 9–14 only need two injections and women aged 15–45 only need three injections."*	360379	56 (5%)
16/10/2017-25/02/2021	Shortage of HPV vaccines	*"HPV vaccines are too difficult to get. It's especially hard to get a dose of 9vHPV vaccine. In Shenzhen, 225,000 people competed for 8,790 appointments to receive the 9vHPV vaccine in October 2020. HPV vaccination coverage in China is too low, and the overall vaccination rate is less than 1%."*	55399	56 (5%)
31/12/2019-03/05/2020	Domestic 2vHPV vaccine approved	*"Recently, the State Drug Administration approved the application for registration of the 2vHPV vaccine Cecolin, which is the first approved domestically produced HPV vaccine for women aged 9–45. Cecolin, targeted at HPV 16 and 18, has been supported by national special funds for major new drug development."*	28912	41 (4%)
09/07/2019-22/02/2021	Free HPV vaccination	*"The British government announced on the 9th that from September this year, the coverage of its HPV vaccination programme will be expanded from girls to boys. It is estimated that this will result in tens of thousands of cancer cases being prevented in the next 40 years."*	87839	37 (3%)
03/02/2017-25/02/2021	HPV screening	*"In recent years, HPV vaccines have received heated discussion. Vaccination can reduce future infection. However, to prevent cervical cancer, HPV screening is also necessary. Proper screening methods can detect precancerous lesions early and intervene in time. Cervical cancer vaccination is not a substitute for HPV screening."*	8766	28 (2%)
15/12/2020-17/12/2020	Cervical cancer rising in young Chinese people	*"Cervical cancer is the largest malignant tumor of female reproductive tract in China. There are 110,000 new cases and 50,000 deaths every year. In recent years, cervical cancer is rising in young Chinese people. At the same time, HPV vaccination has become a hot topic."*	17059	16 (1%)
20/12/2017-22/12/2017	Experts against HPV vaccination	*"Wang Jian, chairman of the Beijing Genomics Institute (BGI), objects to Chinese women going abroad for HPV vaccination. 'The price of a HPV vaccine in Hong Kong is about 4,000 yuan, and one needs to be reinjected every five years. However, genetic testing only costs 50 yuan every three years. Moreover, whether foreign vaccines are suitable for Chinese people need further consideration.'"*	25055	15 (1%)
15/08/2017-15/01/2021	Men and HPV vaccination	*"Harald zur Hausen, the father of HPV vaccines, said that although men do not suffer from cervical cancer, they are the main carriers of HPV virulence factors. Vaccinating men can both protect their partners and themselves, because HPV can also cause other cancers."*	9879	15 (1%)
18/07/2016-29/05/2018	Imported 2vHPV vaccine approved	*"GSK said that the 'Cervarix' they produced was approved by the State Drug Administration, and became the first HPV vaccine in China to prevent cervical cancer. Women aged 9–25 can obtain vaccination earlier next year. HPV vaccines, which have been widely inoculated in over 100 countries globally, finally enter mainland China."*	3730	9 (1%)

[a]dd/mm/yy.
[b]Effect (Disseminative effect) = the sum of retweets, likes and comments.

Table 5. The descriptions of different types of HPV vaccines in hot Weibo posts.

			Type of HPV vaccine			
		Criteria	2v	4v	9v	Sum
Content Categories	Security	The proven safety of the HPV vaccine, and its Lack of severe adverse effects, are discussed.	105 (14.0%)	97 (14.2%)	76 (11.9%)	278 (13.4%)
	Effectiveness	The significant ability of the HPV vaccine to Prevent cervical cancer and related diseases is Mentioned, supported by statistical data or News stories.	175 (23.3%)	161 (23.6%)	146 (22.8%)	482 (23.3%)
	Affordability	The price of the HPV vaccine is objectively Stated, and its affordability is emphasized by Descriptions such as "expensive" or "cheap."	170 (22.6%)	86 (12.6%)	60 (9.4%)	316 (15.3%)
	Appointment	HPV vaccine appointment methods and Vaccination sites are stated, and the difficulty In making appointments is emphasized.	301 (40.1%)	338 (49.6%)	357 (55.9%)	996 (48.1%)
Sum			751 (100.0%)	682 (100.0%)	639 (100.0%)	2072 (100.0%)

$\chi^2 = 64.443^{***}$, $\varphi = 0.176$, Cramer's V = 0.125.

actually be in greater need of HPV vaccination. Similarly, the lack of hot posts about HPV by users in northern China is due to this region being less economically developed than southern China. These differences between the HPV perceptions of users in different regions are due to the lack of attention paid to HPV vaccination in some regions, and will lead to further HPV vaccination problems if policymakers and news media do not intervene.

