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Topic modeling and content analysis of people's anxiety-related concerns raised on a computer-mediated health platform

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Background About one in four Chinese people might suffer or have already suffered from anxiety conditions, with a lifetime prevalence rate of 4.8%. However, many of those who could have benefited from psychological or pharmacological treatments fail to be recognized or treated due to the lack of timely recognition and accurate diagnosis.

Objective This study used a topic modeling approach to explore people's anxiety-related concerns raised on a computer-mediated Chinese health platform, *YOU WEN BI DA* (questioning and answering), to provide implications for accurate diagnosis, targeted education, tailored intervention, and informed policy-making in the course of addressing this condition of public concern.

Methods First, we extracted data from *YOU WEN BI DA* between May 2022 and February 2023. After cleaning the extracted data both using the Python text processing tool *spaCy* and manually, we ascertained the optimal number of topics by drawing on the coherence scores and used latent Dirichlet allocation (LDA) topic modeling to generate the most salient topics and related terms. We then categorized the topics ascertained into different classes of themes by plotting them onto a 2D plane via multidimensional scaling using the pyLDAvis visualization tool. Finally, we analyzed these topics and themes qualitatively to better understand people's anxiety-related concerns.

Results 5 topics with different overall prevalence were ascertained through data analysis. Topic 2 (*tinnitus phobia-incurred concerns*, $n = 639$) is the most popular dominant topic, occurring in 25.1% of the 2545 collected concerns, closely followed by Topics 1 (*neurosis-incurred concerns*, $n = 512$;) and 3 (*sleep, dyskinesia, bipolar, cognitive, and somatic disorders-incurred concerns*, $n = 619$), which appeared in 20.1% and 24.3% of the 2545 concerns respectively. Topic 5 (*social phobia-incurred concerns*, $n = 428$) ranks as the fourth most popular dominant topic, showing up in 16.8% of the 2545 concerns. Topic 4 (*autonomic nerve dysfunction-incurred concerns*, n = 347) accounts for 13.6% of the 2545 concerns. The *t*-distributed Stochastic Neighbor Embedding analysis reveals partial similarities between Topics 2 and 5 as well as between Topics 4 and 5 because many concerns involved in Topics 2 and 5 pertain to people's psychological status of fear and anxiety and the relief and dispelling of such symptoms through medication, and many concerns involved in Topics 4 and 5 relate to people's worries about the negative impact on their nerves and the adjustment and conditioning of such effects through medication.

Conclusion This was the first study that investigated Chinese people's anxiety-related concerns raised on *YOU WEN BI DA* using the topic modeling technique. The automatic text analysis and complementary manual interpretation of the collected data allowed for the discovery of the dominant topics hidden in the data and the categorization of these topics into different themes to reveal the overall status of people's anxiety-related concerns. The research findings can provide some practice implications for health and medical educators, practitioners, and policy-makers to make joint efforts to address this common public concern effectively and efficiently.

Keywords Anxiety disorders, Anxiety-related concerns, Chinese, Topic modeling, Practice implications

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Introduction.

Background

Anxiety disorders refer to some relatively common mental illnesses with diverse clinical manifestations, including panic disorder, generalized anxiety disorder, and specific phobias[1]. Commonly seen in community contexts as well as primary and secondary medical care, anxiety disorders constitute an approximant 12-month prevalence of around 10–14% of the population[2], becoming the most prevalent mental disorders which bring about a substantial related socioeconomic burden for patients, their families, and society[2,3]. The World Health Organization ranks anxiety disorders sixth among all disorders concerning the "years lived with disability" mainly due to the prolonged debilitating course with a high rate of merely intermittent recovery (32.1%) or chronicity (8.6%) at nine-year follow-up[4].

The current status of anxiety disorders in China is no less worrying. About one in four Chinese people might suffer or have already suffered from anxiety conditions, with a lifetime prevalence rate of 4.8%[5]. During the past three decades, these disorders have constituted the most prevalent category of mental disorders in China owing to an overall growth of psychological pressure caused by fast social development[6], biological processes of aging[7], serious public health problems like social isolation among older people[8], and population aging[9]. In addition to the heavy socioeconomic burdens on families and society caused by these symptoms[2,3], the quality of life of patients before and after treatment has also been found to be significantly impacted in China, being much lower than that of healthy individuals[10,11], which warrants extensive and intensive studies to improve both social and individual well-being.

Review of literature

Studies on anxiety disorders

Research on anxiety disorders mainly revolves around diagnoses, epidemiology, causes, and treatments[12]. Diagnosis is mainly based on relevant, specific physical and psychological symptoms, like dry mouth, palpitations and abdominal discomfort incurred by generalized anxiety disorder, blushing, dry mouth and a fear of inappropriate micturition caused by social anxiety disorder, etc[12]. According to Baldwin et al.[12]. , American Psychiatric Association[13], and the World Health Organization[14], the primary anxiety disorders currently consist of panic disorder, generalized anxiety disorder, social anxiety disorder, agora phobia, specific phobias, separation anxiety disorder, selective mutism, substance/medication-induced anxiety disorder, anxiety disorder due to another medical condition, other specified anxiety disorder, and unspecified anxiety disorder. Considerable overlap can be found between various anxiety disorders in terms of acceptable and effective evidence-based medications or cognitive behavioral therapies, but essential differences between them could affect particular treatment decisions, which makes it helpful to remain familiar with their characteristic features and evidence bases for effective treatment[12].

Epidemiological studies show that the global estimates of the lifetime and 12-month prevalence of generalized anxiety disorder are 3.7% and 1.8%, respectively[15], and this disorder is approximately twice as prevalent in women as it is in men[12]. Comorbidity with major depression or other anxiety disorders is frequently found in patients with current generalized anxiety disorder[12]. Globally, lifetime comorbidity has been estimated at 81.9%[15]. The most common comorbid condition is major depressive disorder, being found in 39% of persons with current generalized anxiety disorder and 62% of persons with lifetime generalized anxiety disorder[12]. Other prevalent comorbid conditions in people with generalized anxiety disorder comprise social anxiety disorder, specific phobia, panic disorder, increased rates of alcohol and other substance use disorders, obsessive compulsive disorder and post-traumatic stress disorder[12], as well as medically unexplained chronic pain or chronic physical illness[16]. Epidemiological investigations estimate the lifetime prevalence of panic attacks and panic disorder at 13.2–22% and 1.7–4.7%, respectively[17,18]. Panic disorder comes typically with severe impairments in domestic, occupational, and social functioning, reduced productivity at work, financial decrements[19], psychiatric comorbid conditions like increased risk of suicide attempts[20], and potentially with increased rates of cardiac dysfunctions and diseases, as well as cardiac deaths[20]. The global lifetime prevalence of social anxiety disorder has been estimated at 4.0% with great variations in the level of functional impairments and degrees of comorbidity[21]. According to WHO World Mental Health Surveys involving 18 countries, a mean lifetime prevalence of separation anxiety disorder can be found in 4.8% of the general population[22].

