Research article

Attitudes of Chinese public towards the autism community: Evidence from a decade of Weibo data

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ABSTRACT

Autism is a highly stigmatized developmental disorder in Chinese society, with the public harboring many prejudices and misunderstandings towards individuals with autism.Grounded in ABC attitude theory, explores the status, trends, and characteristics of Weibo users' attitudes towards the autism community. Utilizing natural language processing and machine learning techniques, the study analyzes 1,113,014 Weibo posts concerning autism, spanning from January 1, 2013, to December 31, 2022. Findings indicate that Weibo users generally hold a positive and progressively improving attitude towards the autism community, particularly in affective and behavioral dimensions. However, the cognitive dimension of these attitudes remains relatively underdeveloped. Notable variations in attitudes and their components are evident across demographic variables such as gender, age, educational level, and verification status. These insights offer valuable guidance for policy-making by relevant authorities and contribute to enhancing public acceptance of individuals with autism.

1. Introduction

Autism is a neurodevelopmental disorder marked by social challenges, diminished social interaction, impaired communication or language skills, and repetitive behaviors. World Health Organization data from 2021 indicates that over 70 million people worldwide have ASD, with around one in every 160 children diagnosed as autistic. In China, the ASD population exceeds 13 million, including over 3 million children below 14 years old [1]. Individuals with Autism often experience cognitive deficits, which manifest in various areas including theory of mind [2], executive functioning [3], working memory [4], and episodic memory [5,6].

Recent years have seen heightened public awareness of Autism due to media representation and educational initiatives. However, comprehensive understanding of the condition is still limited. While the term "autism" is widely recognized, many people have a rudimentary grasp of its characteristics and the spectrum's diversity, leading to misconceptions and stereotypes [7]. Common stereotypes include social skill deficits and intelligence. Sasson et al. highlight that individuals with Autism are often unfairly perceived as socially inept and intellectually challenged, disregarding their varied abilities and traits [8]. These stereotypes contribute to social exclusion and discrimination.The stigma surrounding Autism further impedes social integration. It often results in social alienation, where individuals without Autism hesitate to interact socially with those who have Autism, intensifying the isolation felt by many with the disorder [9]. Media depictions of Autism have a dual impact on public perceptions. Although they can foster understanding and acceptance, they also tend to perpetuate stereotypes by portraying individuals with Autism as either highly gifted or facing significant

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challenges, neglecting the spectrum's breadth [10].Despite increased advocacy for inclusive education, educators often report a lack of preparedness in addressing the needs of students with Autism [11]. Additionally, cultural contexts significantly shape attitudes towards Autism. In more collectivist cultures, such as in China and other East Asian countries, the stigma surrounding neurological and developmental conditions is more pronounced, exacerbating the challenges faced by affected individuals [12].

In Chinese society, understanding and awareness of Autism are notably limited. Zhang et al. indicate that the cultural emphasis on normalcy and conformity in China often leads to misconceptions and stigmatization of individuals with Autism [13]. Many in China mistakenly associate Autism with mental illness or intellectual disability. Family and societal expectations significantly influence attitudes towards Autism. The pressure to adhere to social norms and prioritize academic achievement frequently leads to feelings of shame or embarrassment in families with an Autism child, contributing to their social isolation [14].

The traditional Chinese education system, with its excessive emphasis on standardized testing and uniform teaching methods, often fails to meet the diverse needs of children with autism. This may exacerbate the challenges these children face, as the system typically lacks sufficient resources and specialized training for educators in dealing with neurodiversity [15]. Additionally, there is a notable shortage of autism-specific educational programs and support services in China, and mainstream schools lack the specialized resources and trained professionals to support children with ASD. This lack of support not only hinders the educational development of children with ASD but also reinforces negative stereotypes among peers and educators [16,17]. Furthermore, research teams have discussed the cultural stigmatization associated with autism in China, where the public and media portray ASD as foolishness, further complicating the educational experiences of the autism community, often leading to social isolation and limited access to appropriate educational opportunities [18,19]. Scholars have also pointed out the spatial heterogeneity in public attitudes towards the autism community, China is a vast and unevenly developed country, and in urban areas, public awareness and acceptance of ASD are increasing. However, in rural areas, misconceptions and prejudices remain quite severe [20].