As for RQ3, from the content analysis of media description on the 3 types of HPV vaccines, hot posts creators do not make anti-HPV vaccine claims, but they tend to describe different HPV vaccines in a mechanical and homogeneous way, such as by simply listing which types of viruses can be prevented by HPV vaccines and how effective the vaccines are. Previous studies[56,57] have also identified this kind of neutral tone used by media to report HPV-related news. Although it is true that the 9vHPV vaccine offers the best protection against HPV, the 2vHPV vaccines are also effective. Thus, although it is not incorrect for the media to state that 2vHPV vaccines can prevent 70% of cervical cancer, and that the 9vHPV vaccine can prevent 90% of cervical cancer, these statements can be taken by women to mean that "the 9vHPV vaccine is far better than the 2vHPV vaccines," and that only the 9vHPV vaccine is acceptable. There have been some attempts made by Chinese media to rationally persuade women to "not fixate on the 9vHPV vaccine,"[8] but too few such attempts have been made to convince women that waiting to receive the 9vHPV vaccine, and thus not receiving a 2vHPV vaccine, is not the best course of action.

In terms of RQ4, the Chi-square test indicated the safety and effectiveness of 2vHPV vaccines have not been highlighted in media descriptions. In consistent with Li et al.'s[26] finding that Chinese news coverage lacked key epidemiological information, we found that media tend to mention only the price of the 2vHPV vaccines, without stating how efficacious and safe they are. Without public confidence in the safety and effectiveness of 2vHPV vaccines, it will be difficult to eliminate the prejudice and distrust against them. The lack of key epidemiological information seems to be a common problem for social media platforms to describe HPV vaccine. For example, Li and Zheng[33] found that Zhihu articles tended to label HPV as a trigger for "cervical cancer" and ignore its link to other non-cervical conditions or sexually transmitted infection. Chinese women's fixation on the 4v and 9vHPV vaccines may also be due to sensational news media descriptions of the difficulty in obtaining these two vaccines. That is, the news media tend to objectively explain the broader prevention against HPV afforded by the 4v and 9vHPV vaccines compared with the 2vHPV vaccines, and at the same time state that women cannot make appointments to receive a 4v or 9vHPV vaccination. Particularly, the 9vHPV vaccine in China is expensive and it is extremely difficult to obtain a 9vHPV vaccination appointment, for which there is a strict age limit. Thus, while emphasizing the greater effectiveness of the 9vHPV vaccine, news media have also highlighted its unavailability, which may have increased public anxiety and thus increased the demand for the 9vHPV vaccine.

Furthermore, there are also some conceptual misunderstandings in news media descriptions. At present, only a 2vHPV vaccine is produced in China; the 4v and 9vHPV vaccines are produced abroad. However, there has been mention of domestically produced 4v and 9vHPV vaccines in media descriptions. It is possible that some of these have been discussing the future development of other domestically produced vaccines, but readers may be confused about HPV-related information if these aspects are not clearly explained or rapidly clarified. This may have led some women to wait for cheaper 4v or 9vHPV vaccines instead of choosing the readily available 2vHPV vaccines. In addition, news media descriptions often refer to the HPV vaccine as a "cervical cancer vaccine" While a previous study raised that the fact "HPV vaccine" literally translates to "cervical cancer vaccine" in Chinese may give rise to public attention to cervical cancer,[26] it might also induce more anxiety due to the mention of "cancer." Another study based on Chinese social media Zhihu found that many articles tended to label HPV as a trigger for "cervical cancer disease" instead of mentioning its link to other non-cervical conditions or sexually transmitted infection.[33] In fact, although HPV is necessary for the development of cervical cancer, it is not the sole causative factor, and the only infection with one of several high-risk types of HPV can lead to cervical cancer. This conceptual confusion artificially increases the mention of "cancer" in HPV information, causing more fear, and reinforcing women's preference for the 9vHPV vaccine.