Causes of anxiety disorders have widely been explored. Causes of generalized anxiety disorder include genetic factors (e.g., variations in the sub-type of the glutamic acid decarboxylase gene)[23], a higher-than-average number of traumatic experiences and other undesirable life events in childhood[24], threatening stimuli like verbal-linguistic threats[25], difficulties in engaging the prefrontal cortex and anterior cingulate cortex during emotional regulation tasks[26], etc. Panic disorder may result from disturbances in serotonergic neuro-transmission[27], cholecystokinin receptors[28], hyperventilation and hypocapnia[29], disturbances in the coordination between cortical and brainstem functions[30], and psychological factors like life stressors and conditioned stimuli[12,31]. Causes underlying social anxiety disorder may involve genetic components[32] and psychological factors like childhood temperament, parental psychopathology, neuroticism, peer criticism, heightened self-awareness and increased self-evaluation; biases in the processing of emotional information, and persistently negative expectations of social situations[33]. Separation anxiety disorder has been found to be associated with negative models of the self, low self-esteem, self-criticism and dysfunctional attributions to partners' behavior[34], recollections of difficulties associated with

behavioral inhibition[35], the temperament and character dimensions of high 'harm avoidance' and low 'self-directedness'[36], hypersensitivity to inhaled CO_2[37], and lower salivary oxytocin levels[38].

Pharmacological or psychological treatments can benefit the majority of patients exceeding the threshold criteria for diagnosis[39]. However, existing pharmacological and psychological interventions are not ideal[40]. This is why a wide range of novel targets for potential anxiolytics is being investigated[40], but we need more well-ground evidence for efficacy, tolerability, and safety from large-size randomized placebo-controlled trials before putting such compounds into use in routine clinical practice[12].

Despite substantial social and individual impacts incurred by anxiety disorders, many of those who could have benefited from psychological or pharmacological treatments fail to be recognized or treated, bringing about burdens on individuals, families and society[12]. Early prevention is likely to reduce the burdens[41]. An essential prerequisite to prevention lies in timely recognition and accurate diagnosis, which entails a keen awareness of the psychological and physical symptoms and the identification of the pathognomonic features respectively[12]. However, there is no existing research on patients' and/or their relatives' self-reported concerns over anxiety disorders, which, we believe, could facilitate early prevention of anxiety disorders. Considering various stigmas socially attached to mental disorders[42], potential patients or their relatives are most likely to resort to digital health media for help to report their concerns, which, in our view, can offer an important channel to recognize the current status of various mental diseases including anxiety disorders for early prevention and intervention. The self-reported concerns raised by patients or their relatives online could best reveal their physical and psychological symptoms in that they would spell out their conditions in detail without any reservation because they are free from worries about stigmas behind the screen. Recognizing such self-reported concerns and their prevalence can allow for healthcare providers' and social workers' provision of better mental health interventions and support. However, no research has focused on the recognition of the status of anxiety disorders in China to date, particularly through the self-reported concerns raised by users of computer-mediated health platforms, like *YOU WEN BI DA* (https://www.120ask.com/).

Use of natural language processing and social media data to investigate mental health status

Natural language processing (NLP) techniques have been widely used for data mining and unsupervised topic modeling. For example, recent studies[43,44] have applied NLP techniques to conversation and discourse analysis to reveal prevalent topics in the data. Many studies have employed these techniques and social media data to explore the mental health status of the population[45]. They were designed to supervise the trends in depression across the population[46], to better understand the emotional state of the population[47], to explore the mental health impacts of COVID-19[48], to characterize the disparities in mental health support groups[49], to identify just a few.

Though some existing NLP studies sought to develop methods to exploit social media data to approach the mental health status of the population[45–49], no studies exclusively examined anxiety disorders. Besides, although applying NLP (e.g., topic modeling) techniques, these studies did not draw on data reported by patients and their relatives themselves on computer-mediated health platforms. Thus informed, we believe that the investigation of self-reported anxiety-related concerns raised by users of computer-mediated health platforms could provide fresh insights into the anxiety disorders status of the population in that such self-reported data are supposed to be different, at least in certain ways, from solicited data through surveys or questionnaires, especially when we consider such factors as the avoidance of stigmas and the willingness of reporting true-to-fact feelings and conditions that are enabled only through online virtual communication.

Research objective

In the aforementioned background of research, we aimed to investigate the status of anxiety disorders, especially relevant psychological and physical symptoms, among Chinese people, who used the computer-mediated health platform named *YOU WEN BI DA* to address their concerns about anxiety disorders, in the current study. By doing so, we can provide some essential implications for targeted education, tailored intervention, and informed policy-making.

Based on the research objective, we proposed the following research questions:

- **Research question 1**: *What was the status of anxiety disorders among Chinese populations?*
- **Research question 2**: *What dominant topics (themes) and most relevant terms could be identified in the concerns raised by those who resorted to YOU WEN BI DA for help?*
- **Research question 3**: *Were the identified dominant topics (themes) prevalent among Chinese people and thus representative of their status of anxiety disorders?*
- **Research question 4**: *What implications could the identified status and contributing factors provide for health and medical educators, practitioners, and policy-makers?*

A topic modeling (TM) approach was used to process data retrieved from *YOU WEN BI DA*. As a statistical model, TM processes unstructured data and structured information using latent themes[50]. With this model, we could examine the anxiety status and its contributors in question to provide an overall picture of this globally acknowledged health concern in China. The findings would not only fill the gap in the literature but also help health and medical educators, practitioners, and policy-makers make joint efforts to address this public concern effectively and efficiently.

Methods

Data collection and preparation

Using the keyword "*jiaolv*" (anxiety), we searched *YOU WEN BI DA* for questions raised and answers provided concerning anxiety disorders. Subsequently, we extracted all relevant data available, which was posted between May 2022 and February 2023, by using a Python web crawler. After data extraction, we created a data set consisting of 2545 concerns raided by users, the dominant topic in each concern, the contribution of the dominant topic to each concern measured in percentage, and the top 30 terms relevant to each topic. Before analysis, we underwent the standard preprocessing procedures designed in existing literature[51,52] to clean the data using Python 3.0 (Python Software Foundation) and to perform word part-of-speech tagging and text processing using the Python library *spaCy*[53,54]. Data cleaning allowed us to convert the words in the questions and answers into lowercase words, remove stop words, punctuation, numbers, and non-word characters, and stem the remaining text[55]. To generate more interpretable topics of high quality, we limited the parts of speech of words to "noun" (NOUN), "verb" (VERB), "adjective" (ADJ), and "proper noun" (PROPN). The standard preprocessing procedures can significantly enhance the performance of algorithms and stabilize the stochastic inference of LDA (latent Dirichlet al.location)[56].

Topic modeling with LDA

The statistical methods of unsupervised topic modeling algorithms (that do not need prior labeling or annotations of the documents) were designed to analyze the words (terms) of the original texts to reveal the topics (themes) that run through a corpus[57,58]. These algorithms enable users to organize and summarize numerous documents which is unimaginable through manual annotation[55], therefore ascertaining topics hidden in documents[58]. The most frequently used topic modeling algorithms include LDA, NMF, and Bertopic.

