Public psychological distance and spatial distribution characteristics during the COVID-19 pandemic: a Chinese context

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Abstract

The COVID-19 pandemic is a public health emergency, which continues to have a significant impact on the functioning of society and the public's daily life. From the perspective of psychological distance (PD), this study used descriptive, differential, and spatial autocorrelation analysis methods to explore the cognitive distance, emotional distance, expected distance and behavioral distance of the Chinese public in relation to the COVID-19 pandemic. An analysis of 4042 valid sample data found that: (1) The event emotional distance and subject emotional distance were both furthest from the event and subject psychological distance dimensions, and anger about the event was the strongest. (2) The government was the most appealing subject in the process of pandemic prevention and control, but at the same time, the public's sense of closeness to the government was also lower than that of the other three subjects, e.g., medical institutions. (3) Different pandemic regions showed significant differences in PD. Mean scores of PD in each risk region were as follows: High-risk regions > medium-risk regions > low-risk regions. (4) From a global perspective, no spatial autocorrelation was found in PD. However, from a local perspective, high-value regions (provinces with distant PD) are mainly concentrated in the southern regions (Guizhou, Guangxi, Hainan, Jiangxi), and low-value regions (provinces with close PD) are mainly concentrated in North China (Shanxi, Hebei, Beijing). Combined with the relevant conclusions, this paper put forward policy recommendations.

Keywords Psychological distance · COVID-19 · Spatial distribution characteristics · China

Introduction

The global pandemic of COVID-19, which first emerged at the end of 2019, not only affected the lives of hundreds of millions of families, but also disrupted the normal rhythm of economic and social functioning, and caused severe economic losses (Chen & Fu, 2020). Some decisive measures that were taken during the fight against the pandemic, such as city closures, travel restrictions, and social distancing caused, to a certain extent, a sense of psychological panic and other negative emotions among the public (Le et al., 2020). This situation may even lead to a deviation in terms of the public's emotions and perceptions of the pandemic, which is not conducive to pandemic prevention and control and post-pandemic reconstruction. Therefore, it is imperative to understand the public's social and psychological needs as well as the real psychological state of the public during the COVID-19 pandemic, so as to stimulate the public's engagement and attention to public health emergencies. However, to date, little discussion of this subject has taken place. Studies have shown that psychological distance (PD) encourages cooperation (Agerström & Björklund, 2009) as well as consistency of value and behavior in social decision-making (Giacomantonio et al., 2010). Therefore, this study introduced PD to investigate public cognition of the COVID-19 pandemic to understand the level of public attention and engagement throughout the event, and to examine the closeness and distance between the public and the pandemic event/subject.

In 1912, the Swiss psychologist Edward Bullough first proposed the concept of PD, and applied it to the principles of aesthetics, which means that a sense of beauty arises from PD between the viewer's subjective perception and a work of art (Bullough, 1912). As social processes evolve, so too does

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the study of PD, which has a broad impact on multiple aspects of people's lives, including cognitive decision-making, social communication, interpersonal trust, consumer psychology, social behavior, and so on. Scholars like Chen and Li introduced the concept of PD into the field of organizational management and public health research (Chen & Li, 2018; Li et al., 2019). From the perspective of organizational management, Chen and Li (2018) used a combination of qualitative and quantitative research to develop the Employee-Organizational Psychological Distance Scale, which defined PD as a subjective judgment of distance in which employees predict, evaluate, and act on the organization based on the degree of acceptance and actual willingness to pay, and this scale helps to determine the degree of fit or integration between the subject and the perceived object. From the perspective of public health, Li et al. (2019) defined the public's PD to occupational safety and health as the public's subjective perception of closeness and distance based on their knowledge and awareness of occupational safety and health issues, and the resulting behavior promotion tendency for solving occupational safety and health problems.

Based on the background of COVID-19 pandemic, this study defined PD as the individual's perception of the core relationship between the pandemic event and the subject after integrating various types of information, as well as the resulting emotional experience and evaluation of decision-making responses.

By concentrating on two aspects, i.e., the event and subject, in relation to the COVID-19 pandemic, this study further divided PD into event psychological distance (EPD) and subject psychological distance (SPD). EPD refers to an individual's PD to the COVID-19 pandemic event itself. SPD refers to the PD between the individual and the subjects involved in the pandemic (e.g., medical institutions, government, market entities, social organizations). EPD and SPD can be further subdivided into (event/subject) cognitive distance, emotional distance, expected distance, and behavioral distance. Among them, (event/subject) cognitive distance refers to the public's awareness of knowledge about the pandemic, and the level of attention paid to the pandemic subject's behavior. (Event/Subject) Emotional distance refers to the public's emotional perception of the pandemic event and the subject. (Event/Subject) Expected distance refers to the public's perception and judgment based on existing experience or information about the development of a future pandemic event and the behavior of the subject. (Event/Subject) Behavioral distance refers to the public's perception of intimacy and distance in relation to the behavior of participating in pandemic prevention and control.

The pandemic situation in different regions of China is obviously different, and the number of confirmed cases in Hubei Province is much larger than that of other pandemic regions. The pandemic situation in different regions would

significantly affect the psychological state of the public (Xu et al., 2020). Research on the spatial distribution characteristics of the public's PD can provide an in-depth understanding of the public's psychological intimacy and distance to the pandemic event and the subject psychological distance, as well as its spatial aggregation state, in order to determine the relationship between different demographic variables and PD, and the different characteristics of PD in different regions. It is helpful to compare and evaluate the distribution characteristics of PD in different pandemic regions in China, and to provide a reference for differentiated emotional governance and construction. Current research on the spatial distribution characteristics of distance focused on spatial distance, institutional distance, and travel distance, while less research has been conducted on the spatial distribution characteristics of PD for a particular public health event. Based on this, according to the pandemic situation in China, this study divided the regions into high-risk regions (cumulatively confirmed cases >1000), medium-risk regions (100 < cumulatively confirmed cases ≤1000), and low-risk regions (cumulatively confirmed cases ≤100), and carried out spatial exploratory analysis and spatial correlation analysis of the PD in different regions.

This study aimed to address the following research problems: (1) What were the characteristics of PD in China during the outbreak period? (2) Although the four dimensions of temporal, spatial, social, and hypothetical PD are widely adopted by academics, there are other dimensions of PD in some special situations. What are the dimensions of PD during the COVID-19 pandemic? (3) What differences in PD are observed in different pandemic risk areas? Which areas are psychologically far away? The innovative contributions of this study are as follows: (1) This study conducted a large-scale empirical investigation to explore the differences and commonalities of PD and its dimensions in different regions and demographics, as well as the spatial distribution characteristics of PD. (2) Based on the COVID-19 pandemic, two primary indicators of PD are proposed: EPD and SPD.

The remainder of this paper is structured as follows: The second section presents a literature review of the connotation, structure and related theories of PD. The third section elaborates upon the logic and internal relationship of the structural division of PD in relation to the COVID-19 pandemic. The fourth section describes the methods and data that were used, and mainly details the process of collecting data and explaining the research variables. The fifth section presents an analysis of the research results, which includes a descriptive analysis, difference analysis, and spatial distribution characteristics analysis. The sixth section presents the research conclusions and discussion. The final section proposes policy suggestions based on the research conclusions.

Literature Review

Connotation of Psychological Distance

PD has been widely applied in international trade and investment (Håkanson, 2014), organizational management (Vanderstukken et al., 2019), climate change (Jones et al., 2017; Schuldt et al., 2018), social phenomena (Genschow et al., 2019), marketing (Wiebe et al., 2017), and other fields.

PD is well established in the field of international trade. Beckerman first introduced the concept of PD into the study of international trade issues in 1956 and pointed out that, as an important situational factor in cross-border cooperation, PD hinders international trade through cultural differences and affects the importance that firms attach to market information (Beckerman, 1956). Numerous scholars have since explored this area in depth, such as Vahlne and Wiedersheim-Paul (1973), who argued that PD between suppliers and customers involved in the trade process impedes the flow of information between them (Vahlne & Wiedersheim-Paul, 1973).

In the field of marketing, PD refers to a consumer's subjective experience of the distance between an event or an object and themselves, which determines the consumer's psychological representation of the object or event, and influences consumer behavior (Li & Yang, 2017).

In the field of public health, PD refers to the public's PD to occupational safety and health, which is based on the public's knowledge and awareness of occupational safety and health issues, and the resulting behavior promotion tendency for solving occupational safety and health problems (Li et al., 2019).