Most research on attitudes towards individuals with autism has traditionally focused on a singular dimension. However, in psychology, attitudes are conceptualized as an individual's tendency to assess various symbols, objects, or aspects in their environment as either favorable or unfavorable [21]. Breckler's ABC model of attitudes elucidates that attitudes encompass three dimensions: affective, behavioral, and cognitive. This model posits that these dimensions are interconnected, each influencing and reinforcing the others. By understanding how each component contributes to an overall attitude, we can gain deeper insights into how attitudes form and change. This comprehensive approach is crucial in attitude research [22]. Our survey, informed by Breckler's ABC model, aims to provide a more thorough and accurate assessment of attitudes towards individuals with autism. We hypothesize that the content of Weibo posts reflects enduring information shaped by users' affective responses, behavioral tendencies, and cognitive perceptions regarding individuals with autism. This information is categorized into three components: 1. The Affective dimension, capturing Weibo users' emotions or feelings towards individuals with autism. 2. The Behavioral dimension, focusing on Weibo users' actions and intentions towards individuals with autism. This includes their readiness to engage in friendships or classmate relationships with autistic individuals and their support for the rights of the autism community. 3. The Cognitive dimension, concerning Weibo users' understanding of autism and their beliefs about those it affects.

Currently, the academic community primarily utilizes traditional methods, such as surveys, to understand the public's attitudes towards autism. However, surveys have limitations in terms of their scope and are subject to the subjective influences of the participants, particularly with sensitive topics like attitudes, where respondent bias towards social desirability can be a significant issue. This study aims to comprehensively reveal and clarify the current status, trends, and characteristics of the Chinese public's attitude towards individuals with autism by mining large-scale text data from Weibo. As one of China's earliest social media platforms, Weibo boasts a wide user base and can gather certain demographic characteristics. Posts on Weibo represent the spontaneous and natural opinions of users in their daily lives, continuously and non-intrusively recorded on the platform. Such posts are considered more objective, thereby potentially reducing social desirability bias [23]. Employing natural language processing and machine learning technologies, we analyze Weibo texts related to attitudes towards autism, grounded in the ABC model (affective, behavioral, and cognitive components). Our research addresses the following questions.

1) What is the current state of attitudes among Chinese Public towards individuals with autism?
2) How have these public attitudes in China towards autism evolved over time?
3) What are the distinguishing characteristics of individual-level variables among Weibo users, such as gender, age, education level, and verification status?

2. Method

2.1. Data collection

In this study, the keyword "autism" in Chinese was used to search daily for Weibo user posts containing this keyword from January 1, 2013, to December 31, 2022, via Weibo's advanced search. All data downloaded from Weibo were public, accessible to anyone with a Weibo account. Initially, metadata and text data for 1,897,273 autism-related posts were collected.

After manual inspection, we discovered that a significant portion of the collected information consisted of irrelevant content such as dialogues, lyrics, advertisements, etc. To clean the dataset, we used the stopword list from Harbin Institute of Technology for text filtering, leaving 1,113,014 posts available for analysis.The Harbin Institute of Technology Stopword List is specifically designed for the Chinese language context, aiding in the removal of unnecessary or redundant words to refine and focus analyses, and is a necessary prerequisite for natural language processing(NLP) [24].The independent variables comprised gender, age, education level, and Weibo

verification type. The dependent variable was Weibo users' attitudes towards individuals with autism. Each post was assessed and rated according to the Breckler ABC model, which includes affective, behavioral, cognitive, and overall attitude components. Each post was evaluated based on three specific components and assigned a score ranging from 0 to 5 for each. A score of 0 indicates the absence of the specific attitude in the post. For the affective and behavioral dimensions, the scoring was as follows: 1 = strongly negative, 2 = somewhat negative, 3 = neutral, 4 = somewhat positive, 5 = strongly positive. In the cognitive dimension, scores were assigned as 1 = completely inaccurate, 2 = somewhat inaccurate, 3 = neutral, 4 = somewhat accurate, 5 = completely accurate. The overall attitude of each post was determined by calculating the average of these three scores.

2.2. Data analysis

2.2.1. Tokenization and text vectorization

In the context of Chinese language processing, the use of tokenization is a foundation for NLP. This study employs the Harbin Institute of Technology's stopwords list and Jieba for tokenization and stopword processing. Text vectorization is the core of NLP and is crucial for converting human language into data recognizable by computers. The mainstream methods include TF-IDF, word2vec, and deep learning models. This study adopts the word2vec method for text vectorization.

