RESEARCH ARTICLE

The emotion bias of health product consumers in the context of COVID-19

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Abstract

The ongoing COVID-19 has led to an increase in negative emotions and health awareness among consumers. This paper discusses the emotion bias of Chinese consumers during the three periods: the pre-COVID-19 period, the COVID-19 lockdown period, and the COVID-19 normalization period. This study takes health products as the research object and crawls relevant reviews on the JD platform to classify products. The data were classified into emotion, the intensity of emotion was calculated, and the logistic regression model and variance analysis were used to analyze the difference in emotion expression. The study reveals that consumers are willing to express fear and sadness during the COVID-19 lockdown era and are willing to express like emotions before the pandemic compared to the three periods. There are also differences in the emotional intensity of different product reviews. The intensity of emotional expression is more vigorous for consumers who purchase nutritional products, while for those who purchase healthcare equipment, the intensity of emotional expression is lower. This study offers the emotion bias of consumers in response to COVID-19 to provide a theoretical basis and reference solution for implementing marketing strategies for health product companies.

1 Introduction

Coronavirus (CoV) is derived from the Latin word "cor-ona", meaning crown [1] and was first discovered in the 1960s [2]. COVID-19 was first identified in Wuhan, China, in late 2019 and spread rapidly worldwide in the following months. The first case of COVID-19 was reported in a Caribbean island country on 2020/3/10, three months later than in China [3]. At this time, about 3,000 new COVID-19 confirmed cases were being reported daily in European countries such as Italy, and the cumulative number of COVID-19 confirmed cases rapidly exceeded 10,000. COVID-19 was cleared in China on 8 April 2020, at a time when the global COVID-19 epidemic was severe. China is still adhering to the policy approach of dynamic zero, while other countries have declared coexistence with COVID-19.

On 11 March 2020, the World Health Organization (WHO) proclaimed the outbreak of coronavirus disease 2019 (COVID-19) a pandemic [4]. The COVID-19 pandemic has altered not only people's emotions but also their consumption patterns [5], social behavior [6], and hygiene behaviors [7]. Several voices warned of their disruptive impact on food consumption
There is little doubt that COVID-19 has had a profound impact on the livelihoods of people all across the world. The only long-term solution to combat the COVID-19 epidemic is vaccination with the COVID-19 vaccine [9]. It is also the only way to return to everyday life. COVID-19 was widely regarded as a considerable hazard to human health, disrupting people’s lives by influencing their everyday behavior and producing emotions of fear, worry, and despair [10, 11]. COVID-19 has undoubtedly contributed to the current dread, anxiety, and uncertainty climate. When people are in negative emotional states for a long time, their physical and mental health will be severely affected [12, 13]. This undoubtedly constitutes an adverse change in consumers’ emotions compared to the pre-COVID-19 situation.

In previous studies, it has been demonstrated that when a coronavirus threatens individuals, they experience fear-related emotions. They engage in more protective behaviors and seek more relevant health-related information [14, 15]. Health-literate people are more likely to take measures to prevent the spread of COVID-19 [9]. Our views are compatible with fear appeal theories, which claim that people are motivated to undertake behavioral adjustments and learn more about health knowledge when they fear a disease’s dangers [16]. The promotion of health awareness increases the demand for health products. Consumers’ health demands have been demonstrated to influence their purchasing intentions and preferences for health products [17]. Health-conscious consumers are actively working to improve their health behaviors and healthy diet.

The healthcare sector comprises the entirety of the healthy chain, and its new mission is to improve people’s health literacy and their consumption of suitable amounts of health products. Besides, it has blossomed into a burgeoning industry with enormous market potential. Globally and in China, consumption beneficial to one’s health has become a prominent consumer trend. Medical products, health care products, nutritional products, and healthcare management are all examples of conventional health products [17]. Faced with COVID-19, the Chinese population is creating a healthy lifestyle and vigorously searching the Internet for health-related products and professional medical services. In this article, the concept of health products refers to the research of scholars such as Wang et al., including traditional Chinese and Western medicines (over-the-counter medicines), health therapy, health care underwear and weight loss, nutritional products, functional foods and so on.

During a pandemic, consumers’ emotional analysis is an important research issue. Most researchers analyzed user sentiment using particular phrases in messages [18]. Enterprises can determine a product’s popularity by understanding customers’ sentiments [19]. So far, most studies have investigated users’ sentiments on social media, like Twitter [20, 21], and Weibo [22]. Only a few research have been investigated to explore emotional differences during crises [23, 24]. This paper is focused on the difference in consumer emotion based on health products review in JD mall during the pre-COVID-19, COVID-19 lockdown, and normalization period. To our knowledge, no studies have investigated consumer emotion from reviews of health products. There is also no empirical study to date that has considered a comparative analysis of differences in consumer emotional responses in China’s health product industry over the three periods. This study aims to fill this research gap to understand consumers’ emotion distribution and quantify consumers’ emotion scores, followed by exploiting statistical methods of logistic regression and Multivariate analysis of variance to discover differences between emotional expression and emotional intensity. If there is a discernible difference during the three periods, it may help businesses explore consumers’ purchase behavior. We hope that by doing so, we will be able to address the following three research questions:

Question 1: What are the differences between different time and product types in emotion word illustrations?
Question 2: What are the differences between different time and product types in the emotional expression of product reviews?