In the field of social psychology, two definitions have been widely used. Agnew et al. (2004) pointed out that PD is the subjective perception of the distance between the individual and the self, intimately generated by the individual after integrating various types of information received, and the resulting emotional experience. It emphasizes that the individual's perception of distance to the target is a subjective experience and the reference point of distance is the observer himself. According to Trope and Liberman (2010), as a social psychology term, PD is a subjective experience; an individual's perception of the closeness or distance of another individual or group in relation to feelings, attitudes, and behaviors. Those who are distant are psychologically distant, and those who are close are psychologically close. At the same time, they believe that all forms of PD are self-centered and have a common zero distance. Thus, PD is defined as the degree to which the target object differs from the individual's current direct experience in terms of dimensions such as time, space, social, or hypotheses (Liberman & Trope, 2014).

In summary, the definitions of PD from different research perspectives ultimately fall on the same starting point, that is, the individual's perception of events or behavioral subjects is self-centered. The individual first perceives and understands the core relationships of events or other subjects, and then decides to act in accordance with their own judgment.

Dimensions and Measurement of Psychological Distance

In regard to the division of PD dimensions, the academic community mainly conducts research from the perspectives of international trade, organizational context, public affairs and social psychology.

Based on the trade perspective, the most widely respected classification of PD is Dow and Karunaratna's (2006) classification, which divided it into five dimensions, i.e., language differences, religious differences, education levels differences, government levels differences and industrialization levels differences.

Based on the organizational context, Chen and Li (2018) divided PD into six dimensions, i.e., experiential distance, behavioral distance, emotional distance, cognitive distance, spatiotemporal distance, and objective social distance in their study of employee-organizational PD. Experiential distance refers to the employees' perception of the organization's future expectations based on their experience of the existing or trending judgment. Behavioral distance refers to employee perceptions of organizational intimacy and distance in "profitable organization" behavior. Emotional distance represents the employee's perception of emotional closeness and mingling with the organization. Cognitive distance is the perceived level of closeness to the organization in terms of value orientations and personality congruence exhibited by employees. Spatiotemporal distance refers to the closeness and distance perception of the organization that employees develop in time and space based on their level of understanding and involvement. Objective social distance refers to employees' closeness and distance perception of an organization based on similarities in regard to the attribute characteristics of the population.

From a public affairs perspective, Li et al. (2019) constructed a four-dimensional structure of occupational safety and health PD, and explored public attitudes and reactions towards occupational safety and health issues from four aspects: cognitive distance, emotional distance, expected distance, and behavioral distance. Cognitive distance refers to the public's perception and awareness of occupational safety and health related knowledge. Emotional distance refers to the public's perception of the degree of emotional closeness and integration of occupational safety and health issues. Expected distance refers to the public's perception of the future expectations of occupational safety and health issues based on existing experience or the judgment of tendency. Behavioral distance refers to the public's closeness and distance perception of participating in occupational safety and health governance.

Based on the perspective of social psychology, the dimensions of PD are mainly divided into spatial distance, temporal distance, social distance and hypothesis. Spatial distance is the intimacy and distance of the perceiver to the target object. Temporal distance is the time interval between an individual's present and the target object in the past or future. Social distance is the intimacy and distance of the perceiver to the social object. Hypothesis refered to how likely it was that the target event would occur based on the subjective experience of the perceiver (Baranan et al., 2006). Although the four dimensions of temporal distance, spatial distance, social distance and hypothesis are currently widely adopted by academics, Liberman et al. (2007) believed that, in addition to the four dimensions, there should be other dimensions of PD.

Theories Related to Psychological Distance

PD can be understood in terms of theories such as psychosocial distance theory and self-other representations theory, which are used to describe the closeness and distance between individuals in real life. The self-other representation theory includes two views, namely, shared representations (Prinz, 1990) and specific representations. A shared representation means that the subject's representation of the self and other are mutually integrated, and information about others is also a part of the self. A specific representation means that the subject is relatively independent of self-representations and other-representations (Ruby & Decety, 2001). However, in a real situation, some psychological phenomena cannot be explained by the existing theory of PD: Trope and Liberman (2010) proposed Construal Level Theory (CLT).

The initial form of CLT is the time construal level theory, which basically posits that time is one of the dimensions of distance. Based on an individual's present experience, and due to different perceptions of the past and future in relation to the target object, there are different levels of interpretation, which in turn result in different behavioral decisions. The mechanism underlying the reason as to why distance affects the construal level is related to an individual's perception of the reliability of the information obtained. When PD is greater, the individual believes that the information received and acquired during the distance change is less credible. When the distance becomes closer, the individual perceives that the information received is more reliable, more detailed and more visible. Subsequently, scholars gradually extended the theory to three dimensions including spatial distance, social distance and hypothesis, which finally formed a systematic psychological distance theory.

CLT is regarded as one of the most important theoretical achievement in the field of social psychology in recent years, and its "pure cognitive orientation" has laid the foundation for a large number of subsequent experimental studies (e.g., Dhar & Kim, 2007; Breves & Schramm, 2021; Miao & Mattila, 2013). CLT suggests that an individual's response to a cognitive object depends on his or her mental interpretation of that object. It proposes that the individual's level of interpretation of an object is closely related to his or her PD from the object. Therefore, we can derive the basis for CLT: Individuals who perceive a greater PD form more abstract and simple representations of things, whereas individuals who perceive a close PD form more concrete and complicated psychological representations of things. PD representations help people to make more confident predictions about the future, and to make clearer evaluations and behavioral choices (Liberman & Trope, 2008).

In other words, PD affects an individual's perception of their closeness and distance to things, which then influences their decision-making behavior. The farther the PD, the greater the deviation between the individual's cognition and the actual situation; and, the higher the level of interpretation, the less the amount of consideration given to the specific situation. Conversely, individuals tend to interpret at a low level, and they are more inclined to make judgments in specific situations. Based on CLT, this study believed that if the public perceived the PD of the COVID-19 pandemic as being far away, then it may be just an abstract concept, which would cause the public to perceive ambiguity and uncertainty about the pandemic. When the public is close to the pandemic, people will participate in the pandemic prevention and control measures by demonstrating specific behaviors.

The Structural Dimension of Psychological Distance under the COVID-19 Pandemic

Structural Division of Psychological Distance

Li and Hu (2015) pointed out that the basis of individual judgement is knowledge about risk, which plays an important role in risk perception when investigating public risk perception. When discussing the public's awareness of the disease during the COVID-19 pandemic, Luo et al. (2020) believed that awareness of the pandemic was based on the level of understanding of relevant knowledge, including the disease characteristics, related risk factors, and preventive measures. Therefore, this study suggests that cognition, at the event level, refers to the public's understanding of the causes, symptoms, cases and related preventive measures during the pandemic event. At the subject level, it refers to the level of public attention paid to the government, medical institutions, market entities, and social organizations. The public's cognition of the pandemic event and the subject is a reflection of its intimacy and distance in relation to the PD of the pandemic. (Event/subject) Cognitive distance can be used as a measurement dimension to determine the (event/subject) psychological distance.

Emotions represent an individual's attitudes and experiences in relation to whether or not an objective thing meets his or her needs (Abrahamse et al., 2005). If the objective thing meets the individual's needs, they will exhibit a welcoming attitude, which tends to be reflected by emotions such as love, pleasure, and happiness. If it does not meet the individual's needs, the individual will demonstrate an attitude of rejection, which can manifest in the form of emotions such as depression, hate, and anger. This study suggests that emotions, at the event level, reflect the public's anger about the pandemic event, or the feeling of relief as a result of how the pandemic event was managed, and concern about the pandemic event. At the subject level, emotions refer to the public's sense of closeness to the government, medical institutions, market entities and social organizations. This study took the public's emotional distance in relation to the COVID-19 pandemic as a measurement dimension of (event/subject) PD, and examined perceptions of intimacy and distance in terms of the pandemic event and the subject.

Expectation refers to the estimation of future events. From the perspective of actual behavior, an expectation refers to the process by which subjects make specific behavioral decisions based on their judgment of information acquired about the future (Li et al., 2019). This study suggests that an expectation, at the event level, refers to the public's perceptions and judgments about pandemic resource security, administrative measures, pandemic prevention techniques and social recovery, based on existing experience or the information framework. At the subject level, it refers to the public's confidence in the government's ability to govern, the effectiveness of prevention and control measures formulated by medical institutions, the participation of market entities and the assistance provided by social organizations. The public's expectations of the pandemic event and the subject reflects its intimacy and distance in terms of PD to the pandemic. The (event/subject) expected distance can be used as a measurement dimension to determine the (event/subject) psychological distance.

Behavior represents all purposeful activities that are performed by an organization or an individual, i.e., what they do. Chen and Li (2018) used behavioral distance to describe employees' perceived closeness and distance to the organization in terms of "pro-organization" behavior when describing the relationship between employees and the organization. In this context, behavior mainly refers to organizational citizenship behavior, which represents the employee's willingness to act outside of their job duties for the sake of the organization. This study suggests that behavior, at the event level, refers to the public's sense of intimacy and closeness when it popularized knowledge about pandemic prevention and participated in donations and other activities. At the subject level, it refers to the level of coordination shown by the public when cooperating with the government, social institutions, market entities and social organizations. This study incorporated (event/subject)

behavioral distance into one of the measurement dimensions to determine the (event/subject) psychological distance.