NMF displays more advantages in image processing, speech processing, signal processing, and medical engineering. In terms of text processing, NMF, as a good matrix decomposition method, can be well used in topic modeling and make the results of topics interpretable based on probability distribution. However, although NMF and its variant pLSA can explain the topic models from a probability perspective, they can only identify topics for texts in the training samples, and cannot identify topics for texts that are not in the samples. The root cause is that topic modeling methods, such as NMF and pLSA, do not consider the prior knowledge of topic probability distribution, while LDA topic modeling takes this problem into consideration. At present, most text topic modeling uses LDA and its variants.

After comparing the results of LAD and Bertopic in topic modeling, we finally chose LDA for two considerations: topic classification and the number of topics. Bertopic derived five topics from the 2545 concerns/documents (parameter min_cluster_size = 50). Although the number of topics generated are similar to that generated by LDA, the gap between the number of concerns covered in topics generated by Bertopic is relatively huge (topic0: 1987, topic1: 161, topic2: 111, topic3: 105, and topic4: 95, see Table 1 for comparison). Therefore, the relationship between the proportions of topics is not reliable enough. Bertopic does not determine the number of topics in advance. When min_cluster_size was set to 10, the number of topics generated was as high as 41, and there were less than 20 concerns in 20 of the 41 topics. This made topic analysis difficult for the following reasons. First, a large number (985) of the 2545 concerns were covered by topic0, resulting in a large number of topics covering a small number of concerns. Second, if the data set itself is not clear or focused on the topic, then using BERTopic may not be the best choice. If the documents in the data set do not have clear boundaries between topics, or there is considerable overlap and ambiguity between topics, it will be difficult for the BERTopic topic modeling algorithm to accurately divide independent topics. This is because BERTopic relies on similarities between documents and clustering algorithms to identify topics, but it may produce inaccurate or difficult to interpret topics when the topic boundaries are fuzzy. The LDA topic modeling may be more suitable for handling this issue. In sum, although pre-trained BERTopic modeling can perform well in understanding natural language, there may still be some semantic understanding bias when it is used to process Chinese data, in that BERTopic may generate too many topics, many of which contain only a small number of documents, due to the diversity of vocabulary and the complexity of expression in Chinese data.

As an unsupervised machine learning model, the LDA can be applied to diverse research topics[59] and is commonly adopted to summarize topics on social media[45]. Two assumptions underlie the LDA topic modeling: (i) a topic is a combination of terms with a probability distribution; and (ii) a document is generated by a combination of topics with a probability distribution[59]. This algorithm begins with random topic assignments and then calculates the distribution of words in a topic and the distribution of topics in a document[45]. Afterward, it updates the topic allocation of words in an iterative manner until there is a convergence, before returning the distribution of topics in each document and the distribution of words in each topic[45]. Assuming that texts are generated from a mixture of topics[60], the LDA topic modeling technique can efficiently generate topics of better quality[61]. Two probability distribution outputs were generated from the data set created: the probability distribution of topics over documents and the probability distribution of terms over topics[55,58].

Topics	Overall Concerns ($N = 2545$), n (%)
Topic 1	512 (20.1%)
Topic 2	639 (25.1%)
Topic 3	619 (24.3%)
Topic 4	347 (13.6%)
Topic 5	428 (16.8%)

Table 1. Topic prevalence.

To generate the best modeling result, the metrics of "alpha," "eta," "passes," and "random_state" must be set to an optimal state through repeated trials, with "alpha" and "eta" being set to "auto," when the model can return the optimal topic classification, "passes" being set to the optimal times of "30," and "random_state" being set to "1" to achieve the best modeling effect. After setting these parameters, we mainly relied on the perplexity and coherence metrics during the LDA topic modeling. The number of topics was determined by repeating the analysis with different numbers of topics and by comparing the perplexity of each analysis[55]. A lower perplexity value indicates a better model fit[60], and the perplexity value decreases with the increasing number of topics[55]. We considered both the simplicity and interpretability of the textual content in determining the optimal number of topics[52].

The coherence score was used as a judging metric to assess how good a given topic model was and determine the optimal number of topics to be extracted[52]. Topic coherence is a qualitative method that is adopted to score the coherence of a given topic[62]. It calculates the semantic similarity between words with high scores in a topic to determine the consistency of a single topic, therefore improving the semantic understanding of the given topic[50]. We applied the Python package Coherence Model from *Gensim* to calculate the coherence value[63]. In Fig. 1, the coherence score rises to the highest value of 0.71 when the number of topics reaches 5 before decreasing gradually, which implies that the optimal number of topics is 5. Afterward, we visualized the relationship between these 5 topics and their related terms using Python version 3.6.1 and the LDAvis tool[60].

When λ equals 1, terms are sorted according to their frequency in a topic. Therefore, we set $\lambda = 1$ to visualize the inter-topic distance between the 5 topics and the top 30 most relevant terms for each topic, shown in Fig. 2. We classified these 5 topics into different themes to facilitate better analysis based on the computed topic distance[60]. In the 2D plane (Fig. 2), the 5 topics are shown in the form of 5 circles. The size of each circle represents the overall prevalence of the topic, the overlap between Circles 2, 4, and 5 means the overlap between Topics 2, 4, and 5, and the distance between the circle centers stands for topic distance[60]. The content of each topic was generated according to its corresponding set of keywords (terms)[64]. Considering that the output of statistical measures cannot be guaranteed to be interpretable due to the language complexity[65], we complemented automatic text