2.2.2. Manual annotation

To generate annotated teaching data for training and testing classification models, the author team, along with numerous undergraduates and graduate students, manually annotated a random sample of 30,064 Weibo posts using the aforementioned procedure. The quality assurance of the scoring process was conducted through observed practice sessions. Under the observation and guidance of the author team, the evaluators practiced with each other, with the corresponding author being a psychiatrist proficient in assessing autism. These 30,064 Weibo posts were randomly selected on a daily basis during the research period, based on stratified random sampling, to ensure the representativeness of the annotated data.

To assess the Inter-Rater Reliability(IRR) of manual annotation, we employed the Intra-class correlation (ICC) algorithm to calculate the reliability between manual annotation. ICCs are suitable for studies involving two or more coders. Higher ICC values indicate greater IRR, with an ICC estimate of 1 representing perfect agreement and 0 representing only random agreement. After approximately six weeks of discussion and rating, the consistency of the scoring stabilized within an acceptable range, remaining above 0.6. This is in line with the findings of Kevin's research [25], which categorizes IRR as poor for ICC values less than 0.40, fair for values between 0.40 and 0.59, good for values between 0.60 and 0.74, and excellent for values between 0.75 and 1.0.

2.2.3. Development and evaluation of machine learning models

As mentioned, each post should be assessed and rated across three attitudinal aspects, with scores ranging from 0 to 5. Our study's predictive task is framed as a multi-class classification problem for each attitudinal component. However, Li et al. indicated that multi-class classification becomes significantly more complex than binary classification as the number of categories increases, potentially leading to a sharp decline in accuracy [26]. A common strategy to address this complexity is to convert the multi-class problem into multiple binary classification problems. In our approach, we decomposed the three multi-class problems into fifteen independent binary classification problems. The goal of supervised machine learning is to accurately fit these binary classifiers. We tested several models to identify the best performer, including Random Forests, Decision Trees, K-nearest Neighbors, Support Vector Machines, and Bayesian classifiers. To evaluate the effectiveness of these models, we employed several metrics: Precision, Recall, F1 Score (the harmonic mean of precision and recall), and 10-fold Cross-Validation. The results indicated that the Bayesian classifier achieved the highest overall performance, leading us to adopt it for producing the final results, as detailed in the Supplementary Material.

Previous research indicates that machine learning classification results can indeed serve as a reference for evaluating the rationality of annotations. As Smith and Linden pointed out, the reliability of machine learning models, especially those employing supervised learning, depends on the robustness of the model and the representativeness of the training data [27]. This assertion has also been confirmed by the research conducted by Johnson and others [28].

2.2.4. Text classification based on Bayesian classifier

The Bayesian Classifier is one of the most effective theoretical models in the field of expressing and reasoning with uncertain knowledge. It first determines the probability of keywords in new texts appearing in the feature word class, then uses the Bayesian probability formula to solve for the posterior probability, and draws a classification conclusion based on the magnitude of the probability [29]. The calculation formula is as follows: Suppose a text has n features, which are $e_1, e_2, ..., e_n$. There are i categories for the text, namely $m_1, m_2, ..., m_i$. The attribute conditional independence assumption introduced by the Bayesian classifier can be represented by the following formula, $p(m_i|e_1, e_2, \cdots, e_n)p(m_i) = p(e_1|m_i)p(e_2|m_i)\cdots p(e_n|m_i)p(m_i)$. The category to which an individual most likely belongs is the maximum posterior estimate, as shown in the following formula, $C_{MAP} = \underset{C_i \subset C}{\operatorname{argmax}} p(e_1|m_i)p(e_2|m_i)\cdots p(e_n|m_i)p(m_i)$. Each probability value on the right side of the equation can be easily calculated from known conditions, allowing for the determination of the probability of the text belonging to each category. Then, the category with the highest probability is chosen as the final classification result. All posts received scores from 0 to 5 on the Affective, Behavioral, and Cognitive dimensions. All analyses were performed in R (version 4.0.0).