Wang et al. (2019) argued that PD can be defined as the subjective perception of the distance between the self and some objects, events or people. In summary, this study divided PD into EPD and SPD, taking into account the two dimensions of event and subject in relation to the COVID-19 pandemic. EPD refers to an individual's subjective feelings, expectations, and decision-making/judgments about the pandemic event. SPD refers to an individual's proximity, expectation, and decision-making distance to the various subjects involved in the pandemic. According to different dimensions, EPD and SPD were divided into (event/subject) cognitive distance, emotional distance, expected distance, and behavioral distance.

Structural Relationships of Psychological Distance

EPD and SPD are both forms of PD, but they are studied from different perspectives or levels, and they are in a parallel relationship.

Cognition and Behavior Cognition is the logical starting point for public psychological research in emergencies. In the field of risk research, risk perception has a significant influence on the public's response behavior. In the case of sudden catastrophic events, the public's worries and concerns about risk often prompt people to adopt various response behaviors to avoid and reduce risk hazards, so as to relieve inner anxiety and stress. Studies on the COVID-19 pandemic have shown that public awareness is associated with good protective behavior, where the level of awareness includes knowledge of the transmission route of COVID-19, epidemiological characteristics such as disease symptoms, etiological characteristics such as virus type, and effective measures to prevent the virus (Qi et al., 2020). The higher the public's awareness of infectious diseases, the more likely people are to adopt correct and timely health-related behaviors. In exploring the relationship between social members' perceptions of disease and pandemic prevention behaviors, Zhou and Li (2018) found that an individual's perceptions of disease can affect their self-management and treatment compliance, which in turn, directly affects social members' pandemic prevention behaviors and public health security.

Emotions and Behavior Emotions contribute to high levels of behavioral decision making (Dolan, 2002). A large amount of evidence shows that cognitive and emotional factors play a major role in the public's response to emergencies. For example, studies have shown that in relation to emergency situations, public perception and emotions can predict their behavioral responses. In general, the closer the emotional distance, the greater the concern about the event

and the changes that occur as result of the event. Correspondingly, the level of attention and communication behavior in the area of social public opinion may also change (Zhang et al., 2016). In the field of environmental research, a correlation was found between environmental emotions and environmental behavior (Chan & Lau, 2000). Green cognition and green emotions significantly influence green behavior.

Expectation and Behavior In the field of health research, an individual's expectation of health status can significantly influence farmers' enrollment behavior (Zheng et al., 2020). In the field of economics, Zhang and Li (2016) found that realtors' house price expectations had an important influence on their behavior in the land market when they discussed house price expectations, land prices, and the behavior of realtors. Sparks and Raats (1998) assessed the relationship between people's attitudes, behaviors, and beliefs in the context of health and safety incidents by applying the Theory of Planned Behavior, which is based on the assumption that people's behavior is indirectly influenced by a range of complex factors and predictions of behavioral intentions. Attitudes toward emergencies are determined by behavioral beliefs and outcome assessments. Furthermore, behavioral beliefs and outcome assessments include personal expectations about emergencies, the probability of the event occurring, and expected value orientations.

In respect to the relationship between emotions and expectations, emotions and expectations can be seen as a manifestation of public attitudes and they reflect the PD in attitudes in relation to the COVID-19 pandemic. Therefore, the logical relationship between cognitive distance, emotional distance, expected distance, and behavioral distance can be understood in terms of "cognition-attitude-behavior". According to the theory of interpersonal behavior (TIB), there are three salient conditions for the formation of behavioral intentions: attitudes or perceived value of expected results, social factors, and emotional factors or emotional responses. According to the widely influential theory of knowing, feeling, and acting in psychology, the three basic elements that determine an individual's behavior are "knowing", "feeling", and "thinking". Among them, "knowing" represents "cognition and concepts", "feeling" reflects "emotions", and "intention" represents "will" (Tao, 2005). It has been shown that public participation perceptions have a significant effect on public participation attitudes, and public participation attitudes have a significant effect on public participation behaviors, while public participation attitudes play an entirely mediating role between public participation perceptions and public participation behaviors (Li, 2013). In summary, this study constructed the structural relationship of PD in relation to the COVID-19 pandemic, as shown in Fig. 1.

Materials and Methods

Sampling Method and Sample Size

The research was divided into two stages: a pre-survey and a formal survey. The formal research was conducted February 10, 2020 (during the outbreak period), and 5012 members were invited to participate in the study which involved an online questionnaire. The participants of this research were the Chinese public. In view of the importance, representativeness, and scientific nature of the survey, this study signed an agreement with Questionnaire Star, a professional research organization in China, and commissioned it to conduct the survey in China by means of payment. In order to improve the validity of the questionnaire, the purpose of the survey was explained to the respondents in the preamble of the questionnaire, informing them that the research results would only be used for scientific research purposes and emphasizing the importance of careful and truthful completion. A total of 403 valid questionnaires were distributed during the pre-survey stage, and the PD scale was tested for reliability. Factor analysis was carried out, and the scale was revised to obtain the final questionnaire. In order to screen the data, this study eliminated the sample that stated, "I am psychologically relieved about the COVID-19 pandemic in our country" (10 points). Finally, 4042 valid questionnaires were retrieved, with an effective recovery rate of 80.6%. Due to the lack of survey data, the valid sample of provincial-level administrative regions of China did not include Hong Kong, Macao, Taiwan, and Tibet.

Measures and Instruments

Variables

Social Demographic Variables Social demographic variables included gender, age, marital status, monthly family income and educational level.

Organizational Variables Organizational variables included position level and organization nature.

Psychological Distance The PD scale was composed of an EPD scale and SPD scale. The scale structure mainly referred to the scale designed by Li et al. (2019) based on the occupational safety and health problem, and the specific items were designed in the context of the COVID-19 pandemic. 10-point Likert scale was used to measure all items. For the convenience of statistics, SPSS 22.0 was used to convert the scale into a five-point scale in the data analysis section. There are 15 items in the EPD scale and 16 items in the SPD scale. Some examples of the items were provided in Table 1.

Among them: 1) The EPD scale mainly included event cognitive distance (including four sub-dimensions: cause of
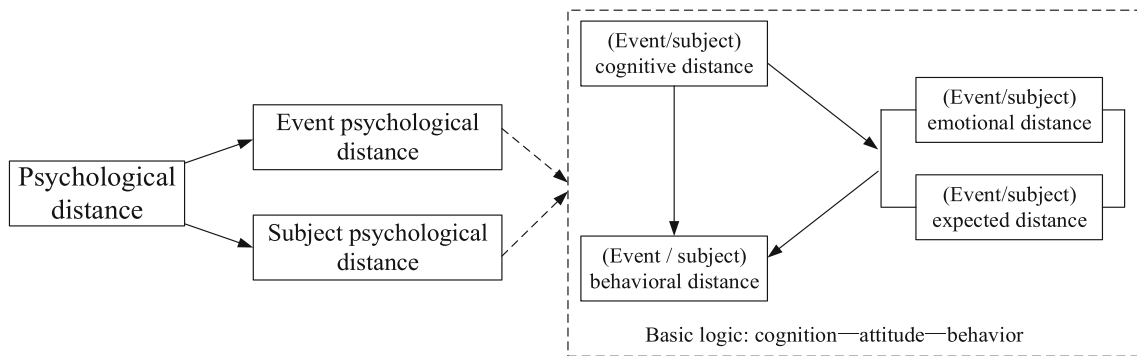
Fig. 1 Structural relationship of PD to the COVID-19 pandemic

the disease, symptoms of the disease, case status, and preventive measures), event emotional distance (including four sub-dimensions: pandemic attention, pandemic concern, anger, and comfort), event expected distance (including four sub-dimensions: pandemic resource security, pandemic administrative measures, pandemic prevention technology, and social recovery from the pandemic), and event behavior distance (including three sub-dimensions: willingness to popularize, willingness to execute, and willingness to pay).

2) The SPD scale mainly included subject cognitive distance (including four sub-dimensions: government attention, medical institution attention, market entities attention, and social organization attention), subject emotional distance (including four sub-dimensions: government closeness, medical institution closeness, market subject closeness, and social organization closeness), subject expected distance (including four sub-dimensions: government governance expectation, prevention and control expectations in medical institutions, market entities' participation expectations, and social organization assistance expectations), and subject behavioral distance (including four sub-dimensions: cooperate with the

government, cooperate with the medical institutions, supervise market entities, and supervise social organizations).