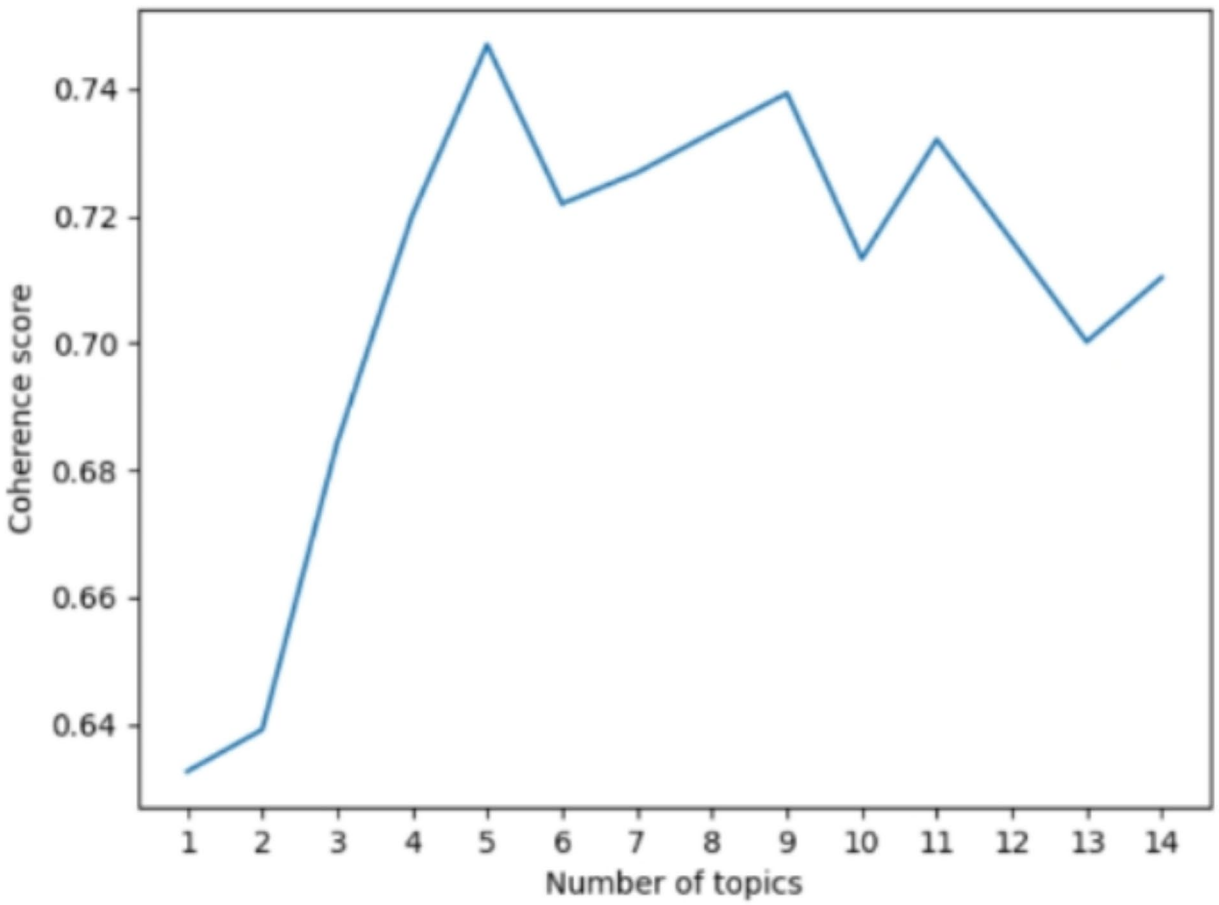

Fig. 1. Coherence score for the topic numbers.

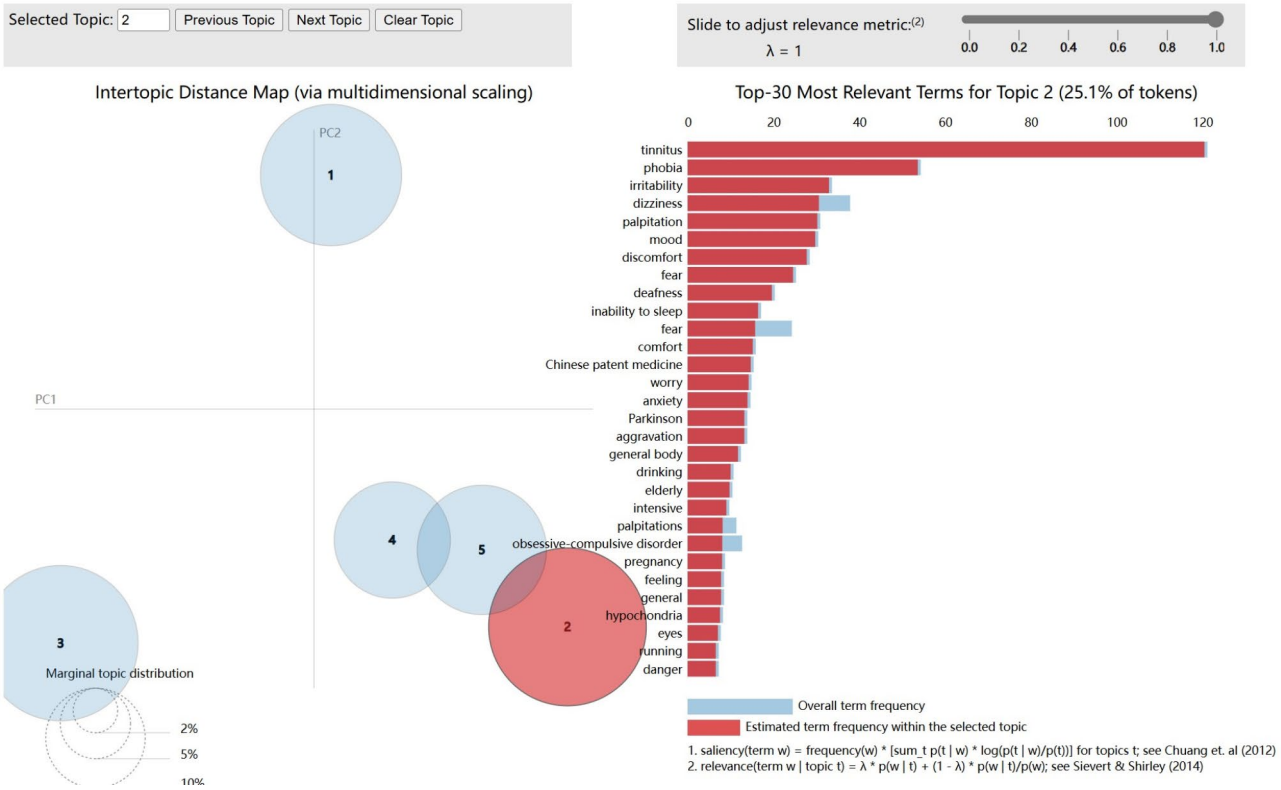

Fig. 2. Intertopic Distance Map and Top 30 Most Relevant Terms for Topic 2. PC: principal component, referring to the interactive web-based visualization in Multimedia Appendix 1 for other topics.

statistics with manual interpretation when analyzing the topics. The topics were named based on the associated keywords to illustrate these topics[64].

Ethical considerations

This study used public data retrieved from a computer-mediated medical and health questioning and answering platform without involving any human participants. Therefore, no ethics board approval was required.

Results

Topic names and prevalence

By applying LDA topic modeling, we classified into 5 topics the collected data of 2545 concerns about the status of anxiety disorders raised by users of *YOU WEN BI DA* between May 2022 and February 2023. The different sizes of the 5 circles representing these 5 topics in Fig. 2 indicate different overall prevalence of these topics in the data collected. Table 1 briefly shows the prevalence of these 5 topics, whose names, counts and percentages are to be presented in the next subsection.