Question 3: What are the differences between different time and product types in the emotional intensity of product reviews?

Here’s the paper’s structure. Section 2 introduces related works about emotion analysis and the influence factor of emotion expression. Section 3 explains the emotion evaluation method and calculation method of emotional intensity. Section 4 presents the differences in emotional expression and emotional intensity. The paper comes to a close with Section 5.

2 Literature review

2.1 Consumer emotion during COVID-19

The COVID-19 coronavirus pandemic has become a global crisis. The virulence of the disease has shaken the world. Big Commerce reports that the COVID-19 pandemic has dramatically changed what, how and when people buy [25]. Unprecedented panic purchase by consumers has been confirmed by the research of Laato et al. [26]. Scholars and journalists have pointed out consumers’ stockpiling behavior during COVID-19 is a form of panic purchase [12]. In the context of the COVID-19 pandemic, supply chain disruptions resulting in empty shelves may increase consumers’ propensity to hoard [27]. Consumers over-buy certain necessities (e.g. food, water, hygiene products) [13] and reduce the consumption of unhealthy food such as unhealthy snacks, candy, and biscuits [28]. Studies have also shown that consumers’ willingness to consume healthy food has increased [11].

This world has experienced several health crises, such as SARS, Ebola, H1N1, etc. [29]. These crises impacted the world economy and health care, sparking fear, panic and anxiety in billions of people. COVID-19 affects consumer sentiment, which also means it has an impact on consumer happiness and achievement [30]. Human emotions are divided into two categories: positive and negative.

During the pandemic, positive emotions have declined, while negative emotions such as anxiety and fear have risen sharply [18]. Research shows that consumers are beginning to worry about their personal and family health and whether existing basic needs can be met [31]. The continued increase in negative consumer sentiment is socially and economically damaging and devastatingly affects the individual immune system [32].

In the last 20 years, sentiment analysis has been studied in numerous industries and with diverse methodologies [33]. Approaches that are based on emotion dictionaries and machine learning are the two primary categories of research ideas that have been proposed for emotion classification methods. The emotion dictionary-based research approach is an unsupervised classification method. It divides emotions into multiple types for research. The most extensively used English dictionary is WordNet [34], the Chinese emotional vocabulary ontology database of the Dalian University of Technology [35], and the NTUSD (Chinese sentiment Dictionary) of National Taiwan University [36] are among the Chinese open-source sentiment dictionaries. Yu et al. [37] adopted a sentiment dictionary approach to perform sentiment analysis on posts in Wuhan during the COVID-19 pandemic.

Machine-learning-based algorithms are essentially text categorization. It utilizes techniques for machine learning to classify text into three categories: positive emotion, negative emotion, and neutral emotion. Support Vector Machine (SVM) [38], Naive Bayes (NB) [39], and Maximum Entropy (ME) [40] are some of the mature classification methods. Samuel et al. [41] measured public sentiment during the pandemic using two basic machine-learning methods.
To properly divide sentiment into several types, the DUTIR Emotion Ontology set was established and maintained by Professor Lin Hongfei and his team at Dalian University of Technology Institute of Information Retrieval (DUTIR) [42], was used as the emotion lexical resource in this study. There are seven sentiment types—sadness, happiness, anger, disgust, surprise, like, or fear. The impact of negative words and degree adverbs on emotional intensity is also considered when calculating the emotional intensity of each type of emotion. We quoted negative vocabulary and degree vocabulary and assigned a different weight to calculate emotional intensity.

2.2 Influencing factors of emotional expression

According to existing research, consumer sentiment is mainly affected by social factors, individual factors, and product factors. Social factors mainly include the social environment and mass media. As far as the social environment is concerned, the current society is in the COVID-19 period. According to a study, unpleasant emotions like anger, fear, and disgust altered dramatically, although sadness and joy did not [43]. As far as individual factors are concerned, the current research on gender differences is abundant. Many Scholar’s research [44, 45] have shown that women were more open in expressing their emotions than men. Besides, individual emotions are also affected by age and education level. Boshoff’s research showed that as age increased, emotional expression behavior would decrease [46]. From the perspective of education level, Acevedo demonstrated that those with lower levels of education have stronger emotional expression skills than people with higher levels of education in terms of education level [47]. Regarding product factors, product categories influence consumers’ emotions when shopping offline or online. An analysis of online evaluations found a correlation between product features and consumers’ sentiment orientations [48].

In addition to existing research, product types also play an essential role in emotional expression. Each consumer’s awareness and attention to the product are different, so their response to the characteristics of different products is also inconsistent. Zhang et al. found that different product categories moderate the impact of emotions [49]. Contextual elements such as product kind influence a technique’s capacity to convey the natural feeling of a review [50].

Current research has verified that the product types have an impact on consumer emotion and have not elaborated on the emotion bias of this factor. Based on previous studies, this research mainly studies the differences between emotion type and emotion intensity and conducts a fine-grained emotion classification of health product reviews.