Statistical Analysis

SPSS version 22.0, GeoDa and ArcGIS software were used to analyze the data. The data analysis applied in this study mainly included descriptive analysis, difference analysis, spatial exploratory analysis, and spatial autocorrelation analysis. Qualitative variables are described in frequency and percentage terms. An exploratory factor analysis was conducted to test the reliability and validity of the scale, and then the mean and standard deviation were used to descriptively analyze the scores of each dimension of PD. For the descriptive analysis, a PD level ruler was used to classify the different levels of PD in order to compare the differences between the dimensions in a more concise and intuitive manner.

One-way ANOVA was used to test the difference between EPD and SPD in terms of demographic variables. Finally, in order to explore the spatial distribution characteristics of

Table 1 Some examples of the items

Dimension	Sub-dimensions	Some examples of the items
EPD	event cognitive distance	I have a good understanding of the cause of COVID-19.
	event emotional distance	The COVID-19 pandemic is a matter of life, and I have paid great attention to it.
	event expected distance	I think resources for the COVID-19 pandemic will be increasingly secured in the future.
	event behavioral distance	I am willing to popularize the knowledge about the COVID-19 pandemic to the people around me.
SPD	subject cognitive distance	I keep an eye on the government's management of the COVID-19 pandemic.
	subject emotional distance	The government's efforts for the COVID-19 pandemic have made me feel very close.
	subject expected distance	I think that the government will strengthen the governance of the COVID-19 pandemic in the future and the governance methods will become more and more scientific.
	subject behavioral distance	I will actively cooperate with the government to do a good job in the prevention and control of the COVID-19 pandemic.

different dimensions of PD, spatial exploratory analysis and spatial autocorrelation analysis were used to analyze PD.

Results

Descriptive Statistical Analysis

Sample Information

Table 2 shows general information related to the samples. Overall, 72.4% of the respondents were male and 27.6% were female. 24.4% of the respondents were aged 20 and below, and 63% were aged 21–35.

Reliability and Validity Test of the Scale

The PD Scale consisted of 31 items, all of which were rated using a self-report method which was based on a 10-point Likert-type scoring system that was converted into a five-grade scoring by means of SPSS version 22.0 (SPSS Inc., Chicago, IL, USA).

SPSS version 22.0 was used to test the reliability and validity of PD, as shown in Table 3. The Cronbach's α values for EPD scale and SPD scale are 0.939 and 0. 968 respectively, indicating that the scales passed the reliability test. In terms of validity, the content validity and the structural validity were tested. In this study, the PD scale was developed by carrying out a literature analysis and by referring to relevant scales. The scale was then modified to take into account the realities of the pandemic. At the same time, the scale was further tested and revised by conducting preliminary research. Thus, it can be concluded that the PD scale in this study has good content validity. In terms of its structural validity, the Kaiser-Meyer-Olkin (KMO) value, Bartlett's test of sphericity, and explanatory variance of items were used to test the scale. The KMO value of both subscales was more than 0.9, and the sig. Value

of Bartlett's test was 0.000, which showed that the scale had higher validity.

Descriptive Analysis

Based on the public's psychological proximity and distance to the COVID-19 pandemic event and the subject, mean values were categorized according to the order of their proximity and distance at the "integrated" level [1 point-2 points), the "touching distance" level [2 points-3 points), the "existence" level [3 points-4 points), and the "exclusion" level [4 points-5 points] (Li & Chen, 2019). The integrated level means that the public is always concerned about the COVID-19 pandemic and can actively participate in the fight against the pandemic by their thoughts and actions. The touching distance level means that the public has a high level of attention and investment in the COVID-19 pandemic, and can even participate in the fight against the pandemic at the expense of its own interests. The existence level means that the public does not actively pay attention to the COVID-19 pandemic and adopts a more passive method of cooperating with the authorities in the fight against the pandemic. The exclusion level refers to the public's psychological state of resistance to the COVID-19 pandemic and their refusal to cooperate with the authorities in the fight against the pandemic (Fig. 2).

Furthermore, this study conducted a descriptive statistical analysis of the total valid sample, as shown in Table 4.

In respect to EPD, Table 4 shows that, overall, the public's expectations and behavior throughout the COVID-19 pandemic were at the integrated level, and the public had a high level of confidence in future pandemic prevention and control measures. In addition, the public showed a willingness to take active action during the pandemic, and do a good job in protecting and implementing relevant protective measures. The public's cognition and emotions about the COVID-19 pandemic were at the touching distance level, indicating that people had a strong emotional perception of the pandemic.

Table 2 Sample distribution

Gender	Frequency	Percentage	Marital status	Frequency	Percentage
Male	2926	72.4%	Unmarried	2160	53.4%
Female	1116	27.6%	Married (first marriage)	1545	38.2%
Age	Frequency	Percentage	Divorced	168	4.2%
20 and under	985	24.4%	remarry	110	2.7%
21–25	1106	27.4%	others	59	1.5%
26–30	883	21.8%	Education level	Frequency	Percentage
31–35	558	13.8%	Junior high school and below	401	9.9%
36–40	282	7.0%	High school (secondary school, vocational high school)	1048	25.9%
41–45	101	2.5%	Junior college	973	24.1%
46–50	66	1.6%	Undergraduate	1317	32.6%
over 50	61	1.5%	Master degree and above	303	7.5%

Table 3 Reliability and validity test of the PD scale

Scale	Cronbach's Alpha Coefficient	KMO value	Bartlett's sphericity test		
			Approximate chi-square	df	Sig.
Event psychological distance scale	0.939	0.966	43,558.157	105	.000
Subject psychological distance scale	0.968	0.978	59,748.356	120	.000

From the perspective of the SPD as a whole, the public's cognition, emotions, expectations, and behavior towards the government, medical institutions, market entities, and social organizations were all at the integrated level. The public is always concerned about the COVID-19 pandemic and is also very willing to cooperate with relevant subjects in respect to prevention and control work. In terms of the mean value of the cognitive distance, medical institutions < government < social organizations < market entities, indicating that the public paid the greatest amount of attention to medical institutions and the government during the outbreak period. In terms of the mean value of the emotional distance, medical institutions < social organizations < market entities < government, indicating that, at present, the public very much recognizes the efforts of medical institutions, and relatively speaking, the public's recognition of the government is not high. In terms of the mean value of the expected distance, medical institutions < government < market entities < social organizations, indicating that the public expects more from medical institutions and the government during the outbreak period, and relatively less from social organizations in the future fight against the pandemic. In respect to the mean value of behavioral distance, government < medical institutions < market entities < social organizations, indicating that the public is more willing to cooperate with the government and to take corresponding actions, and the government has a stronger appeal.

Difference Analysis

A one-way ANOVA was carried out to test the difference between EPD and SPD in relation to the demographic variables, as shown in Table 5.

Spatial Distribution Characteristics

Spatial Exploratory Analysis

(1) Regional division.

In order to explore the spatial distribution characteristics of different dimensions of PD, it was first necessary to divide China into regions. There are two main types of methods for dividing regions:

1) Existing methods of regional division. 1) Economic division. According to the National Bureau of Statistics, China is divided into four economic regions; the eastern, central, western, and northeastern regions. 2) Administrative division. China is divided into Northeast China, North China, Northwest China, East China, Central and Southern China, and Southwest China. 3) Economic zone division. It is divided into eastern coastal areas, central inland areas, and western remote areas. 4) Eight regional divisions: Northeastern China, Northern
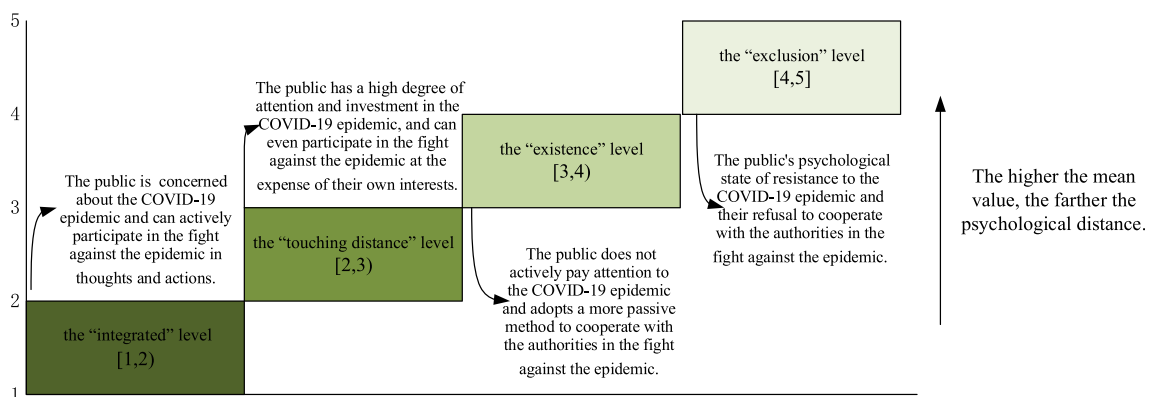
Fig. 2 PD level