The limitations of this study must be acknowledged. Although we aimed to explore media descriptions of HPV vaccination, the study was only based on a single social media platform (Sina Weibo). In addition, we only focused on hot Weibo posts, which means that this study did not examine all public opinions on HPV. There may be more diversified and in-depth topics about HPV in some health forums and knowledge exchange platforms, which also warrant future investigation. Finally, errors and omissions may have occurred in data collection based on keywords, and even though machine coding is highly reliable, it may also have had processing flaws.

Conclusion

Compared with other topics on social media platforms, HPV-related topics are at an obvious disadvantage, which may lead to a vicious circle of ignorance. News media should disseminate HPV health information actively, accurately, and efficiently, to educate, persuade and guide women to protect themselves from HPV as soon as possible. As HPV topics are closely related to public health and should not include misinformation, journalists should improve their ability to communicate with public health experts and organizations. Such collaboration with public health professionals will help journalists to better understand the key points of HPV information that need to be disseminated, and avoid common knowledge mistakes. At present, there is an adequate supply of 2vHPV vaccines in China, and these have good antiviral effects and are relatively inexpensive. Thus, based on regular communications with public health organizations, news media should recommend that women receive a 2vHPV vaccine, rather than simply describing the three types of HPV vaccines without making recommendations. This will decrease the number of women who are anxiously waiting to receive a 4vHPV or 9vHPV vaccine, and thus missing the opportunity to be best protected by receiving a readily available and effective 2vHPV vaccine.