3 Method

3.1 Data collection and the corpus

To investigate the emotion bias of consumers in different phases, three product review datasets were constructed by crawling health product reviews from the JD Mall platform in China. The datasets contained health product reviews collected before COVID-19, during the lockdown, and during the normalization of COVID-19 prevention and control in a total of about 38000 reviews.

Our first dataset consisted of health product reviews before the pandemic. The period pre-COVID-19 was about three months between 10 November 2019 and 22 January 2020. The second dataset we used contained reviews collected during the COVID-19 lockdown in Wuhan. The period of COVID-19 was the lockdown era in Wuhan between 23 February and 8 April 2020. The third dataset we used contained reviews collected after the COVID-19 lockdown in Wuhan. The COVID-19 normalization period lasted about three months between 8 April 2020 and 1 July 2020.
Data were collected using a three-step procedure. The initial step was identifying health product items in the JD Mall platform. According to the broad definition of health products and JD’s product classification, we select the following four types of health products as the objects of this study: traditional Chinese and Western medicines, nutritional products, functional foods, and healthcare equipment. The second step was to filter out each of the four health products with the most reviews. For this purpose, product items with less than 5000 reviews were removed from this analysis. Those with less than 5000 reviews could be recently launched and cannot afford a thorough analysis. The third step was to crawl product reviews via crawler. The following data items were crawled: review content, and review time. Of all the entries collected, duplicated records were eliminated. As shown in Fig 1, The final dataset for analysis consisted of the remaining 37,997 reviews (traditional Chinese and Western medicines = 5,074, nutritional products = 14,219, functional foods = 6,390, healthcare equipment = 12,314). And the collection and analysis method complied with the terms and conditions for the source of the data.

3.2 Degree adverb dictionary
A degree adverb dictionary is being compiled by us right now, and its foundation is the degree adverbs that HowNet provides. There are 219 adverbs in total. Amplifiers (such as “very”) that
boost the semantic intensity of a surrounding lexical item and downtowners (such as “slightly”) that lower it is the most frequently noted in extant studies.

Every degree adverb in the lexicon is given a certain modification weight determined by whether or not it has a reinforcing or deactivating impact. More specifically, the modification weight of a degree adverb is set to 3 if it can heighten the emotional intensity of sentiment words it modifies. Examples of such degree adverbs include “extremely,” “too much,” and “very.” The modification weight is set to 0.5 if it lessens the sentiment intensity of a sentiment term, like “little,” “a little,” or “a little bit.”

3.3 Negative adverb dictionary
The negative word carries a negative connotation. When an emotionally charged term is modified with a word with a negative connotation, the initial emotional inclination will be inverted. As a result, it has an impact on the emotional polarity of the entire evaluation. For example, in Chinese, “I don’t like this apple”, in this statement, the whole sentence shows a negative tendency.

If an emotive word has more than one negative adverb in front of it, the polarity is determined by the number of negative adverbs. When the number is even, the original emotional polarity is preserved; when the number is odd, the emotional polarity is transformed into an opposite site. As a result, the negative adverb’s influence factor for the emotion term \( w \) is described as follows:

\[
    w = (-1)^r
\]

\( r \) represents the number of negative adverbs.

3.4 Variable operationalization
In the research, product categories and time are independent variables. Time includes three periods (the pre-COVID-19 period, the COVID-19 lockdown period, and the normalization period). Product categories include traditional Chinese and Western medicines, functional foods, nutritional products, and healthcare equipment.

Here are two dependent variables. One is multiple emotions expressed in health product reviews. The other one is the emotional intensity of health product reviews. This investigation utilized the DUTIR Emotion Ontology set as the emotion lexicon resource. Then refer to dutir’s classification method to divide emotions into seven categories. Then, each review was tagged with an emotion type—sadness, happiness, anger, disgust, surprise, like, or fear. Finally, calculate the emotional intensity. The specific technique of calculation is outlined in the following:

Use \( p \) to represent a health product review and identify each emotional word after using the jieba tool to segment reviews, and the negative words and degree words before the emotional words. Since emotions are divided into seven categories in the emotion dictionary, when calculating the emotion of a comment, you need to calculate the emotional intensity of each emotion. For the \( i \) – \( th \) emotion, the \( j \) – \( th \) emotion word, the calculation rules of emotional intensity are as follows:

\[
    p_{ij} = w_a e_{ij} (1 \leq i \leq 7; j > 0; n \geq 0)
\]

Where \( a_{ij} \) means the weight of the degree adverb, \( e_{ij} \) represents the emotional intensity. Then comprehensively calculate the emotional intensity of a certain emotion. In other words, add up the emotional intensity of all emotional words belonging to that emotion, and the formula
is as follows:

\[ p_i = \sum_{j=m}^{n} p_{ij} (1 \leq i \leq 7; 0 < j < m; n \geq 0) \]  

(3)

Where \( m \) represents the number of emotion words of the \( i \)-th emotion.

4 Results and discussion

4.1 Descriptive statistical analysis

The comment variable information is listed in Table 1.

According to statistics, among the approximately 200,000 comments crawled, we screened out 8254 reviews before the epidemic (accounting for 21.7%), 14046 reviews during the epidemic lockdown period (accounting for 37.0%), and 15697 reviews during the normalization of COVID-19 prevention and control (accounting for 41.3%) for the experiment.