Table 4 Descriptive statistics of PD

Dimensions and items	Mean	Standard deviation	Variance	Dimensions and items	Mean	Standard deviation	Variance
Psychological distance	**1.94**	0.663	0.440	**Subject psychological distance**	**1.90**	0.699	0.489
Event psychological distance	**1.99**	0.669	0.447	**Subject cognitive distance**	**1.91**	0.758	0.575
Event cognitive distance	**2.04**	0.813	0.661	16. Government attention	1.88	0.853	0.728
1. Causes of disease	2.09	0.956	0.914	17. Medical institutions attention	1.87	0.843	0.711
2. Symptoms of disease	2.06	0.922	0.849	18. Market entities attention	1.94	0.861	0.742
3. Case status	2.05	0.918	0.843	19. Social organization attention	1.94	0.865	0.749
4. Preventive measures	1.97	0.906	0.821	**Subject emotional distance**	**1.92**	0.748	0.560
Event Emotional Distance	**2.13**	0.661	0.437	20. Government closeness	1.96	0.862	0.742
5. Pandemic attention	1.92	0.897	0.805	21. Medical institutions closeness	1.86	0.838	0.703
6. Pandemic concern	1.86	0.897	0.805	22. Market entities closeness	1.93	0.846	0.716
7. Anger	2.63	1.079	1.163	23. Social organization closeness	1.91	0.860	0.739
8. Comfort	2.12	0.924	0.853	**Subject expected distance**	**1.89**	0.759	0.576
Event expected distance	**1.87**	0.764	0.583	24. Government governance expectations	1.89	0.854	0.729
9. Pandemic resource security	1.87	0.880	0.774	25. Prevention and control expectations in medical institutions	1.88	0.842	0.710
10. Pandemic administrative measures	1.86	0.864	0.746	26. Market entities' participation expectations	1.89	0.847	0.717
11. Pandemic prevention technology	1.84	0.857	0.734	27. Social organization assistance expectations	1.90	0.848	0.720
12. Social recovery from the pandemic	1.89	0.858	0.737	**Subject behavioral distance**	**1.88**	0.761	0.580
Event behavior distance	**1.90**	0.772	0.596	28. Cooperate with the government	1.85	0.846	0.716
13. Willingness to popularize	1.86	0.862	0.742	29. Cooperate with the medical institutions	1.86	0.844	0.713
14. Willingness to execute	1.91	0.869	0.755	30. Supervise market entities	1.90	0.856	0.733
15. Willingness to pay	1.93	0.900	0.810	31. Supervise social organizations	1.91	0.854	0.729

coastal Comprehensive Economic Zone, eastern coastal region, southern coastal region, Middle Yellow River region, Middle Yangtze River region, Southwest region, and Northwest China region.

2) Divide the region according to the characteristics of the research object. The distribution of PD to the COVID-19 pandemic mainly corresponds to the pandemic situation in various regions. According to the severity of the pandemic, this study divided China into three regions, i.e., high-risk regions (10,000 and above, 1000–9999 cumulatively confirmed cases), medium-risk regions (500–999, 100–499 cumulatively confirmed cases), and low-risk regions (10–99, 1–9 cumulatively confirmed cases). Table 6 shows the specific region division and the number of valid questionnaires. The sample data of Hong Kong, Macau, Taiwan, and Tibet were missing, and the data were due on February 29, 2020. At the same time, in order to determine whether the traditional division method was more suitable for the research situation, we also analyzed the spatial difference based on the four commonly used economic regions in the research process (Table 6).

(2) Spatial differences analysis of public psychological distance and its dimensions.

According to the regional division, the respective PD scores of each risk region were calculated, and the results are shown in Fig. 3.

Obvious differences were found in relation to PD. In respect to the pandemic regions, the mean value of the PD of each risk region was as follows: high-risk regions > medium-risk regions > low-risk regions. In terms of PD in the high-risk regions, Henan was at the touching distance level, while all of the other provinces in high-risk regions were at the integrated level. Among the medium-risk regions, the PD of Guangxi, Guizhou, Hainan, Jiangxi, Shaanxi, and Tianjin was at the touching distance level, and other provinces were at the integrated level. In the low-risk regions, Qinghai was at the touching distance level in terms of PD, and all of the other provinces in low-risk regions were at the integrated level. From the perspective of economic regions, Northeast China was at the integrated level in terms of PD. The PD of Tianjin in the east, Jiangxi and Henan in central China, and Guangxi, Guizhou, Shaanxi, and Qinghai in the west was at the "touching distance" level.

Table 5 One-way ANOVA results for EPD and SPD according to demographic variables

	Gender	Age	Family monthly income	Education level	Number of family members	Position level
F	38.419	11.385	16.102	35.269	6.525	13.138
Sig	.000	.000	.000	.000	.000	.000
Event psychological distance	male > female	20 and under√ over 50√	5000RMB and below√ 50,000–100,000RMB√	Junior high school and below√	1–2√	Senior management√
F	55.134	9.307	13.955	30.888	7.580	13.694
Sig	.000	.000	.000	.000	.000	.000
Subject psychological distance	male > female	20 and under√ over 50√	5000RMB and below√	Junior high school and below√	1–2√	Senior management√

"✓" represents a group whose EPD and SPD was at the "touching distance" level.

Gender. The EPD (M = 2.03) and the SPD (M = 1.95) of male groups was distant.

Age. There were significant differences between different age groups in respect to the EPD and the SPD, which showed V-shaped characteristics. The EPD (M = 2.12) and SPD (M = 2.01) in the 20 and under group were at the touching distance level. The EPD (M = 2.08) and the SPD (M = 2.00) of the 55 above group were at the touching distance level. The EPD (M = 1.77) and the SPD (M = 1.68) in the 36–40 age group were the closest, which constituted an inflection point.

Family monthly income. The EPD (M = 2.20) and the SPD (M = 2.10) of groups with a family monthly income of 5000 RMB and below were both at the touching distance level. The EPD (M = 2.08) of groups with monthly incomes of 50,000–100,000 was at the touching distance level.

Educational level. The EPD (M = 2.30) and the SPD (M = 2.21) of groups with low education levels (junior high school and below) were at the touching distance level.

Position level. The EPD (M = 2.19) and SPD (M = 2.12) of the senior management group pandemic event were at the touching distance level.

Spatial Autocorrelation Analysis

Spatial autocorrelation mainly refers to the degree of correlation between a certain attribute value in a geographic spatial area and the same attribute value in its adjacent spatial area. The spatial autocorrelation coefficient is usually used as a basic measurement index to test whether a certain attribute value in a unit area is geographically clustered (Goodchild et al., 2000). Spatial autocorrelation is divided into global spatial autocorrelation and local spatial autocorrelation (Sridharan et al., 2007). In this study, the global Moran's I index was used to reflect the spatial dependence of the PD, and a local indicator of spatial association (LISA) clustering graph was used to analyze the local spatial dependence of the PD in different provinces.

The purpose of spatial autocorrelation analysis is to determine whether a variable is spatially related, and how closely related it is. The spatial autocorrelation coefficient is often used to quantitatively describe the dependence of things in space. Specifically, the spatial autocorrelation coefficient is used to measure the spatial distribution characteristics of physical or ecological variables and their influence on the field. If the value of a variable becomes more similar as the measured distance decreases, this variable is spatially positively correlated. If increasing differences are observed in the measured value as the distance decreases, it

Table 6 Division of pandemic regions

Pandemic regions	Provincial-level administrative region	Number of valid questionnaires
high-risk regions (cumulatively confirmed cases >1000)	Hubei, Guangdong, Henan, Zhejiang, Hunan	490
medium-risk regions (100<cumulatively confirmed cases ≤1000)	Anhui, Jiangxi, Shandong, Jiangsu, Chongqing, Sichuan, Heilongjiang, Beijing, Shanghai, Hebei, Fujian, Guangxi, Shaanxi, Yunnan, Hainan, Guizhou, Tianjin, Shanxi, Liaoning, Gansu	2929
low-risk regions (cumulatively confirmed cases ≤100)	Jilin, Xinjiang, Ningxia, Inner Mongolia, Qinghai	262

Fig. 3 Spatial distribution of PD

indicates a negative spatial correlation. If the measured value does not show any spatial dependence, then this variable shows spatial irrelevance or spatial randomness.