Note

1. DiVoMiner is available at https://www.divominer.cn/

Disclosure of potential conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

1. World Health Organisation. Vaccine in national immunization programme update; 2020 [accessed 2021 Mar 27]. www.who.int/entity/immunization/monitoring_surveillance/VaccineIntroStatus.pptx.
2. Pan SY, Zhang D, Zhang JW. caught in the crossfire: how contradictory information and norms on social media influence young women's intentions to receive HPV vaccination in the United States and China. Front Psychol. 2020;11:14. doi:10.3389/FPSYG.2020.548365.
3. Wang Q, Zhang W, Cai HN, Cao Y. Understanding the perceptions of Chinese women of the commercially available domestic and imported HPV vaccine: a semantic network analysis. Vaccine. 2020;38:8334–42. doi:10.1016/J.VACCINE.2020.11.016.
4. Schiller JT, Castellsague X, Garland SM. A review of clinical trials of Human Papillomavirus prophylactic vaccines. Vaccine. 2012;30:F123–F38. doi:10.1016/j.vaccine.2012.04.108.
5. Luxembourg A, Moeller E. 9-Valent human papillomavirus vaccine: a review of the clinical development program. Expert Rev Vaccines. 2017;16:1119–39. doi:10.1080/14760584.2017.1383158.
6. BJNEWS. HPV vaccines are hard to get, when can an appointment be made? 2020. [accessed 2021 Mar 27]. https://www.bjnews.com.cn/detail/159617396715715.html.
7. China Vaccine. China's HPV vaccination rate is lower than that of Rwanda, experts call for free vaccination; 2018. [accessed 2021 Mar 27]. https://www.cnvax.com/t/10525.
8. CCTV. State food and drug administration: prevention of cervical cancer should not only focus on the nine price HPV vaccine; 2019. [accessed 2021 Mar 27]. http://news.cctv.com/2019/07/06/ARTI75yjwnGtagXohu61Z2J0190706.shtml.
9. Zhongmin. Domestic HPV vaccines will be open for appointment from May! How to make an appointment and what should be paid attention to? 2020. [accessed 2021 Mar 27]. https://www.zhongmin.cn/news/detail_55467.html.
10. Tencent Prism. Failure appointment in HPV vaccines similar to license plate lottery; 2020. [accessed 2021 Mar 27]. https://xueqiu.com/6718098612/157371719.
11. Xinmin Evening News. It's hard to book 4v and 9vHPV vaccines! Expert says why not consider domestic bivalent vaccine; 2021. [accessed 2021 Jul 20]. http://wap.xinmin.cn/content/31979311.html.
12. 18:00NEWS. The success rate of 9vHPV vaccine lottery is 1.7%, and the supply will increase this year; 2020. [accessed 2021 July 22]. http://static.scms.sztv.com.cn/ysz/dsdb/ggpd/18dxw/78184507.shtml.
13. China Newsweek. 420,000 people participated in the Vaccine Lottery, success rate less than 2%. Why is HPV vaccine so hard to get? 2021. [accessed 2021 July 22]. http://www.inewsweek.cn/kj/2021-07-13/13197.shtml.
14. China Vaccine. Supply of Gardasil 9 is shortage, and supply to Hong Kong will be suspended in the next month; 2017. [accessed 2021 Mar 27]. https://www.cnvax.com/t/10472.
15. Zeng Z, Yang H, Li Z, He X, Griffith CC, Chen X, Guo X, Zheng B, Wu S, Zhao C, et al. Prevalence and genotype distribution of HPV infection in China: analysis of 51,345 HPV genotyping results from China's largest CAP certified laboratory. J Cancer. 2016;7:1037–43. doi:10.7150/jca.14971.
16. Lo KWK, Wong YF, Chan MKM, Li JCB, Poon JS, Wang VW, Zhu SN, Zhang TM, He ZG, Wu QL, et al. Prevalence of human papillomavirus in cervical cancer: a multicenter study in China. Int J Cancer. 2002;100(3):327–31. doi:10.1002/ijc.10506.
17. Xing J, Tan T, Guo YL, Zhu JQ, Zheng AW, Yu AJ, Niu Z. Heat maps present the spatial distribution of human papillomavirus infection in Zhejiang Province, China. Oncol Lett. 2021;21:6. doi:10.3892/OL.2021.12627.
18. Liao GD, Jiang XY, She B, Tang HJ, Wang ZY, Zhou HR, Ma Y, Xu W, Xu H, Chen W, et al. Multi-infection patterns and co-infection preference of 27 human papillomavirus types among 137,943 gynecological outpatients across China. Front Oncol. 2020;10:9. doi:10.3389/FONC.2020.00449.