3. Results

3.1. Overall attitudes expressed in the past 10 years

Table 1 summarizes the expression levels and valence of attitude comments on Weibo. The scores across the different dimensions are quite similar, ranging from the lowest at 2.813 to the highest at 3.842. The cognitive dimension scored slightly lower compared to the other dimensions. All three dimensions were frequently expressed, with the affective component being the most prevalent.

3.2. Decadal trends in attitudes toward autism

Fig. 1 illustrates the trend in attitudes of mainland Chinese Weibo users towards individuals with autism over the last decade. Over these years, there has been a steady increase in the affective, behavioral, and cognitive dimensions of Weibo users' attitudes towards individuals with autism. However, the starting point for the cognitive dimension was very low.

3.3. Weibo users'attitudes toward autism on the individual-leve

3.3.1. Gender differences

Table 2 presents descriptive statistics and results of independent sample t-tests comparing male and female subjects. The t-values indicate that males scored significantly lower than females across all dimensions. Cohen's D is a measure of effect size used to quantify the size of the average difference between two groups relative to the standard deviation. The results show that the Affective dimension falls within the large effect size range, indicating the greatest difference between genders in this dimension. Although there is a significant difference in the Cognitive dimension as indicated by the t-value, Cohen's D is in the small effect size range (Large effect size:>0.8, Medium effect size:0.5–0.8, Small effect size:0.2–0.5). This means that the difference between the two groups is smaller and, while statistically significant, may not be practically significant.

3.3.2. Age differences

Individuals who posted the relevant Weibo posts were categorized into four age groups based on their age at the time of posting: Adolescents (under 18 years), Young Adults (18–34 years), Middle-aged Adults (35–59 years), and Older Adults (60 years and above). Descriptive statistics and a one-way ANOVA were employed to compare these age groups, as detailed in Table 3. The results from Tukey's Honestly Significant Differences (HSD) test indicated distinct variations across the groups in different dimensions. In the affective dimension, Middle-aged Adults scored the highest, with Older Adults following and Adolescents scoring the lowest. Regarding the behavioral dimension, Middle-aged Adults demonstrated the strongest support for the rights of individuals with autism. In the cognitive dimension, Young Adults and Adolescents showed more accurate conceptions compared to the Middle-aged and Older Adults, with Young Adults exhibiting the highest accuracy. Overall, in terms of attitudes towards individuals with autism, Middle-aged Adults registered the highest scores, significantly outperforming Young Adults, Older Adults, and Adolescents, who had the lowest scores.

3.3.3. Education differences

Weibo users were classified into one of three education groups (primary, secondary, and higher education) and then analyzed based on the highest level of education they had attained at the time of posting relevant comments on Weibo. Comparative analysis of the three education groups was conducted through descriptive statistics and results of variance analysis, as shown in Table 4. Significant differences were found in the affective and behavioral components, as well as the overall scores. The Tukey's Honestly Significant Differences (HSD) test revealed that users with higher and secondary education demonstrated more positive emotions towards individuals with autism, more support for their rights, and a more positive overall attitude compared to those with primary education. Compared to those with secondary education, individuals with higher education levels showed more positive emotions, greater support for rights, and a more positive overall attitude towards individuals with autism. No significant differences were found in the cognitive dimension.

3.3.4. Verification type differences

Table 5 provides the descriptive statistics and results of a one-way ANOVA, which compares the three verification groups on Weibo across all attitudinal components. The analysis revealed significant differences in all three components as well as in the overall scores. Institutionally verified Weibo users consistently demonstrated more positive attitudes—or greater cognitive accuracy—compared to

Table 1
General survey results on Weibo users' attitudes towards individuals with autism.

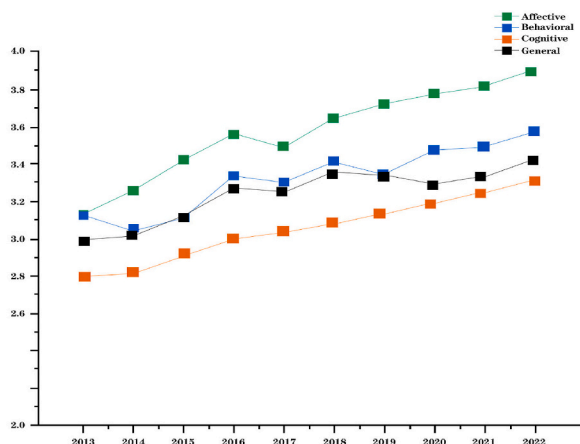| Components	Text data	M±SD	Percentage (%)
Affective	1015625	3.842 ± 1.463	91.25
Behavioral	727132	3.211 ± 1.451	65.33
Cognitive	705873	2.813 ± 1.260	63.42
General		3.220 ± 1.381	

Fig. 1. Ten-year attitudinal trends in China for Autism.