Topic terms and content

Figure 2 also shows the top 30 most relevant terms for Topic 2, representing 25.1% of tokens. As this topic constitutes the highest proportion of the collected data, it is presented as a typical illustration. Since the blue bar and the red bar represent the overall term frequency and the estimated term frequency within the selected topic, respectively, the topic content can be better interpreted based on this approach[66,67]. The word clouds of the 5 dominant topics in Fig. 3 and the weight of the top 10 most relevant terms of these 5 topics in Fig. 4 complement Fig. 2 in demonstrating the term frequency of the top 30 most relevant terms of each topic and implying the content of each topic. Based on these figures and content analysis of the 2545 concerns, we could ascertain the names of these topics. In Topic 1, “neurosis”, “mania”, “severe”, “attack”, “psychological”, “panic”, “conditioning”, “relapse”, “trigger”, and “anxiety neurosis” rank the top 10 most relevant terms. With these terms in mind, we analyzed and ascertained the content of the concerns under investigation and then named this topic *anxiety neurosis-incurred concerns* in that it pertains to users’ psychological panic and mania at the attack, conditioning, severity, and relapse of neurosis, as well as at the triggering of anxiety neurosis. With regard to Topic 2, the top 10 most relevant terms, “tinnitus”, “phobia”, “irritability”, “dizziness”, “palpitation”, “mood”, “discomfort”, “fear”, “deafness”, and “inability to sleep”, coupled with content analysis of the concerns under discussion, allowed us to study the content of this topic and name it *tinnitus phobia-incurred concerns*. In the same vein, we derived the names of the other 3 topics. The names of the 5 topics and their top 30 most relevant terms (keywords) are shown in Table 2.

Fig. 3. Topic modeling word clouds of the 5 dominant topics.

Topic 2 (*tinnitus phobia-incurred concerns*, $n = 639$) is the most popular dominant topic, occurring in 25.1% of the 2545 collected concerns, closely followed by Topics 1 (*anxiety neurosis-incurred concerns*, $n = 512$;) and 3 (*sleep*, *dyskinesia*, *bipolar*, *and somatic disorders-incurred concerns*, $n = 619$), which appeared in 20.1% and 24.3% of the 2545 concerns. Topic 5 (*social phobia-incurred concerns*, $n = 428$) ranks as the fourth most popular dominant topic, showing up in 16.8% of the 2545 concerns. Topic 4 (*autonomic nervous dysfunction-incurred concerns*, n = 347) accounts for 13.6% of the 2545 concerns.

Intertopic distance and classification of topics into themes

Figure 2 provides an overview of the topic model we constructed. The 5 circles in this figure represent the 5 topics dominating the 2545 concerns raised by users. The intertopic distances characterized by multidimensional scaling on the 2D plane in Fig. 2 imply the semantic similarity between these 5 topics: Topics 4 and 5 slightly overlap and Topics 2 and 5 slightly overlap, thus being merely slightly semantically similar; these 3 topics are semantically distant from Topics 1 and 3, which are also semantically distant from each other. Considering this, we found it optimal to keep the 5 dominant topics covered in the data as 5 separate themes, as shown in Table 2.

Clustering of topic groups in the data

We used t-distributed Stochastic Neighbor Embedding (t-SNE) to visualize the coherence of topic groups. In Fig. 5, the t-SNE describes the clustering of topic groups in the data. As the concerns about anxiety disorders can include multiple topics, we can find visible crossovers between the topic clusters in the t-SNE[66]. Figure 5 displays

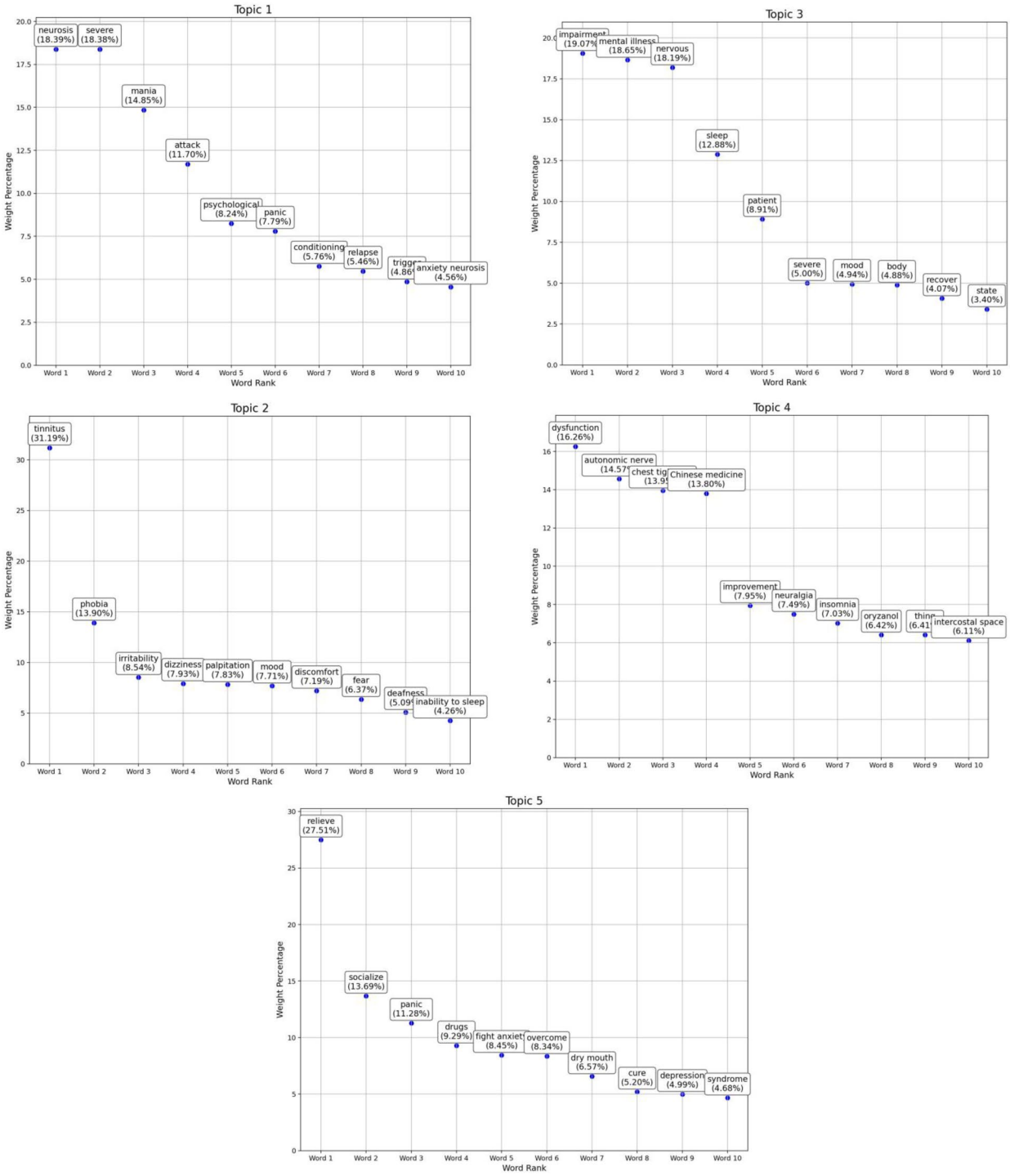

Fig. 4. Weight of top 10 most relevant terms for the 5 topics.

that partial similarities exist between Topics 2 (*tinnitus phobia-incurred concerns*) and 5 (*social phobia-incurred concerns*) as well as between Topics 4 (*autonomic nervous dysfunction-incurred concerns*) and 5. This may be explained by the fact that many concerns involved in Topics 2 and 5 pertain to people's psychological status of fear and anxiety and the relief and dispelling of such symptoms through medication, and many concerns involved in Topics 4 and 5 relate to people's worries about the negative impact on their nerves and the adjustment and conditioning of such effects by means of medication. In addition, Topics 1 (*anxiety neurosis-incurred concerns*) and 3 (*sleep*, *dyskinesia*, *bipolar*, *and somatic disorders-incurred concerns*) are dissimilar both from each other and from Topics 2, 4, and 5, as shown by Fig. 5.