19. Wang ZL, Gu Y, Wang H, Chen JY, Zheng YW, Cui BX, Yang X. Distribution of cervical lesions in high-risk HPV (hr-HPV) positive women with ASC-US: a retrospective single-center study in China. Virol J. 2020;17(1):10. doi:10.1186/S12985-020-01455-2.
20. Zheng Y, Fan YG, Zeng Y, Liu SY, Gao LM. Different genotype distribution of human papillomavirus between cervical and esophageal cancers: a study in both high-incidence areas, Xinjiang, China. Biomed Res Int. 2020;2020:7. doi:10.1155/2020/7926754.
21. Guo C, Du H, Belinson JL, Wang C, Huang X, Qu X, Wu R. The prevalence and distribution of human papillomavirus among 10,867 Chinese Han women. Infect Agent Cancer. 2021;16(1):21. doi:10.1186/S13027-021-00360-9.
22. Tracy L, Gaff HD, Burgess C, Sow S, Gravitt PE, Tracy JK. Estimating the impact of Human Papillomavirus (HPV) vaccination on HPV prevalence and cervical cancer incidence in Mali. Clinical Infectious Diseases. 2011;52:641–45. doi:10.1093/cid/ciq190.
23. CCTV. Experts say the prevention and control rate of 2vHPV vaccine reached 84.5%. It is recommended to vaccinate as soon as possible; 2021. [accessed 2021 Jul 20]. https://news.cctv.com/2021/07/19/ARTIBl0E7qzylfCF4SAtZV5O210719.shtml.
24. Marlow LAV, Waller J, Wardle J. Trust and experience as predictors of HPV vaccine acceptance. Hum Vaccin. 2007;3:171–75. doi:10.4161/hv.3.5.4310.
25. Liu SS, Liu Y, Zhang T, Wang L, Huang JL, Liang H, Chen G, Liu CJ, Zhang YM. The developing family doctor system: evidence from the progress of the family doctor signing service from a longitudinal survey (2013-2016) in Pudong New Area, Shanghai. BMC Fam Pract. 2021;22. doi:10.1186/S12875-020-01353-0.
26. Li WB, Nowak G, Jin Y, Inadequate CM. Incomplete: Chinese Newspapers' coverage of the first licensed Human Papillomavirus (HPV) vaccine in China. J Health Commun. 2018;23:581–90. doi:10.1080/10810730.2018.1493060.
27. Lu XY. Lessons from Weibo: media convergence and contemporary Chinese politics. Javnost-Public. 2020;27:126–39. doi:10.1080/13183222.2020.1728492.
28. Ortiz RR, Smith A, Coyne-Beasley T. A systematic literature review to examine the potential for social media to impact HPV vaccine uptake and awareness, knowledge, and attitudes about HPV and HPV vaccination. Human Vaccines Immunother. 2019;15:1465–75. doi:10.1080/21645515.2019.1581543.
29. Kang GJ, Ewing-Nelson SR, Mackey L, Schlitt JT, Marathe A, Abbas KM, et al. Semantic network analysis of vaccine sentiment in online social media. Vaccine. 2017;35:3621–38. doi:10.1016/j.vaccine.2017.05.052.
30. Luisi MLR. From bad to worse: the representation of the HPV vaccine Facebook. Vaccine. 2020;38:4564–73. doi:10.1016/j.vaccine.2020.05.016.
31. Agergaard TE, Smith ME, Nielsen KH. Vaccine assemblages on three HPV vaccine-critical Facebook pages in Denmark from 2012 to 2019. Media Commun. 2020;8:339–52. doi:10.17645/mac.v8i2.2858.
32. Zhang CP, Gotsis M, Jordan-Marsh M. Social media microblogs as an HPV vaccination forum. Human Vaccines Immunother. 2013;9:2483–89. doi:10.4161/hv.25599.
33. Li JH, Zheng H. Coverage of HPV-related information on Chinese social media: a content analysis of articles in Zhihu. Human Vaccines Immunother. 2020;16:2548–54. doi:10.1080/21645515.2020.1729028.
34. Su XL. Content analysis of HPV vaccine messages on Chinese social media. J Messenger. 2020;12:63–73. doi:10.26623/themessenger.v12i1.1814.
35. Leader AE, Burke-Garcia A, Massey PM, Roark JB. Understanding the messages and motivation of vaccine hesitant or refusing social media influencers. Vaccine. 2021;39:350–56. doi:10.1016/J.VACCINE.2020.11.058.
36. Tian XY, Batterham P, Song S, Yao XX, Yu G. Characterizing depression issues on Sina Weibo. Int J Environ Res Public Health. 2018;15:11. doi:10.3390/ijerph15040764.
37. Wei L, Hu YM. Issue presentation in the Chinese microblogosphere: an empirical study of Sina Hot Weibo. J Zhejiang University. 2014;44:41–52.