Table 1 reveals that like emotion had the highest proportion in the distribution of emotion words, accounting for more than 70%. And happiness emotion accounted for a proportion reaching 11.9%. Disgust emotion accounted for more than 9.3%, while the other emotions accounted for a smaller percentage of the total. Reviews related to nutritional products accounted for 37.42%, while reviews about health care equipment accounted for 32.41%. The reviews of the other two products accounted for 16.81% and 13.35%, respectively, a difference of 3.5%.

4.2 Emotional high-frequency words

This analysis presents a bar chart that provides excellent detail with the exact frequency of emotional words. This section compared the high-frequency words for the seven emotions at the three stages: the pre-COVID-19 period, the COVID-19 lockdown period, and the COVID-19 normalization period.

The results in Fig 2 showed that the most frequently appearing words were “blame”, “bad”, “but”, “constipate”, and “protein”. Comparing the three graphs above, “blame”, “bad”, and “constipate” had shown a rise. The word blame usage had more than tripled. During the COVID-19 lockdown, “protein” fell compared to before COVID-19, but it rose during COVID-19 normalization.

Table 1. Product reviews’ variable information.

| Variable        | Number | Percentage |
|-----------------|--------|------------|
| Time            |        |            |
| The pre-COVID-19 period | 8254   | 21.70%     |
| The COVID-19 lockdown period | 14046  | 37.00%     |
| The COVID-19 normalization period | 15697  | 41.30%     |
| Product categories |       |            |
| Traditional Chinese and Western medicines | 5074  | 13.35%     |
| Nutritional products | 14219  | 37.42%     |
| Functional foods  | 6390   | 16.81%     |
| Healthcare equipment | 12314  | 32.41%     |
| Emotion          |        |            |
| Like             | 57695  | 75.70%     |
| Happiness        | 9108   | 11.90%     |
| Sadness          | 1248   | 1.60%      |
| Anger            | 155    | 0.20%      |
| Fear             | 627    | 0.80%      |
| Disgust          | 7097   | 9.30%      |
| Surprise         | 279    | 0.30%      |

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Of the fear emotion, "intensely" was the most frequently used word related to the emotion of fear in the pre-COVID-19 period, followed by "focus", "careful", and "embarrassed". During the lockdown of COVID-19, "virus" was the most used word, followed by "intensely", "urgent", and "difficult". Top words that appeared in this period included "virus", "urgent", and "fear" during the COVID-19 normalization period. As illustrated in Fig 3, "intensely" and "virus" increased by several times during the COVID-19 lockdown and normalization period.

Fig 4 showed that "good", "satisfaction", "worth", "like", and "hope" were used the maximum number of times in three periods. "Exquisite", "timely", and "grateful" had also shown a striking rise as compared to before COVID-19. Compared to the COVID-19 normalization period, "good", "word", and "satisfaction" doubled before COVID-19.

According to Fig 5, the most frequently appearing word was "rest assured", and the secondary word was "stand up" in pre-COVID-19. However, the most frequently appearing word was "stand up", followed by "rest assured" in two other phases. Besides, "safe" has also been expressed more times after the outbreak of COVID-19. "Rest assured" and "get up" nearly increased by two times during COVID-19 normalization compared to before the COVID-19 period but minimally increased during the transition from the COVID-19 lockdown period to the epidemic normality.

As shown in Fig 6, the top words of sadness emotion in the health product reviews were "wound", "sick", and "disappoint" in three phases. After the outbreak of COVID-19, consumers expressed "wound" more often. But the number of times that "wound" was expressed...
decreased significantly after the normalization of COVID-19 prevention and control. “Disap-
point” changed similarly. “Sick” has been expressed as increased and then decreased as
COVID-19 progresses.

For surprise emotion, consumers expressed words like “original” and “magical” more often
in three periods, followed by “suddenly”, “strangeness”, and “extremely”. Among them, “origi-
nal” and “magical” increased twice during COVID-19 normalization compared to before the
COVID-19 period. “Strangeness” and “extremely” have also risen remarkably after the COVID-
19 outbreak. It can also be seen that “amazing” only appears during COVID-19 in Fig 7.

“Angry” was expressed frequently. “Complaint” was the secondary frequent word in pre-
COVID-19. “Break out” was the frequent secondary word in the two other phases. By compar-
ing Fig 8, we can see that “angry” did not increase much before and during COVID-19. “Break
out” spiked during the epidemic, but the number of times consumers expressed it dropped
after the epidemic.

### 4.3 Emotion bias in the context of COVID-19

Emotion is the study’s dependent variable, classified into seven categories: liking, happy, sorrow,
anger, fear, disgust, and surprise, in no particular order.

As a result, for analysis, we chose an unordered multiple logistic regression model. The
multiple logistic regression model compares the selected category and the reference category
in each variable to examine the influence of each element, and the result reflects the event’s

![Fig 3. Emotional high-frequency words of fear in the pre-COVID-19 (a), COVID-19 lockdown (b), and normalization era (c).](https://doi.org/10.1371/journal.pone.0278219.g003)
probability. The formula is as follows:

$$\logit \left( P_i = \ln \frac{P_i}{1 - P_i} \right) = \beta_0 + \sum \beta_i x_i$$  (4)

The reference category is denoted by $i$. $P_i$ is the conditional probability of the $j-th$ event occurring. $\beta_i$ is the regression coefficient of the independent variable, $x_i$ is the independent variable, and $\beta_0$ represents a constant term.