(1) Global autocorrelation

Global spatial autocorrelation was used to verify the spatial pattern of the entire study area, and to describe the degree of spatial dependence of related variables in the entire area. The global Moran's I index is often used for research. It can be expressed as follows:

$$Moran's\ I = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} \left(y_i - \overline{y}\right) \left(y_j - \overline{y}\right)}{\left(\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}\right) \sum_{i=1}^{n} \left(y_i - \overline{y}\right)^2} \quad (1)$$

Among them, W_{ij} represents the spatial weight matrix; y_i, y_j represent the observation values of i and j area respectively; and n is the number of samples in the study area. The value range of Moran's I is [−1, 1]. A value of less than 0 indicates a negative correlation, a value equal to 0 means that no correlation was observed, and a value greater than 0 indicates a positive correlation. The absolute value indicates the strength of the correlation. For the Moran's index, the standardized statistic Z can be used to test whether there is a spatial autocorrelation relationship in n regions. The calculation formula for Z is:

$$Z = \frac{I - E(I)}{\sqrt{VAR(I)}} \quad (2)$$

When the Z value is positive and significant, it means that there is a positive spatial autocorrelation, that is, similar

observations (high or low values) tend to be spatially clustered. When the Z value is negative and significant, it indicates that there is a negative spatial autocorrelation, and similar observations tend to be distributed/scattered. When the Z value is zero, the observations are distributed independently and randomly.

(2) Local autocorrelation

The local autocorrelation reflects the degree of correlation between a regional unit and the neighboring unit on the same research object, that is, the local Moran's index of each regional unit i describes the degree of spatial agglomeration between the regional unit and the surrounding regional unit. The sum of the local Moran's index of each regional unit is proportional to the global Moran's index. The local Moran's I index and LISA graph were used to analyze the local spatial autocorrelation. The local Moran's I index can be expressed as follows:

$$Local\ Moran's\ I = \frac{\left(x_i - \overline{x}\right)}{\sum_i \left(x_i - \overline{x}\right)^2} \sum_j w_{ij} \left(x_i - \overline{x}\right) \quad (3)$$

If the local spatial autocorrelation is significant, the correlation can be divided into four types according to the specific conditions of the unit itself and its neighboring units, i.e., the four quadrants: The first quadrant is "High-High"; high-value areas are also surrounded by high-value areas. The second quadrant is "Low-High"; low-value areas are surrounded by high-value areas. The third quadrant is "Low-Low"; low-value areas are still low-value areas around them. The fourth quadrant is "High-Low"; high-value areas are surrounded by low-value areas.
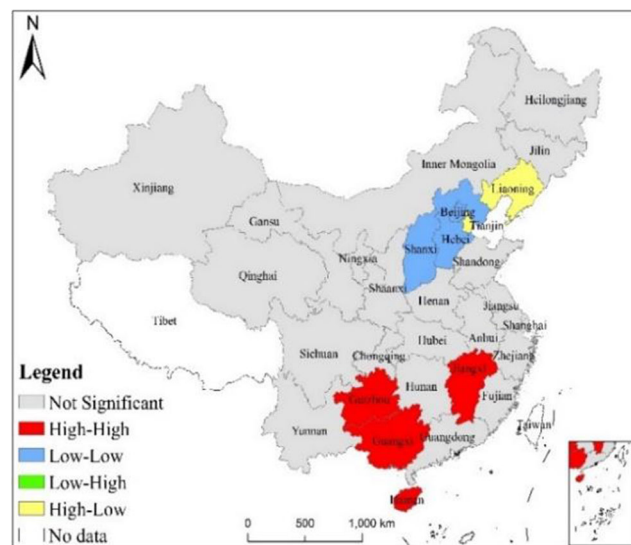

Fig. 4 LISA

(3) **Spatial autocorrelation test of public psychological distance.**

Global spatial autocorrelation and local spatial autocorrelation are based on the overall and local detection of the distribution of spatial objects, and the determination of spatial relations requires consideration of the spatial weight matrix. Different spatial weights correspond to different spatial relationships, which contributes to differences between the global and local spatial autocorrelation analysis of spatial objects. This paper took the PD of each province as the research object, and applied global and local spatial autocorrelation analysis methods to construct an inverse distance matrix, i.e., the spatial position relationship of the two provinces is reflected by their distance, and the threshold was the software default suggested value. This study calculated the global Moran's I index according to the formula. The standardized statistic $Z(I)$ of the test and the critical P value of the significance level were calculated. The results showed that the global Moran's index of PD in 30 provincial administrative regions in Mainland China was positive, but close to 0 ($I = 0.0178$). Thus, the correlation was weak. In the normal distribution hypothesis, $P > 0.1$ ($P = 0.207$), the result of the global Moran's index test was not significant.

Above all, the autocorrelation of PD was weak, and almost no spatial autocorrelation was found. However, from the local autocorrelation shown in Fig. 4, it can be seen that the high-high agglomeration region is concentrated in the South China (Guizhou, Guangxi, Hainan, and Jiangxi), the low-low agglomeration region is concentrated in North China (Shanxi, Hebei, and Beijing), and the high-low agglomeration region is concentrated in Tianjin and Liaoning.

Conclusion and Discussion

(1) **The public's expectations and behavior in relation to the pandemic were at the integrated level, while the public's cognition and emotions were at the touching distance level. The public's cognition, emotions, expectations, and behavior in relation to pandemic subjects (i.e., government, medical institutions, market entities, and social organizations) were at the integrated level.**

One study classified the dimensions of individual knowledge of COVID-19 as knowledge about transmission routes, the confidence level in diagnoses, and the satisfaction with COVID-19 health information, and concluded that dissatisfaction with available health information about the COVID-19 pandemic was significantly associated with higher Integrated Health Survey (IES-R) scores and Psychosocial Support System (DASS) stress subscale scores (Wang et al., 2020b).

The cognitive distance of this study consisted of two parts, the first of which examined the event cognitive distance, which mainly refers to the public's awareness of knowledge related to pandemic events (i.e., the public's awareness of the causes, symptoms, cases and preventive measures); the second part involved subject cognitive distance, which mainly refers to the public's perception of the level of attention that is paid to the behavior of pandemic subjects (i.e., the level of attention paid to the government, medical institutions, market subjects and social organizations). From the results of the descriptive analysis, it can be seen that the public's event cognitive distance was greater than the subject cognitive distance, such that the public's awareness of preventive measures is greater than that of the causes and symptoms of COVID-19. This study found that the public was highly concerned about the pandemic and maintained a positive attitude about the progression of the pandemic. The public also showed a behavioral willingness to engage in practical measures to prevent and control the pandemic. The sizeable distance observed between event cognition and emotion can be explained by the following two aspects: On the one hand, it can be attributed to the priming effect and schematic processing of the cognitive mechanism. During the early stage of the pandemic, information related to the pandemic triggered the public's attention and processing expectations of the relevant stimulus (i.e., information). When the information received by the public is not sufficient, they will process the received information in accordance with the schema formed by past cognitive experience, which will cause information distortion. This in turn leads to greater panic and anger. The pandemic affected every family, and people feared for their lives and the health of their families. When coupled with uncertainty about the future progression of the pandemic, this resulted in far emotional distance. On the other hand, faced with the sudden outbreak of COVID-19, the public became prone to negative emotions, such as fear, anxiety, and anger. These stressful emotions may impair cognitive functioning and cause some degree of cognitive impairment, resulting in far event cognitive distance, which is at the "touching distance" level.

(2) **The event emotional distance and subject emotional distance were both furthest from the event and subject psychological distance dimensions, and anger about the event was the strongest among them.**

Having reviewed relevant research on pandemic infectious diseases, it was found that pandemics can cause negative emotions. For example, some scholars used online questionnaires to explore PD in relation to a pandemic and found that when the public perceived that the Severe Acute Respiratory Syndrome (SARS) pandemic was closer to them, they perceived more negative emotions, such as tension, fear, anger, and pessimism (Gao et al., 2003). Van Lent et al. (2017) used

Twitter data to show that the closer the public perceived the Ebola outbreak, the greater the level of concern and fear about the outbreak. A study of 1210 respondents from 194 cities in China found that more than half of the respondents defined the psychological impact of COVID-19 on their well-being as moderate or severe, and about one-third of the respondents reported moderate or severe anxiety symptoms (Wang et al., 2020b). As COVID-19 spreads rapidly and is highly contagious, it poses a great threat to human life and health, endangers public psychological health, and causes varying degrees of emotional problems among the public.

(Event/subject) Emotional distance refers to the public's perception of the emotional closeness of the pandemic event and the subject. This study conducted investigations during the outbreak of the pandemic, and found that the public's life and work were severely affected by the pandemic. The public faces emotional, physical and mental exhaustion due to prolonged excessive stress and depression. During the COVID-19 pandemic, the public's negative emotions about the pandemic were relatively strong, and the emotional distance of the event was far away, which was at the touching distance level. The stronger the public's perception of the dangers and threats posed by the pandemic, the greater the level of anger. This research finding was consistent with those observed during the SARS outbreak (Qan et al., 2003), and it is in line with people's psychological development laws in response to public health emergencies.