38. Zhang Y, Li B, Liu CY. Topic-oriented monitoring of public sentiment towards popular Weibo events—A case study on regular 'Odd-even' vehicle restriction in Beijing. J Chin Inform Proc. 2015;29(5):143–151+159. CNKI:SUN:MESS.0.2015-05-020.
39. Wang JZ, Zhou Y, Zhang W, Evans R, Zhu CY. Concerns expressed by Chinese social media users during the COVID-19 pandemic: content analysis of Sina Weibo microblogging data. J Med Internet Res. 2020;22:13. doi:10.2196/22152.
40. Lee D, Hosanagar K, Nair HS. Advertising content and consumer engagement on social media: evidence from Facebook. Manage Sci. 2018;64:5105–31. doi:10.1287/mnsc.2017.2902.
41. DiVoMiner. What is DiVoMiner? 2019. [accessed 2021 Mar 27]. https://me.divominer.cn/#/home
42. Wang D, Guo ZS. Framing and construal level: a comparative analysis of press coverage of China's "One Belt One Road" initiative. Journalism & Communication. 2020;27:5–20+126. CNKI:SUN:YANJ.0.2020-03-001.
43. CCTV. China's first cervical cancer vaccine approved, expected to be officially launched early next year; 2016. [accessed 2021 Mar 27]. http://news.cctv.com/2016/07/21/ARTI2Je014Umdh3wf9sHjNwb160721.shtml.
44. Sohu. Merck 4vHPV cervical cancer vaccine Gardasil will be launched in China soon; 2017. [accessed 2021 Mar 27]. https://www.sohu.com/a/141863935_464396.
45. CCTV. 2vHPV cervical cancer vaccine in main land China; 2017. [accessed 2021 Mar 27]. http://news.cctv.com/2017/08/02/ARTIYwPMM8F22QCExTM6zgrM170802.shtml.
46. Sina medicine. Merck 4vHPV vaccine started to fight for cervical cancer vaccine market; 2017. [accessed 2021 Mar 27]. https://med.sina.com/article_detail_100_2_36588.html.
47. CCTV. The 9-valent cervical cancer vaccine was approved in only 8 days, with its price slightly higher than the international level; 2018. [accessed 2021 Mar 27]. http://news.cctv.com/2018/05/17/ARTIZ6bHapKl8MxreHGGQTYZ180517.shtml.
48. CCTV. Bid farewell to import dependence, the first domestic 2vHPV cervical cancer vaccine has been approved for marketing, which can be vaccinated at the age of 9-45; 2020. [accessed 2021 Mar 27]. http://news.cctv.com/2020/01/02/ARTI9pAYirz0Z7wwyWbsvdMP200102.shtml.
49. Cha M, Haddadi H, Benevenuto F, Gummadi KP. Measuring user influence in Twitter: the million follower fallacy. Paper presented at the AAAI 2010, Georgia, USA; 2010, July 11-15.
50. Yu H, Construction MX. Steering of risk issues in social media context: a study case of Shandong vaccine incident. J Intelligence. 2017;36(3):79–85. CNKI:SUN:QBZZ.0.2017-03-039.
51. Hoffman BL, Fetter EM, Chu KH, Shensa A, Hermann C, Wolynn T, Williams D, Primack BA. It's not all about autism: the emerging landscape of anti-vaccination sentiment on Facebook. Vaccine. 2019;37(16):2216–23. doi:10.1016/j.vaccine.2019.03.003.
52. Zhou M, Qu SJ, Zhao LD, Kong N, Campy KS, Wang S. Trust collapse caused by the Changsheng vaccine crisis in China. Vaccine. 2019;37(26):3419–25. doi:10.1016/j.vaccine.2019.05.020.
53. Wilson SL, Wiysonge C. Social media and vaccine hesitancy. BMJ Global Health. 2020;5(10):e004206. doi:10.1136/bmjgh-2020-004206.
54. Hu D, Martin C, Dredze M, Broniatowski DA. Chinese social media suggest decreased vaccine acceptance in China: an observational study on Weibo following the 2018 Changchun Changsheng vaccine incident. Vaccine. 2020;38:2764–70. doi:10.1016/j.vaccine.2020.02.027.
55. Cao L, Zheng JS, Cao LS, Cui J, Xiao QY. Evaluation of the impact of Shandong illegal vaccine sales incident on immunizations in China. Human Vaccines Immunother. 2018;14:1672–78. doi:10.1080/21645515.2018.1473697.
56. Xiao X, Su Y. Still a "female problem": a framing analysis of the Human Papillomavirus (HPV) vaccine in Chinese online news. Chin J Comm. 2020;13:275–92. doi:10.1080/17544750.2020.1714683.
57. Zhang W, Wang Q. The failure of news coverage supportive of human papillomavirus vaccination: the investigation of the effects of online comments on female college students" vaccination intention. Vaccine. 2019;37:5681–87. doi:10.1016/j.vaccine.2019.08.007.