The result of data analysis using logistics regression (Table 2) explained that time was a significant factor to fear emotion (p-value = 0.001 < 0.05), sadness emotion (p-value = 0.042 < 0.05) and like emotion (p-value = 0.032 < 0.05). While time was not a significant factor in other emotions (p > 0.05). The COVID-19 normalization period is the reference object. In the fear emotion, compared with the COVID-19 period and the COVID-19 normalization period, the influence of time played an important role in expressing fear emotion, and the impact was positive. Combined with adjusted OR, the OR value of the COVID-19 era was 0.669 times that of the COVID-19 normalization era, which showed that the probability of the COVID-19 era expressing anger is 0.669 times that of the COVID-19 normalization era. Similarly, this variable had a significantly positive impact on like emotion ($\beta = 0.17$) and sadness emotion ($\beta = 0.052$).

Regarding the product categories, healthcare equipment was the reference object. This variable had a significant impact on anger emotion, disgust emotion, fear emotion, like emotion, and sadness emotion (p-value < 0.05). In sad emotion, the value of the coefficient for
traditional Chinese and Western medicines increases by 0.140 units compared to healthcare equipment. In other words, it positively affected the emotional expression of sadness emotion. Similarly, functional foods had a significantly positive impact on emotional expression ($\beta = 0.594$). Consumers purchasing traditional Chinese and Western medicines and functional foods were more likely than consumers purchasing healthcare equipment to express sadness emotion.

Traditional Chinese and Western medicines and functional foods played an essential role in the emotional expression of like (p-value < 0.05), and the impact was positive. The probability of preferring expressing happiness emotion by consumers purchasing healthcare equipment was 24.3% lower than consumers purchasing traditional Chinese and Western medicines (OR = 1.243) and 36.7% lower than consumers purchasing functional foods (OR = 1.367). Nutritional products failed the significance test.

For fear emotion, traditional Chinese and Western medicines were positively correlated with the emotional expression of fear, and the impact was significant (p-value = 0.00 < 0.05). Nutritional products (p = 0.00 < 0.05) and functional foods (p = 0.001 < 0.05) had a very significant effect on expressing fear, and the relationship was negative. With the other conditions unchanged, the rate of occurrence of expressing fear emotion increased by 1.63 times for traditional Chinese and Western medicines (OR = 1.63). The rate of occurrence of expressing fear emotion decreased by 0.489 times for nutritional products (OR = 0.489) and decreased by 0.552 times for functional foods (OR = 0.552).

In anger and disgust emotion, product categories were significantly positive in the multinomial ordinal logistic regression model (p-value < 0.05). Consumers who purchased traditional

Fig 5. Emotional high-frequency words of happiness in the pre-COVID-19 (a), COVID-19 lockdown (b), and normalization era (c).

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Chinese and Western medicines, functional foods and nutritional products were more inclined to express anger and disgust emotion. The results indicated that product categories and time strongly related to seven emotional expressions.

4.4 Bias of emotional intensity in the context of COVID-19

In question 3, the dependent variable, emotional intensity, was a continuous variable, and the independent variable was categorical. One-way analysis of variance was performed to analyze consumers’ emotional intensity across time and product categories.

Table 3 revealed that there was a significant difference in time and anger emotion (F = 4.819, P-value = 0.038<0.05). It meant the time significantly affected the intensity of anger emotion. There was, however, no significant impact between time and other emotions (p-value >0.05).

The p-value of product categories in sadness, fear, anger, and surprise did not reach the corrected significance level. Therefore, the result showed no significant difference in the intensity of the five emotional expressions. Product categories were statistically significant in happiness, like and disgust emotions (P-value<0.05), and F-value was high. The intensity of emotional expression differed significantly among the three emotions.

One-way ANOVA can only test whether the control variables significantly affected the observed variables. It cannot test the extent to which the control variables affect the observed
variables at different levels. Therefore, it was necessary to use post-hoc multiple testing methods to test the degree of influence of control variables on test variables at different levels.

The time multiple comparison test results are shown in Table 4.

The Bonferroni post hoc test has examined multiple comparisons [51]. The post hoc tests using the Bonferroni correction revealed that the intensity of consumers’ anger expression during the pre-COVID-19 and COVID-19 lockdown was significantly higher than during the COVID-19 normalization period.

The results of the multiple comparison test for product categories were shown in Table 5.

As can be seen from the mean difference in Table 5, the emotional intensity of nutritional products and healthcare equipment reviews was higher than in traditional Chinese and Western medicine and functional foods when consumers expressed happiness emotions. When consumers expressed like emotion, the emotional intensity of nutritional products and healthcare equipment reviews was higher, and the emotional intensity of traditional Chinese and Western medicine reviews was lower. When consumers expressed disgust emotions, the emotional intensity of functional foods comments was higher, while the emotional intensity of nutritional products was lower.