Topics and keywords
Topic (Theme) 1: ***Anxiety neurosis-incurred concerns*** • **Keywords**: neurosis; mania; severe; attack; psychological; panic; conditioning; relapse; trigger; anxiety neurosis; heart; pain; syndrome; irritability; effect; upset; sinusitis; valid; compulsion; headache; does it work; know; concentration; attention; method; digestive tract; hydrochloric acid; acute; spirit; breast
Topic (Theme) 2: ***Tinnitus phobia-incurred concerns*** • **Keywords**: tinnitus; phobia; irritability; dizziness; palpitation; mood; discomfort; fear; deafness; inability to sleep; fear; comfort; Chinese patent medicine; worry; anxiety; Parkinson; aggravation; general body; drinking; elderly; intensive; palpitations; obsessive-compulsive disorder; pregnancy; feeling; general; hypochondria; eyes; running; danger
Topic (Theme) 3: ***Sleep***, ***dyskinesia***, ***bipolar***, ***and somatic disorders-incurred concerns*** • **Keywords**: impairment; mental illness; nervous; sleep; patient; severe; mood; body; recover; state; examine; mania; pressure; belong; feel; sports; discontinue medication; condition; over; judge; take medicine; harm; get well; fainting; child; develop; foreign body sensation; thirsty; moderate; ringing in the brain
Topic (Theme) 4: ***Autonomic nervous dysfunction-incurred concerns*** • **Keywords**: dysfunction; autonomic nerve; chest tightness; Chinese medicine; improvement; neuralgia; insomnia; oryzanol; thing; intercostal space; Delexin; talking; patient; teenager; fever; shock; cause; weakness; symptom; conditioning; dizziness; shortness of breath; heartbeat; accompanied by; confirmed; function; anorexia; adjustment; vitamins; whole body
Topic (Theme) 5: ***Social phobia-incurred concerns*** • **Keywords**: relieve; socialize; panic; drugs; fight anxiety; overcome; dry; mouth; cure; depression; syndrome; tremor; should; conditioning; eliminate; food; anger; solve; take; nerve; talent; nervous; relaxation; fear; bitter mouth; sweating; effectiveness; hereditary; separation; headache; no

Table 2. Topics (themes) and corresponding keywords.

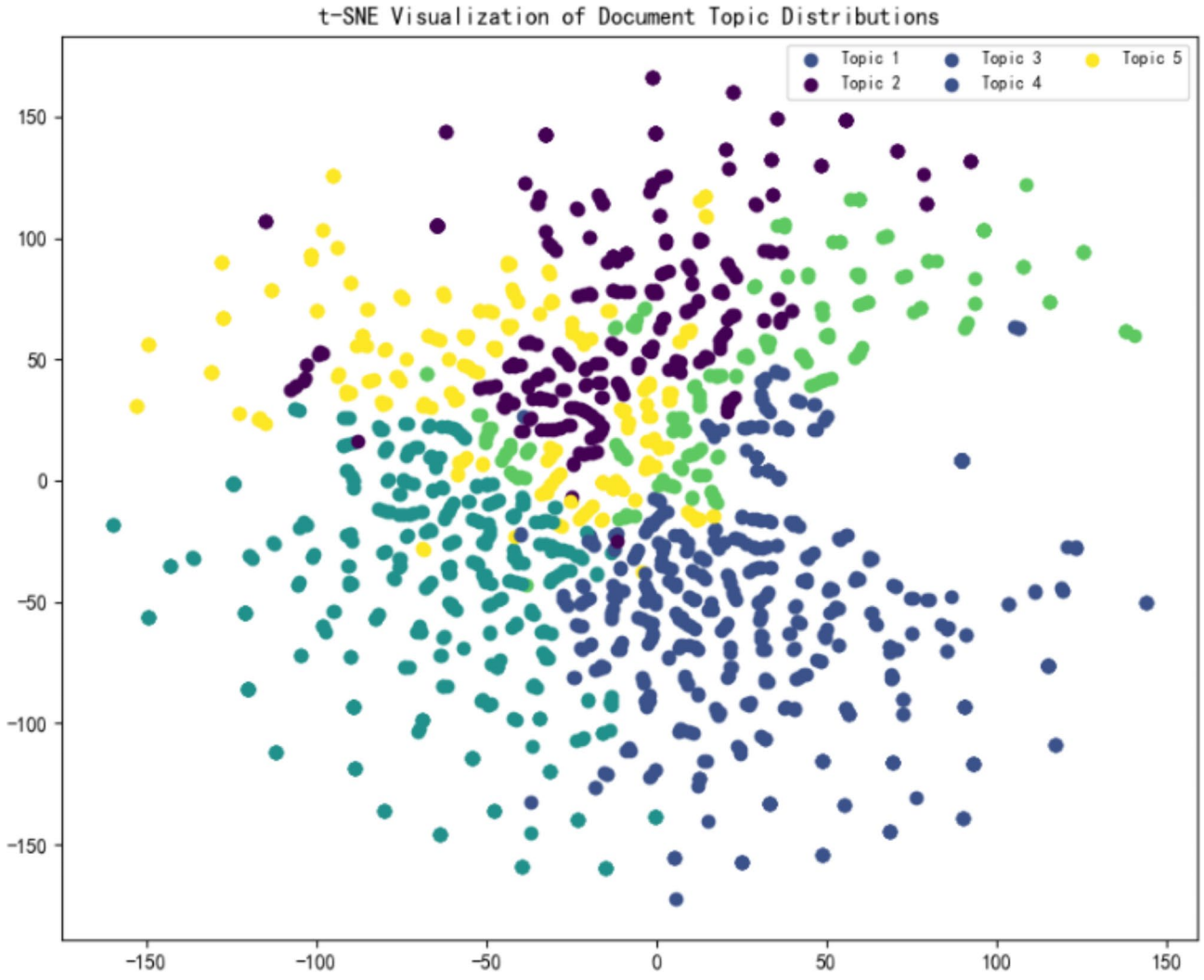

Fig. 5. t-distributed Stochastic Neighbor Embedding (t-SNE) plot for the topic groups identified.

Discussion

Principal findings in relation to previous studies

Considering that approximately one in four Chinese people may suffer or have already suffered from anxiety conditions, with a lifetime prevalence rate of 4.8%, but that many of those who could have benefited from psychological or pharmacological treatments fail to be recognized or treated due to the lack of timely recognition and accurate diagnosis, we recognized 5 topics (themes) among the 2545 anxiety-related concerns raised by Chinese people who resorted to *YOU WEN BI DA* to address their concerns.