Table 2
Gender differences in Weibo users'attitudes toward Autism.

Components	Male	Female	t	Cohen's D
	M±SD	M±SD		
Affective	3.462 ± 1.411	3.583 ± 1.501	−4.563***	0.812
Behavioral	3.263 ± 1.342	3.273 ± 1.403	−3.962**	0.742
Cognitive	2.835 ± 1.133	2.933 ± 1.303	−2.034*	0.223
General	3.198 ± 1.206	3.235 ± 1.064	−4.112***	0.610

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 3
Age differences in Weibo users'attitudes toward Autism.

Components	1 Adolescents (<18 years)	2 Young Adults (18–34 years)	3 Middle-aged Adults (35–59 years)	4 Older Adults (≥60 years)	F	Multiple Comparisons	η2
	M±SD	M±SD	M±SD	M±SD			
Affective	3.501 ± 1.320	3.84 ± 1.498	4.210 ± 1.518	4.134 ± 1.312	187.59***	3 > 1,2,4; 4 > 1,2; 2 > 1	0.0029
Behavioral	3.401 ± 1.414	3.425 ± 1.471	4.421 ± 1.661	3.923 ± 1.267	275.33***	3 > 1,2,4; 4 > 1,2; 2 > 1	0.0042
Cognitive	3.141 ± 1.312	3.271 ± 1.279	2.96 ± 1.26	2.55 ± 1.102	70.16***	2 > 1,3,4; 1 > 3,4; 3 > 4	0.0011
General	3.375 ± 1.142	3.422 ± 1.120	3.592 ± 1.207	3.382 ± 1.089	127.84***	3 > 1,2,4; 2 > 1,4; 4 > 1	0.0020

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 4
Education differences in Weibo users'attitudes toward Autism.

Components	1 Elementary education	2 Secondary education	3 Higher education	F	Multiple Comparisons	η2
	M±SD	M±SD	M±SD			
Affective	3.216 ± 1.516	3.621 ± 1.501	3.601 ± 1.510	70.93***	2 > 1,3; 3 > 1	0.0015
Behavioral	3.142 ± 1.450	3.228 ± 1.478	3.343 ± 1.470	23.74***	3 > 1,2; 2 > 1	0.0005
Cognitive	2.871 ± 1.229	2.689 ± 1.318	2.977 ± 1.272	3.27		
General	3.018 ± 1.120	3.233 ± 1.122	3.486 ± 1.150	33.19***	3 > 1,2; 2 > 1	0.0007

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 5
Verification type differences in Weibo users'attitudes toward Autism.

Components	1 Unverified	2 Personal verification	3 Institutional verification	F	Multiple Comparisons	η2
	M±SD	M±SD	M±SD			
Affective	3.462 ± 1.546	3.471 ± 1.48	3.81 ± 1.51	1558.20***	3 > 1,2	0.0048
Behavioral	3.125 ± 1.246	3.375 ± 1.43	3.42 ± 1.46	370.69***	3 > 1,2; 2 > 1	0.0012
Cognitive	2.816 ± 1.228	2.985 ± 1.32	3.08 ± 1.33	793.24***	3 > 1,2; 2 > 1	0.0025
General	3.110 ± 1.089	3.291 ± 1.05	3.44 ± 1.09	1505***	3 > 1,2; 2 > 1	0.0046

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

those categorized as personally verified or unverified. In contrast, personally verified users generally showed more positive or accurate attitudes than unverified users, although no significant difference was observed in the affective component.

4. Discussion

Regarding research questions 1 and 2, we discovered that the overall attitude of Weibo users towards the autistic community, including its three dimensions, is relatively positive and has steadily increased over time, with the cognitive dimension scoring the lowest. The scores for the cognitive dimension are the lowest. This aligns with the findings of Wei and others, indicating that there is a persistent lack of cognitive of ASD among the Chinese public, including professionals who interact directly with individuals with ASD. This gap underscores the necessity for targeted educational programs and training projects for parents, caregivers, educators, and medical professionals [30,31]. A study focusing on parents of children with autism in China revealed that despite improvements in social acceptance and support, significant challenges still remain in the cognitive understanding of autism [32].