### 4.5 Discussion

In this study, we track the emotion bias from November 11, 2019, to July 1, 2020, covering the pre-COVID-19 period, the COVID-19 lockdown period, and the COVID-19 normalization period.
period. Specifically, this paper uses the DUTIR Emotion Ontology set. Firstly, emotion is divided into seven categories to analyze consumer emotion. Then this research analyzes emotion bias and emotional intensity bias using statistical methods. A minimum of three significant findings emerge from this study.

Firstly, this paper counts the high-frequency words of seven emotions during three periods. “Outbreak” and “getting angry” become high-frequency words for anger emotion during the epidemic, which is associated with the disease’s origin in Wuhan, China. A study [52] showed that fear is the predominant negative reaction to COVID-19. Among them, “virus” is the most negative word for fear emotion, followed by “intensely” and “urgent”. With the changes in the spread of infectious diseases, people would pay attention to and search for virus-related vocabulary [53]. The sense of oppression caused by the virus is getting heavier, and consumers would seek ways to avoid infection. Consumers’ demand for health increases. As a primitive sensation, disgust was associated with a propensity to avoid other people and diseases [54]. Therefore, the number of consumers expressing “blame” increases significantly in the COVID-19 lockdown and normalization phase and is twice that before the epidemic.

As COVID-19 progress, however, consumer emotion tends to become more optimistic as essential goods and medical supplies are not in short supply, which can meet the health needs of consumers. There is not much difference in the expression of happiness and like emotion during the three periods. This is because JD.com product reviews are mostly positive reviews nowadays. Sellers hope that more positive reviews could attract consumers to increase their turnover so they will delete negative product reviews. “Regret”, “sick”, “disappoint”, and “wound” had become high-frequency words for sadness emotion in the pre-and amid-
COVID-19 phases. With so much uncertainty and mental trauma caused by COVID-19, people are increasingly worried about their health, loved ones, and economic future. Vaccines are the primary factor in the fight against neo-coronavirus and are the ideal solution to COVID-19 [9]. Currently, the Chinese government is promoting vaccination against New Coronavirus through various social media, and vaccination rates have reached over 90%.

Secondly, there are differences in the expression of emotion types among consumers in different periods. Compared to the COVID-19 normalization phase, consumers have more willingness to express fear and sadness during the epidemic lockdown phase and have more willingness to express like emotions before COVID-19. There is no significant difference in other emotional expression in the three periods. This finding was in line with prior research, which found that negative emotions like anger and sadness are more prevalent during pandemics [55]. The continuing Covid-19 poses a global threat to human life and has evoked an array of negative emotions, including fear, rage, and despair. And consumers’ life satisfaction declines [9]. Some studies have shown that life satisfaction and health correlate positively [56]. As a result, people are more willing to focus on features and behaviors that can help them

| Dependent variable | Independent variables | β     | P-value | Adjusted OR | 95%CI of adjusted OR |
|--------------------|-----------------------|-------|---------|-------------|-----------------------|
| Anger              | The pre-COVID-19 period | 0.089 | 0.676   | 1.093       | (0.719,1.662)         |
|                    | The COVID-19 lockdown period | 0.145 | 0.439   | 1.156       | (0.801,1.667)         |
|                    | Traditional Chinese and Western medicines | 1.432 | 0       | 4.188       | (2.644,6.633)         |
|                    | Nutritional products   | 0.401 | 0.07    | 1.494       | (0.967,2.306)         |
|                    | Functional foods       | 1.233 | 0       | 3.433       | (2.036,5.789)         |
| Disgust            | The pre-COVID-19 period | 0.008 | 0.847   | 1.008       | (0.929,1.094)         |
|                    | The COVID-19 lockdown period | -0.006 | 0.869 | 0.994       | (0.926,1.067)         |
|                    | Traditional Chinese and Western medicines | 0.459 | 0       | 1.582       | (1.423,1.758)         |
|                    | Nutritional products   | 0.482 | 0       | 1.619       | (1.505,1.741)         |
|                    | Functional foods       | 0.453 | 0       | 1.573       | (1.399,1.769)         |
| Fear               | The pre-COVID-19 period | -0.145 | 0.245 | 0.865       | (0.676,1.055)         |
|                    | The COVID-19 lockdown period | 0.290 | 0.001   | 1.337       | (1.118,1.599)         |
|                    | Traditional Chinese and Western medicines | 0.489 | 0       | 1.63        | (1.315,2.022)         |
|                    | Nutritional products   | -0.715 | 0       | 0.489       | (0.399,0.601)         |
|                    | Functional foods       | -0.594 | 0.001   | 0.552       | (0.384,0.975)         |
| Like               | The pre-COVID-19 period | 0.170 | 0.032   | 1.185       | (1.014,1.384)         |
|                    | The COVID-19 lockdown period | 0.090 | 0.197   | 1.094       | (0.955,1.253)         |
|                    | Traditional Chinese and Western medicines | 0.217 | 0.028   | 1.243       | (1.024,1.509)         |
|                    | Nutritional products   | 0.045 | 0.522   | 1.046       | (0.911,1.201)         |
|                    | Functional foods       | 0.313 | 0.004   | 1.367       | (1.108,1.686)         |
| Happiness          | The pre-COVID-19 period | -0.145 | 0.374 | 0.865       | (0.629,1.191)         |
|                    | The COVID-19 lockdown period | -0.202 | 0.145 | 0.817       | (0.622,1.073)         |
|                    | Traditional Chinese and Western medicines | 0.173 | 0.379   | 1.189       | (0.809,1.747)         |
|                    | Nutritional products   | -0.018 | 0.897   | 0.982       | (0.748,1.289)         |
|                    | Functional foods       | -0.170 | 0.492   | 0.844       | (0.520,1.370)         |
| Sadness            | The pre-COVID-19 period | -0.011 | 0.709   | 0.989       | (0.932,1.049)         |
|                    | The COVID-19 lockdown period | 0.052 | 0.042   | 1.054       | (1.002,1.108)         |
|                    | Traditional Chinese and Western medicines | 0.140 | 0       | 1.15        | (1.066,1.241)         |
|                    | Nutritional products   | 0.028 | 0.284   | 1.028       | (0.977,1.081)         |
|                    | Functional foods       | 0.594 | 0       | 1.81        | (1.667,1.967)         |
regain control and assurance, such as buying, to lessen unpleasant sensations [57]. Changes in consumer behavior might be explained as a corrective response to the COVID-19 emergency’s dread and worry. Besides, there are differences in the expression of emotion types among consumers in different product categories. Consumers who purchased traditional Chinese and Western medicine, nutritional products, and functional foods are more willing to express anger and disgust than those who purchased healthcare equipment. Consumers who purchase traditional Chinese and Western medicine and healthcare equipment are more willing to express fear emotion. And consumers who purchase traditional Chinese and Western medicine and functional foods are more willing to express like and sadness emotions. To sum up, consumers who purchase traditional Chinese and Western medicine, nutritional products, and functional foods are more willing to express their emotions. COVID-19 has persisted significantly longer than