(3) **The government was the most appealing in the process of pandemic prevention and control, although public felt less close to the government than to the other three subjects, such as medical institutions.**

The government, as the party who has access to all information during public health emergencies, decides whether such information is disclosed in a timely and accurate manner, which directly affects public perception and the public's attitudes towards the pandemic. At the early stage of the pandemic, due to uncertainty about the situation and the need for a certain amount of time to identify the virus, relevant departments failed to disclose all information about the pandemic in a timely manner, which affected the public's goodwill and closeness towards the government and relevant departments. As a result, the public's emotional distance from the government was relatively remote compared to other subjects. However, the status and nature of the Chinese government means that the government is the most important subject and commander in the prevention and control of the pandemic, so it has the strongest appeal and authority. The follow-up series of public health measures implemented by the Chinese government, such as the wearing of masks in public places, the cancellation of mass gatherings, the extension of the Spring Festival holiday, travel restrictions, and school closures, also

effectively controlled the pandemic (Fang et al., 2020). By comparing differences in the psychological influence level, and the anxiety and depression level between Poland and China during the COVID-19 pandemic, it has been found that the proportion of respondents who wore masks was lower in Poland than in China, while the level of anxiety, depression and stress was significantly higher in Poland than in China (Wang et al., 2020a). Tan et al. (2020) conducted a study of the immediate psychological effects and psychoneuroimmunology prevention measures of the labor force who returned to work during the COVID-19 pandemic, and found that individual psychoneuroimmunology prevention measures (including hand hygiene and wearing masks) and organizational measures (including significant improvement in workplace hygiene and company concerns) were associated with milder mental symptoms. Therefore, wearing masks can reduce the public's sense of anxiety, depression and other adverse psychological effects, and these measures can help to control the pandemic more effectively.

(4) **EPD and SPD showed obvious differences in demographic variables, such as gender, age, and monthly household income. The levels of different PD dimensions were concentrated at the interval between the integrated level and the touching distance level.** It is worth noting that: 1) The male population was at the touching distance level in terms of the event/the subject psychological distance. The youth group, who formed the backbone of society, was at the integrated level in terms of the event/subject psychological distance. 2) Young people, groups with low economic income, those of low social status, and people from lower educational backgrounds were at the touching distance level in terms of the event/subject psychological distance and their dimensions.

Women had a stronger perception of the pandemic than men. Studies have shown that females have higher levels of emotional perception and empathy than males, and their emotions are more vulnerable and sensitive (Wang et al., 2010). In respect to the prevention and control of the pandemic, the youth group played an irreplaceable role. The mental state of the youth group was more peaceful, and their expectations for the future development of the pandemic and their investment in the pandemic were higher. Those under the age of 20 belonged to the Generation Z, and their negative sentiment towards this major public health emergency was relatively strong. The low-income groups were impacted more by this pandemic, and they expressed deeper concerns and panic about the future development of the pandemic. At the same time, the flood of various information sources and some negative news reports during the outbreak of the pandemic caused some grass-roots groups to feel at a loss about what they

should do, which can cause psychological panic and other problems. Studies have shown that during the COVID-19 pandemic, the information received by the public was mainly communicated by the mass media and peer-educators (Tran et al., 2020d). Therefore, it is necessary to promote the dissemination of up-to-date information on prevention and control policies and regulations through the mass media, particularly when dealing with public health emergencies.

(5) **Different pandemic regions showed significant differences in PD. High-risk regions had the farthest PD, and the PD in the central and western regions was generally far.**

The conclusions reached in this study are consistent with the "Psychological Typhoon Eye Effect" (Liang et al., 2008), which differs from the general view and the ripple effect (that is, the impact of unfortunate events gradually attenuate as it spreads outward from the center of the event). The psychological typhoon eye effect is similar to the "typhoon eye" phenomenon in meteorology. It refers to a mostly calm area found in the center of a strong cyclone. In other words, greater **PD** is observed in areas that are at a higher pandemic risk. Previous studies on the 2008 Sichuan earthquake and the SARS pandemic also verified the psychological typhoon eye effect. For example, a study by Li et al. (2009) found that residents in severely affected areas had the lowest level of concern about safety and health after the earthquake, while those far away from the earthquake area were more concerned about safety and health issues after the earthquake, and they were also more mentally and spiritually vulnerable. The reason for this phenomenon can be explained by Festinger's Theory of Cognitive Dissonance and benefit judgment. On the one hand, the theory of cognitive dissonance posits that cognitive dissonance is an uncomfortable mental state, in which individuals experience two incompatible beliefs or cognitions (Festinger, 1957), resulting in a state of dissonance. In order to adjust this state, individuals may unconsciously reduce the risk of self-assessment, which is comparable to the low-risk perception of high-risk regions in this study, so as to achieve a consistent state. On the other hand, according to the benefit judgment, although the pandemic situation in high-risk regions is severe and people in these areas are confronted with life threatening situations, their material security and right to access medical assistance are prioritized, and these resources, in turn, act as a buffer against the public's stress disorder response following a psychological trauma (Wang et al., 2000). In the process of combatting the pandemic, health professionals, medical students and community workers play a key role in guiding people to respond to the pandemic. Understanding the main information sources for disease prevention that these groups usually consult will encourage the adoption of more effective communication strategies with regard to these topics, so that

people can acquire enough accurate knowledge to minimize the propagation of misleading information among the local public (Tran et al., 2020c). Some studies have shown that medical students can play a more effective role in controlling an outbreak if they receive training in pandemic control and if any gaps in their training needs are addressed (Nguyen et al., 2020). For regions with high-risk characteristics in public health emergencies, training and playing the leading role of relevant subjects can reduce the public's psychological insecurity and anxiety.

(6) **Overall, no spatial autocorrelation was found in the Chinese public's PD. However, from a local perspective, high-value regions (distant provinces) are mainly concentrated in the southern regions (Guizhou, Guangxi, Hainan, Jiangxi), and low-value regions (closer provinces) are mainly concentrated in North China (Shanxi, Hebei, Beijing).**

PD mainly depends on an individual's perception of the core relationship between the pandemic event and related subjects, and it is not limited to the interaction between neighboring provinces. Therefore, in general, no spatial autocorrelation was observed. From a local perspective, PD has a certain agglomeration effect. Remote provinces were mainly concentrated in the south because the pandemic risk level of southern provinces was generally higher than that of northern areas. According to the psychological typhoon eye effect, the PD of the public in southern areas was farther. There are two main reasons why the close provinces were mainly concentrated in the northern region of China. On the one hand, the northern region of China was far away from the center of the pandemic, and fear of the pandemic was even higher. During the period of the outbreak, people in North China were especially afraid of an influx of foreigners, so they paid greater attention to every piece of information about the pandemic. They were also more willing to take action in order to control the pandemic more effectively. On the other hand, as the "heartland" of China, North China is an important area of economic prosperity and transportation. Both the government and the public in North China were highly concerned about the pandemic.

In summary, for high-risk areas and areas with high PD, pay close attention to rural areas, mountainous areas or other poorer areas with increased communication risks due to lack of materials and information dissemination channels (Tran et al., 2020b), and the primary health system in these areas is underdeveloped. Therefore, it is imperative that preventive measures be taken to avoid increasing the burden on the health system and enhance the long-term emergency response ability to fight against public health emergencies (Tran et al., 2020a). The psychological impact of the pandemic on the public is long-term. As a psychological intervention method to promote mental health, Cognitive Behavioral Therapy (CBT) has been
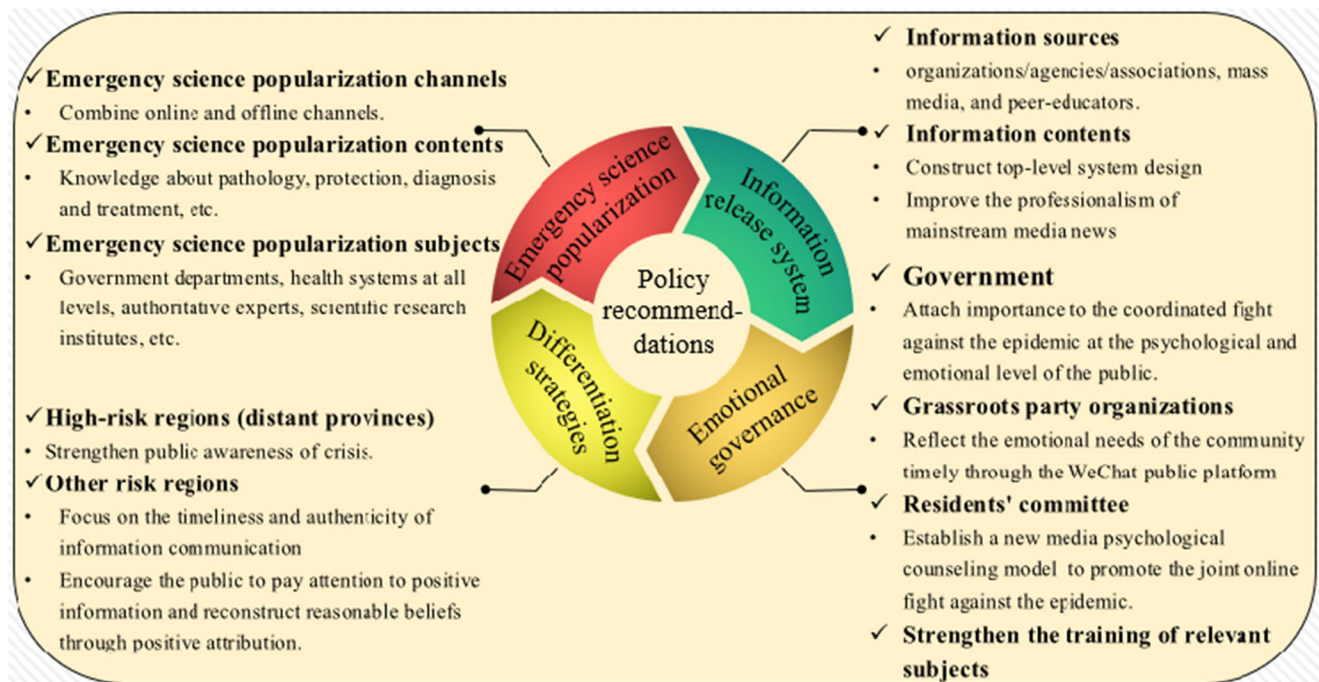
Fig. 5 Policy recommendations