As we ascertained through topic modeling coupled with content analysis, *tinnitus phobia-incurred concerns* (Topic 2) constituted the most popular dominant topic covered in the data. Our finding of the association between tinnitus (phobia) and anxiety disorders aligns well with previous studies. A positive association has been identified between anxiety and tinnitus severity by many studies[68]. For example, Singh et al.[69] reported that patients who suffered from tinnitus showed a higher prevalence of anxiety, and found that 45% of patients with tinnitus had anxiety[70]. Similarly, Chen et al.[71] observed an increased risk of anxiety disorders among those with tinnitus. Tinnitus has been ascertained as a risk factor or indicator of poor mental health, including an increased risk of psychiatric disorders[72–75], and connected with an increase in anxiety symptoms[75]. Our finding, together with relevant findings reported by previous studies, necessitates a targeted screening of those with tinnitus for the diagnosis of anxiety disorders, as argued by a recent study that proposes that "there should be a screening or assessment of patients with tinnitus"[69], because symptoms of anxiety increased in respondents with tinnitus, which must be considered during the treatment of these patients[76].

We found that *anxiety neurosis-incurred concerns* (Topic 1) also contributed to anxiety disorders among our respondents. Anxiety neurosis, also referred to as generalized anxiety disorder, is a neurotic disorder featuring persistent excessive anxiety, which does not result from organic brain disease or any other psychiatric disorder[77]. It is listed as one kind of anxiety disorders[78]. Its symptoms include worries, fears, uncontrollable and persistent concerns, difficulty making decisions, irritability, headaches, muscular aches, stomach aches, other inexplicable pains, insomnia[78], mild feelings of fatigue, apprehension and tension, restlessness, uncontrollable emotional discomfort, tremors, sustained muscle tension, tachycardia, dyspnoea, hypertension, increased respiration, and profuse perspiration[77]. In our study, we also attested to some of these symptoms of anxiety neurosis or generalized anxiety disorder, such as irritability, fears, headaches and various other pains, tachycardia, uncontrollable emotional discomfort, etc. Anxiety neurosis is one of the most commonly encountered psychiatric disorders[79]. Cases of anxiety neurosis are more prevalent in people than other types of neurosis, and an estimated 30–40% of cases of neurotic patients are cases of anxiety[79]. The intimate association between neurosis and anxiety can provide practice implications for targeted screening, recognition, diagnosis, and treatment of both conditions.

In our study, *sleep*, *dyskinesia*, *bipolar*, *and somatic disorders-incurred concerns* (Topic 3) were found to constitute anxiety-related concerns raised by the respondents. Previous studies have discovered the link between sleep, dyskinesia, bipolar, cognitive, and somatic disorders and anxiety. Most patients suffering from anxiety disorders experience various sleep disorders: In general practice, the prevalence of sleep disorders amounts to 73%[80]. On the other hand, Chronic sleep disorder is a potential stressor that increases anxiety[80]. Sleep disturbances, especially insomnia, display a high prevalence in anxiety disorders[81]. An estimated 24–36% of subjects with insomnia and an estimated 27–42% of those with hypersomnia suffer from anxiety disorder[82,83]. As a result, sleep disturbance is regarded as a diagnostic symptom for some anxiety disorders, such as generalized anxiety disorder (GAD) and post-traumatic stress disorder (PTSD), and complaints like insomnia or nightmares have even been integrated into the definitions of some anxiety disorders, for example, GAD and PTSD[81]. As can be seen, it is imperative to detect sleep disorders as early as possible and treat them as timely as possible[80].

Dyskinesia is also intimately related to anxiety. As we found in this study, it was one of the anxiety-related concerns raised by some respondents, who claimed that their status of anxiety disorders resulted in dyskinesia. This finding is in tune with the finding reported by Dias et al.[84], who argued that levodopa-induced dyskinesia was preceded by higher levels of trait anxiety. On the other hand, dyskinesia can trigger anxiety complaints. People with primary ciliary dyskinesia and their caregivers risk developing symptoms of anxiety, with about 30% of mothers caring for adolescents with primary ciliary dyskinesia reporting increased anxiety[85]. In another study, 41.7% of the primary ciliary dyskinesia sub-sample presented symptoms of anxiety[86]. These findings entail a pressing need for psychological care in primary ciliary dyskinesia[85]. Finally, the very limited number of prior studies on the association between dyskinesia and anxiety that we can retrieve calls for more investigations to be conducted in this line of research.

Bipolar disorder is closely linked to anxiety. A recent study attested to "the role of childhood separation anxiety as a precursor of bipolar disorder"[87]. This link has also been ascertained in other studies, including Faedda et al.[88], Brückl et al.[89], to identify but two. Brückl et al.[89] identified a specific connection between childhood separation anxiety with adolescence and early adulthood bipolar disorders. Similarly, several other studies[90–92] confirmed the close association between anxiety disorders and prospectively observed bipolar disorder. Maina et al.[93] even hypothesized an intriguing relationship based their findings: anxiety symptoms do not "identify a distinct disorder (comorbidity of bipolar disorder)", and should be regarded as "an epiphenomenon of bipolar disorder itself".

In our study, some respondents were concerned about somatic disorders resulting from anxiety disorders. This causal association has been identified in previous studies. As a study argued, anxiety disorders contribute to the development of psychogenic somatic pathology[80]. Similarly, Bekhuis et al. revealed a higher prevalence of all clusters of somatic symptoms in patients with anxiety disorders than in controls, and they also found that all types of anxiety disorders were independently associated with somatic symptoms[94]. Somatic symptoms often manifest anxiety disorders[95]. Somatic symptoms are also experienced by many people with Generalized Anxiety Disorder[96]. In primary care, somatic symptoms are usually presented by patients with anxiety and depression[97,98].

Some respondents in the current study mentioned *autonomic nervous dysfunction* (Topic 4) as one anxiety-related concern. This has been confirmed in existing studies. As Göçen and Özden claimed, autonomic dysfunction can be detected in psychiatric disorders, including panic disorder, depression, bipolar disorder, schizophrenia, post-traumatic stress disorder, anxiety disorders, and substance addiction[99]. This is because psychiatric disorders often show disruptions of the activities of the vagus nerve, which is likely to cause autonomic dysfunction[99]. Autonomic dysfunction occurs during the course of psychiatric disorders, not necessarily at the beginning of disease, and accelerates its progression[99]. More importantly, the decrease of heart rate variability, a reliable indicator for evaluating autonomic functions, is more likely to make individuals with psychiatric disorders risky of a sudden cardiac death[99]. As can be seen, controlling autonomic functions is essential to the reduction of disease symptoms and morbidity and mortality resulting autonomic dysfunction[99]. Therefore, interventions and remedies need to be timely delivered for better patient outcomes. Hydrogen-rich water has been proven useful for improving anxiety disorders and autonomic nerve function in daily life[100]. Besides, music therapy has been attested to improving autonomic dysfunction in generalized anxiety disorder patients and could be adopted as an adjunct to pharmacotherapy in clinical psychiatry for good cardiac health in patients with generalized anxiety disorder[101].