|                | Sum of square | Df   | Mean square | F      | p-value |
|----------------|---------------|------|-------------|--------|---------|
| Happiness      |               |      |             |        |         |
| Time           | 0.790         | 2.000| 0.395       | 0.391  | 0.687   |
| Product categories | 7.213     | 3.000| 2.404       | 7.233  | 0.011   |
| Like           |               |      |             |        |         |
| Time           | 1.160         | 2.000| 0.580       | 0.599  | 0.570   |
| Product categories | 7.291     | 3.000| 2.430       | 7.532  | 0.010   |
| Anger          |               |      |             |        |         |
| Time           | 4.823         | 2.000| 2.411       | 4.819  | 0.038   |
| Product categories | 1.175     | 3.000| 0.392       | 0.384  | 0.767   |
| Sadness        |               |      |             |        |         |
| Time           | 1.478         | 2.000| 0.739       | 0.792  | 0.482   |
| Product categories | 1.563     | 3.000| 0.521       | 0.502  | 0.692   |
| Fear           |               |      |             |        |         |
| Time           | 2.611         | 2.000| 1.305       | 1.618  | 0.251   |
| Product categories | 1.288     | 3.000| 0.429       | 0.400  | 0.757   |
| Disgust        |               |      |             |        |         |
| Time           | 2.373         | 2.000| 1.187       | 1.424  | 0.290   |
| Product categories | 5.819     | 3.000| 1.940       | 3.829  | 0.048   |
| Surprise       |               |      |             |        |         |
| Time           | 0.613         | 2.000| 0.307       | 0.313  | 0.739   |
| Product categories | 1.486     | 3.000| 0.495       | 0.498  | 0.694   |

Table 3. One-way analysis of variance between time and product categories and emotional intensity.

|                | (I)/Time                   | (J)/Time                     | (I-J)/Mean Difference |
|----------------|----------------------------|------------------------------|------------------------|
|                | The pre-COVID-19 period    | The COVID-19 lockdown period | 0.145613903            |
|                | The COVID-19 lockdown period | The pre-COVID-19 period      | 1.4116915*             |
|                | The COVID-19 normalization period | The pre-COVID-19 period      | -0.145613903           |
|                |                             | The COVID-19 normalization period | 1.2660776*            |

* represents p-value<0.05.

Table 4. Multiple comparison tests of time.

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previous epidemics. Due to fears about infection, online shopping has risen rapidly, and people are hoarding health supplements like nutritional products and functional foods for fear of the uncertainty brought on by the disaster. After that, consumers will share their experiences on the platform JD to relieve their worries and bring some help to others. A diet characterized by healthy foods reduces the risk and severity of COVID-19 [9]. Correspondingly, healthcare equipment is a high-priced product that is beyond the reach of consumers. For the average consumer, healthcare equipment is used less frequently and must be used under a relevant professional’s guidance. And the number of people who consume it is less, so fewer people are expressing emotions.