shown to be useful and effective for mental and medical diseases (Soh et al., 2020), and it can effectively treat traumatic stress disorder. For example, in the event of public health emergencies, CBT can relieve anxiety by teaching relaxation skills to patients who exaggerate the risk of infection, which can help to strengthen the public's psychological defenses and contribute to the development of a good psychological model. With the development of technology, CBT has gradually turned to online psychotherapy, such as Internet-based psychotherapy interventions, which addresses the geographical distance between most patients and their physicians (Zhang & Ho, 2017).

Policy Recommendations

Based on previous research conclusions, the following policy recommendations are proposed: A basic overview is illustrated in Fig. 5.

(1) **Place a greater emphasis on popularizing emergency science and encouraging the public to adopt healthy behaviors in a timely and effective manner**. From the research conclusions, it can be seen that the public was at the "touching distance" level in terms of the event cognitive distance and event emotional distance, and both cognition and emotion affect behavior. The public's awareness and perception of the COVID-19 pandemic affect the effective prevention and control of the pandemic. Therefore, strengthening daily science education,

especially emergency science education in the face of public health emergencies, can enhance public awareness of the disease. It will reinforce each individual's pandemic prevention behavior and attitude to public health safety, which will encourage self-management and treatment compliance. Specifically, online and offline communication channels (online channels such as Weibo, SMS, science websites, online courses, knowledge competitions, etc.; offline channels such as TV, on-the-spot communication, etc.) can be used to create a multi-dimensional science communication matrix. Efforts should be made to boost the popularization of knowledge about pathology, protection, diagnosis, and treatment in public health emergencies. In addition to keeping abreast of the latest developments in the pandemic situation, those involved in the popularization of emergency science (e.g., government departments, health systems at all levels, authoritative experts, scientific research institutes, etc.) can also contribute to transforming relevant scientific principles and knowledge into easy-to-understand popular science articles, popular science comics, and popular science videos, so as to reinforce daily emergency science education for broad grass-roots communities and help the public to adopt healthy behaviors in a timely and effective manner.

(2) **Establish an information release system for public health emergencies.** In the process of fighting against the COVID-19 pandemic, problems have been observed in the pandemic information release system. Information is confidence, and false information can propagate the

spread of rumors, which in turn affects the public's PD from the pandemic, especially for low-income groups, who can be overwhelmed by the flood of information sources during the early stages of the pandemic. The establishment of a public health information dissemination system for emergencies can begin from two starting points: One involves the source of information, and the other relates to the content of the information. Among them, assessing the primary and effective sources of information about emergencies plays an important role in helping the public to make timely responses and wise decisions. 1) Information sources include organizations/agencies/associations, mass media (e.g., Internet, online newspapers, social networks; radio and television; printed newspapers.), and peer-educators (relatives, etc.). In the era of new technological changes, "the Internet, online newspapers, and social networks" deserve greater attention, especially by the government, as the representative of authority, which uses the Internet and social networks to monitor the authenticity of information that is released by official accounts under the situation of the continuous strengthening of the digital social governance model, thus ensuring the authority of government websites. Providing timely, comprehensive and true information about the pandemic, timely propaganda to restore the original appearance of emergencies, helping the public to determine the authenticity of information, and eliminating the spread of rumors from the source will help to reduce the public's sense of panic and further strengthen the public's closeness to and trust in the government, which can bolster social strength and consolidate the foundation for collaborative anti-pandemic efforts. 2) Regarding the information content, relevant subjects should give full play to the role of information communication, especially in the case of the media, which plays an irreplaceable role in linking facts and opinions about emergencies. On the one hand, it is necessary to sort out the temporary and emergency effective policies and measures that are adopted in the fight against the pandemic, and to transform them into a top-level system design, which can provide a reference for public opinion supervision and increase information transparency. On the other hand, the professionalism of the mainstream media news should be enhanced. In addition, full play should be given to the role of the mainstream media in supervising the functioning of society. The media should accept public scrutiny and communicate responsible news, so as to prevent the spread of false information and to avoid panic among the public.

(3) **Strengthen the emotional governance of pandemic events to prevent the spread of negative public sentiments.** Emotional factors play a major role in public health emergencies. The changes that have occurred in public emotions, such as the anger that erupted during the outbreak of the pandemic, are enduring and difficult to control, which can greatly affect the public's understanding of the government and relevant subjects. It is important to reduce the PD by preventing and effectively diminishing the public's negative emotions about major public health emergencies, and by strengthening the psychological anti-pandemic sentiment led by emotional governance. The implementation and responsibility for the prevention and control of the COVID-19 pandemic focuses on the grass-roots governance of the real society and the virtual community. However, governance is not the responsibility of a single government entity, and the participation of civil society is equally important. The implementation of emotional governance is mainly reflected at the grass-roots level, which not only emphasizes the diversification of governance subjects, but also emphasizes the diversification of governance methods. 1) As the most credible entity in the community, grassroots party organizations can reflect the emotional needs of the community in a timely manner via the WeChat public platform. They can actively guide the public to accept positive social emotions and channel negative emotions, thereby preventing any further intensification of negative social emotions. 2) The residents' committee is the ideal subject to realize grassroots emotional governance. The new media psychological counseling model should be set up to call on community workers and psychological counselors to provide psychological support and emotional counseling, and to promote the joint online fight against the pandemic. The residents' committee should take advantage of social "strong relationship" groups (e.g., relatives, friends, etc.), and other close WeChat friends (e.g., leaders, colleagues, etc.) to ensure that the public will adjust their emotional state as soon as possible during the public health emergency. 3) It is necessary to strengthen the training of relevant subjects. The training of influential subjects, such as medical students, can help to improve their mastery and ensure that they are better prepared by providing them with pandemic-related knowledge. These subjects can play the role of "opinion leader", influence surrounding groups, help trainees to develop a closer relationship with to the public, appease the public's negative sentiments and enhance their awareness of the pandemic. Training content should not be limited to health education knowledge; rather, it should also focus on the mobilization of communities, support local life and social security, and identify and notify the community of a pandemic.

(4) **Adopt differentiation strategies for different risk regions to strengthen public crisis awareness and psychological counseling.** The psychological typhoon eye effect is a key concept in this study, and its existence was confirmed after the 2008 Sichuan earthquake, the SARS

pandemic and the COVID-19 pandemic. In order to minimize the impact of this effect in emergency situations and increase the level of integration in respect to PD, the government and relevant departments should adopt differentiated strategies for different regions. For high-risk regions (distant provinces), the public's awareness of crisis situations should be strengthened. For other risk regions, a focus should be placed on the timeliness and authenticity of information communication and better information transparency. The spread of rumors should be addressed at the source, and the public should be encouraged to pay attention to positive information, which can facilitate the treatment of traumatic stress disorder among the public by focusing on positive attributions in response to negative events and CBT. This would allow the public to reconstruct reasonable beliefs by focusing on positive attributions when confronted by negative events. In this manner, individuals can learn to disregard negative emotions, and adopt a mind-set of "follow yourself, believe in yourself".

Code Availability Not applicable.

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Data Availability The datasets generated during or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare that they have no competing interests.

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