Finally, *social phobia* (Topic 5) was also considered as one of the anxiety-related concerns as raised by some respondents in our study. Social phobia is listed as one form of anxiety disorders[78]. Previous studies, for example, Gunlu[102], found that generalized anxiety disorder could significantly predict perceived stress and social distancing phobia. Roth et al. found that when asked about anxiety symptoms that they showed, people with social phobia were more likely than those without to believe that other people interpreted anxiety symptoms as indicators of intense anxiety or a psychiatric condition and were less likely to believe that other people interpreted these symptoms as indicators of normal physical states[103]. People living with social phobia are frequently fearful of showing symptoms that can be interpreted as signs of anxiety (e.g., sweating, shaking or blushing)[97]. These patients hold such a concern not only because they think that others may recognize these symptoms, but also because others will relate such symptoms to negative characterological traits[104]. Therefore, close medical attention needs to be paid to social phobia among people, which is of great significance, individually and socially.

Implications and future directions

This study points to the significance of not only the timely recognition of people's anxiety-related concerns but also the computer-mediated health platform as an effective alternative or a positive supplement to the physical health institution. These two aspects can facilitate delivering accurate diagnosis, targeted education, tailored intervention, and informed policy-making in the course of addressing the common public concern of anxiety disorders.

The timely recognition of people's anxiety-related concerns is crucially important in the following aspects. First, the timely recognition of these concerns is most likely to pave the way for accurate diagnoses and targeted treatments, promising to greatly reduce the burden caused by anxiety disorders on individuals and society. Additionally, such recognition can help public health educators and practitioners make informed decisions on how to administrate targeted education and tailored intervention among those susceptible to anxiety disorders, so as to effectively alleviate their symptoms and enable them to fight against these conditions for the benefit of their normal functioning both in family, in social circles, and at work. Moreover, the timely recognition of people's anxiety-related concerns could empower health policy-makers in terms of formulating, promulgating, and implementing relevant policies, which can attend to and enhance people's mental health, and thus promote social, economic, and cultural development in the long term.

The computer-mediated health platform has become an effective alternative or a positive supplement to the physical health institution. This fact can bring about some benefits. First, computer-mediated health platforms can be used as a valuable data source for the monitoring of the real-time anxiety disorders of the population. This is because people would like to report their true-to-fact feelings or experiences on these platforms timely without any worries about stigmas which may be incurred during personal visit to health facilities. Such data can provide insights into the real status of anxiety disorders for research, clinical, and policy-making purposes. Second, the improvement and development of computer-mediated health platforms can help reduce the burden of the overburdened health institutions and provide more opportunities for the individuals to have their anxiety disorders attended to in a timely manner. To this end, government authorities and health institutions need to make joint efforts to facilitate the establishment and operation of these digital health platforms. Third, such platforms may turn out to be an ideal alternative for individuals who are preoccupied by their busy working schedule, who want to spend less because of their economically disadvantaged status, and who find it inconvenient to personally visit health institutions due to disabilities, old age, weak physical conditions, illness, pregnancy, and other conditions.

Future research should explore the integration of artificial intelligence into computer-mediated health platforms to enhance real-time data analysis and personalized intervention strategies. Additionally, expanding these platforms to include community support features could foster peer interactions, reducing feelings of isolation among users. Longitudinal studies will be essential to assess the long-term efficacy of these digital solutions in managing anxiety disorders, paving the way for broader implementation in diverse populations. Building on these insights, future applications might also include the development of mobile health apps that leverage machine learning algorithms to predict anxiety flare-ups based on user input and behavioral data. Furthermore, partnerships with tech companies could enhance user experience and ensure the platforms are accessible across various devices. Expanding the scope to incorporate mindfulness and cognitive-behavioral therapy resources may empower users to take proactive steps in their mental health journey, ultimately fostering a more resilient society. Moreover, the potential for integrating virtual reality experiences into these platforms could revolutionize exposure therapy for anxiety disorders. By simulating real-world scenarios in a controlled

environment, users can confront their fears safely and effectively. Additionally, fostering collaboration with educational institutions to create training modules for healthcare providers on utilizing these platforms can enhance the overall efficacy of anxiety management strategies. Finally, exploring the scalability of these solutions in low-resource settings will be crucial for promoting mental health equity on a global scale.

Strengths and limitations

This study has the following strengths. First, we used authentic data derived from computer-mediated health platforms, which can help minimize biases potentially incurred by data solicited through surveys, interviews, or questionnaires. During data collection through these tradition methods, study participants may consider the issues of privacy and stigma, possibly reporting their concerns with reservation. Second, we compared the most popular topic modeling approaches, including LDA, BERTopic, NMF, and pLSA, and chose LDA as the best one that was most suitable for analyzing our data. As a result, our topic modeling results and principal findings can be relatively reliable and generalizable.

There are some limitations concerning this study. First and foremost, we could only retrieve data on people's anxiety-related concerns ranging between May, 2022, and February, 2023 due to unknown reasons. The limited size of the data sample may slightly influence the generalizability of the findings. In the future, we will conduct further studies on the same subject by deriving more data from other computer-mediated health platforms to test the generalizability of the findings of this study and possibly add more findings to those ascertained in this study, so as to provide a relatively full picture of people's anxiety-related concerns. Secondly, our data covered a relatively short period of less than one year. A study spanning a considerably longer time duration is likely to present the dynamics of people's anxiety-related concerns chronologically, which may promise to reveal some potential factors, like the outbreak of the COVID-19 pandemic, which might impact individuals' perceptions of concerns possibly inducing anxiety disorders. Thirdly, we were unable to retrieve the users' demographic information, including their socioeconomic background, education, gender, age, etc. These factors may affect the users' perceptions and self-reporting of anxiety-related concerns. Inability to relate these factors to the users' concerns may make it impossible to deliver accurate diagnosis, targeted education, tailored intervention, and informed policy-making in the course of addressing this condition of public concern. This warrants further studies on such associations.

Conclusion

This was the first study that investigated Chinese people's anxiety-related concerns raised on *YOU WEN BI DA* using the topic modeling technique. The automatic text analysis and complementary manual interpretation of the collected data of 2545 concerns allowed for the discovery of the dominant topics hidden in the data and the categorization of these topics into different themes to reveal the overall status of people's anxiety-related concerns. The 5 relevant topics (themes) ascertained can provide some practice implications for health and medical educators, practitioners, and policy-makers to make joint efforts to address this common public concern effectively and efficiently.

Data availability

The datasets used and/or analysed during the current study are available from the first and corresponding author Yi Shan (victorsyhz@hotmail.com) on reasonable request.

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Y. S., Y. L., S. Z., Y. Y. and H. L. designed and wrote this article. Y. S, Y. L., Y. Y., S. S. and Yong S. did the data analysis. Y. S. and Y. L. wrote and edited this article. Y. L. S. S., Yong S. and H. L. conducted the survey and collected the data. All authors reviewed and approved the final manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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