Finally, time significantly differed in the emotional intensity of expressing anger. The emotional intensity of product reviews in the pre-COVID-19 and the lockdown phase was higher, and the emotional intensity in the normalization phase was lower. Anger is viewed as a negative emotion with a high level of arousal. And anger intensity was high during COVID-19. One reason is that the significant fear signals identified here are red lights regarding escalating consumer tension, which could lead to psychological severe suffering due to diminished self-control [58]. In this circumstance, rage emotions would be more intense. Wuhan’s closure of the city for nearly three months, with consumers unable to leave their homes and unable to secure basic necessities and inadequate supplies of epidemic prevention supplies, was a significant reason for the change in consumer sentiment.

Reviews of different product types have differences in the expression intensity of happiness, like, disgust emotion. The emotional intensity of nutritional products and healthcare equipment reviews is higher in happiness and like emotion. Nutritional products and healthcare equipment can regulate body functions and increase immunity. Positive sensations of relaxation and happiness were experienced more frequently and powerfully. When consumers use Nutritional products and healthcare equipment, consumers naturally become happy when they feel protected. Yet, the intensity of disgust emotion in functional food reviews is higher when consumers are expressing disgust. Some studies show consumers dread functional foods significantly more than organic and conventional food [59]. Psychology explains that high levels of fear produce awe and obedience. Low levels of fear produce aversion. Fear can lead to aversion. This also indirectly reflects that the findings of this thesis are well-founded. As a result, this may cause an aversion to functional foods among consumers.

Table 5. Multiple comparison tests of product categories.

| (I)Product categories          | (J)Product categories          | (I-J)Mean Difference |
|--------------------------------|--------------------------------|---------------------|
| Traditional Chinese and Western medicines | Nutritional products       | -1.09315*          |
|                                 | Functional foods              | 0.403911           |
|                                 | Healthcare equipment          | -1.49706*          |
| Nutritional products            | Traditional Chinese and Western medicines | 1.09315*          |
|                                 | Functional foods              | 1.49706            |
|                                 | Healthcare equipment          | -0.403911          |
| Functional foods                | Traditional Chinese and Western medicines | -0.403911          |
|                                 | Nutritional products          | -1.49706*          |
|                                 | Healthcare equipment          | -1.90097           |
| Healthcare equipment            | Traditional Chinese and Western medicines | 1.49706            |
|                                 | Nutritional products          | 0.403911           |
|                                 | Functional foods              | 1.900978           |

* represents p-value<0.05.

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5 Conclusion

Changes in customer behavior have had a substantial impact on the health product business as the COVID-19 influence. Regarding this research, we collect health product reviews in JD mall from November 11, 2019, to January 22, 2020, in China. This study examines emotion bias in the three stages (the pre-COVID-19 era, the COVID-19 lockdown era, and the COVID-19 normalization era). The research result indicates that “outbreak” and “get angry” become high-frequency words for anger emotion during the epidemic, and “virus” is the most negative word for fear emotion. “Regret”, “sick”, and “the wound” become high-frequency words for sadness emotion amid the COVID-19 lockdown. However, there are not many differences in happiness and like emotions before and during COVID-19. Further, the study reveals that time and product categories have a difference in the expression of the following emotions: fear, sadness, and like. Besides, product categories have a very significant effect on expressing disgust and anger. Finally, the time has a difference in the emotional intensity of anger, and product categories have a significant difference in the emotional intensity of disgust, like, and happiness. The current research has substantial implications theoretically and practically by revealing changes in consumer emotion that lead to consumer behavioral choices during COVID-19.

Our research has three major implications for a health product company. First, COVID-19 is projected to have a long-term impact on consumer behavior because the recovery will not be a quick process. The fear of the coronavirus is still present. As a result, marketers can actively advertise how a company employs sanitary habits and safety standards to assuage consumers’ fears about the threat, thus establishing a healthy and honest brand image.

Secondly, industry-wide campaigns and consumer communication can be beneficial by emphasizing the low danger of viral transmission through food handling and consumption. Enterprises can develop a system to better communicate with dealers and consumers, transmit their information and declare their commitment to consumers, and improve consumers’ trust in the brand.

Finally, since consumers who purchase nutritional products and healthcare equipment will express like and happiness emotions more often, companies can focus on the research and development of these two types of health products and develop strong advertising campaigns that emphasize the professionalism of the enterprise and the reliability of health products.

While our study contributes to theory and practices, there are some limitations, too. First, this paper’s selection of review websites is limited. The fact that only JD mall is chosen could lead to a platform bias. As a result, future research can also look at COVID-19’s impact on different platforms. Second, this study only considers time and product categories in selecting variables. In future research, more variables (age, gender, etc.) can be selected to explore their role in emotional expression in more dimensions. Finally, the current paper focused on consumer sentiment changes over some time. However, as the global economy enters a phase of recovery, consumer behavior may periodically change, depending on the pandemic’s development and individuals’ ability to adjust to the ever-changing ‘new normality.’ As a result, it is advisable to do a year-by-year analysis over the next several years to acquire a more in-depth insight into the post-pandemic consumer. Hence, dealing with these limitations could be the direction for future research.

Author Contributions

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Investigation: Lian Yuan.
Methodology: Lian Yuan, Mingyan Wang.
Project administration: Mingyan Wang.
Software: Lian Yuan.
Supervision: Mingyan Wang.
Validation: Mingyan Wang.
Visualization: Lian Yuan.
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