One possible explanation for the steady improvement in attitudes towards individuals with autism might be linked to socio-economic development. Research underpinning modernization theory has established a significant connection between socio-economic progress and value transformation [33], including shifting perceptions related to autism [34]. Inglehart and others have posited that in very poor countries, residents primarily focus on basic survival needs. However, as a country becomes wealthier, its citizens increasingly prioritize personal freedoms, quality of life, and tolerance for individual differences [33]. Since the reform and opening up, China has undergone significant positive changes in its socio-economic, political, cultural, and environmental aspects alongside rapid economic development. Accordingly, the Chinese people have become increasingly concerned with cultural values and personality development. The Chinese government has provided better protection and support for individuals with autism by enacting and improving relevant laws and regulations. For example, the revision of the "Law on the Protection of Persons with Disabilities" in China has enhanced the protection of the rights and interests of individuals with autism. Professional training for medical and educational workers has been strengthened to improve their ability to recognize, diagnose, and intervene in autism. At the same time, the government has invested more resources in research and intervention projects on autism in the fields of education and healthcare. Through policy support and collaborative projects, employment opportunities and vocational skills for individuals with autism have been enhanced, increasing societal acceptance of adults with autism. Additionally, the increasing involvement of non-governmental organizations (NGOs) in advocacy and education, as observed by Chen and others, has played a crucial role in creating a supportive environment for individuals with autism and their families. These NGOs are essential in bridging the gap between the autism community and the general public and promoting better understanding and acceptance [35].

Increased exposure to individuals with autism may be another contributing factor to reducing prejudice. According to Allport's contact hypothesis, under certain conditions, intergroup contact can effectively decrease prejudice towards minorities [36]. Similarly, the parasocial contact hypothesis suggests that one-sided relationships with media characters can lead to more favorable attitudes towards minority groups when positive information about these groups is presented in the media [37]. This type of contact, including interactions on social media platforms, underscores the significance of engaging with minority groups to combat prejudice [38]. Frequent exposure to images of individuals with autism or direct intergroup interactions can foster more tolerant and positive attitudes towards them [39]. In China, Weibo, a leading social media platform, plays a crucial role in spreading awareness about autism through various mediums such as films, TV shows, advocacy, news, and literature. The platform's widespread use significantly enhances both direct and parasocial interactions with autistic individuals. Moreover, the increasing public discussions about autism and the extensive internet penetration in China are likely to cultivate more accepting attitudes towards individuals with autism.

Concerning research question 3, our study uncovers significant differences in attitudes among public towards individuals with autism, varying across individual variables such as gender, age, education level, and verification status.

The more positive attitude of women towards individuals with autism may be influenced by inherent gender differences in social behavior and drives. From an early age, girls often show a stronger interest in social interactions and human faces, along with more prosocial behaviors compared to boys [40]. This tendency could extend to their perceptions of individuals with autism. Gender differences in socialization, empathy, and caregiving roles contribute to this phenomenon. Women are typically socialized to be more nurturing and empathetic, traits that are conducive to forming positive attitudes towards individuals with special needs [41]. Additionally, studies indicate that women generally exhibit higher levels of empathic concern, which can lead to more favorable views and interactions with the autism community [42].Traditional caregiving roles, often assumed by women, may also play a role. These roles demand qualities like patience, understanding, and adaptability, which are valuable in interactions with individuals with autism [43]. Therefore, these factors combined – socialization, empathy, and caregiving roles – significantly influence women's more positive

attitudes towards the autism community.

Middle-aged adults often demonstrate more favorable attitudes towards individuals with autism than their younger counterparts, a phenomenon influenced by several factors including life experience, maturity, and exposure to diversity. Firstly, middle-aged individuals usually have a wealth of life experiences, fostering greater empathy and understanding. This broad exposure to various life situations and demographics, including individuals with disabilities, tends to cultivate more accepting and compassionate perspectives [44].Additionally, maturity and emotional development, attributes that typically enhance with age, can lead to more patient and tolerant attitudes towards individuals with autism [45]. Moreover, middle-aged adults are likely to have personal encounters or media exposure related to autism, which can increase their awareness and decrease stigmatization associated with the condition [46]. Collectively, these elements - life experience, maturity, and a greater exposure to diversity - are integral in shaping the more positive attitudes of middle-aged individuals towards the autism community.

Individuals with higher education levels often display more positive attitudes towards individuals with autism compared to those with lower educational backgrounds, influenced by various factors. First, higher education usually involves exposure to a wide range of perspectives and ideas, which promotes tolerance and understanding of differences, including those pertaining to autism [47]. This educational experience often includes specific learning about disabilities, thereby reducing misconceptions and stigmatization [48]. Moreover, higher education is linked to the development of critical thinking skills that enable individuals to challenge stereotypes, leading to more nuanced and informed views of individuals with autism [49]. Additionally, those with higher education levels are more likely to have access to diverse information and resources about autism, further enhancing their understanding and empathy towards those on the autism spectrum [50].Collectively, these factors suggest that the expansive perspectives gained through higher education, specific disability education, enhanced critical thinking, and increased access to information significantly contribute to the more positive attitudes of highly educated individuals towards the autism community.

Observations indicate that opinion leaders, particularly institutionally verified Weibo users, demonstrate more favorable attitudes and accurate understandings of individuals with autism. However, this finding might be influenced by social desirability bias. Verified users, under pressure to align with mainstream values and maintain their follower base, may tend to post more positive comments. A significant volume of autism-related comments from institutional users, such as official mass media accounts, international organizations, and autism charities, exhibit supportive attitudes. These positive attitudes likely reflect genuine efforts to combat discrimination and enhance autism awareness rather than merely adhering to social desirability norms. In contrast, the attitudes of personally verified users might still be influenced by social desirability bias. However, our methodology effectively mitigates this bias more than traditional survey methods. Firstly, the analyzed Weibo posts represent spontaneous expressions of opinion, recorded in a continuous, non-intrusive manner, making them less prone to social desirability influences [51]. Secondly, our approach uses objective text data from Weibo users, collected without direct or indirect interactions, thereby eliminating biases that might be introduced by the researcher's influence or the subjects' perceptions of the research aims.

5. Conclusions

Based on an analysis of 1,113,014 Weibo posts related to the autistic community from January 1, 2013, to December 31, 2022, we investigated the current status, trends, and characteristics of attitudes towards the autistic community among Weibo users. Our goal was to gain a comprehensive understanding of the views of the Chinese public towards this group. Our methodology incorporated both "horizontal" and "vertical" analyses using a substantial and objective dataset of Weibo texts. The horizontal analysis examined attitudes at an individual level, while the vertical analysis focused on how these attitudes have evolved over the past decade. This dual approach highlights the potential of integrating natural language processing, big data, and machine learning technologies in psychological research. We found that the overall attitude of Weibo users towards the autistic community is relatively positive and has shown a steady improvement over time, with the cognitive dimension scoring the lowest. Significant differences were also observed in individual-level variables such as gender, age, education level, and verification status. To effectively reduce and eliminate public discrimination and prejudice against the autistic community, it is essential to implement continuous and targeted measures based on our findings at various levels.

The study, however, has some limitations that necessitate further improvements. Firstly, while our classification of Weibo text data strives for accuracy, it requires further optimization. The artificial attitude annotations used in our automatic classification training dataset were based on external assessments rather than users' self-evaluations, which might not accurately capture the true sentiments of Weibo users. Secondly, the absence of personal data for some users restricted the utilization of certain data segments. Additionally, considering the limitations of the Bayesian classifier model, which categorizes texts into five distinct classes, we recognize the potential of more advanced deep learning models, such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Pretrained Language Models, for more nuanced emotion recognition. Future research will focus on exploring these sophisticated models to achieve a finer analysis of emotions.

Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations. All experimental protocols were approved by the Ethics Committee of Wuhan Institution of Bioengineering(ID:J20221013). Informed consent was obtained from all subjects and/or their legal guardian(s).

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

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CRediT authorship contribution statement

Xiaowen Li: Writing – original draft, Software, Conceptualization. **Hao Xu:** Writing – review & editing, Conceptualization. **Jun Zhang:** Resources, Conceptualization.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e35113.

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