Intervention Strategies for Health Rumors: An Information Lifecycle Perspective

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Abstract

Effectively governing health rumors represents a major challenge in the era of social media. The dissemination of health rumors is driven by factors at both the information level and the information-processing subject level. Based on information lifecycle theory, this process can be divided into three stages—generation, evaluation, and dissemination—to systematically summarize and analyze intervention strategies for health rumors at each stage: the generation stage emphasizes prevention, focusing on psychological inoculation of the public and improving their health literacy; the evaluation stage concerns individuals' subjective agency, including attention to information accuracy and promotion of analytical processing; the dissemination stage achieves precise debunking by enhancing the credibility of refutation information, effectively utilizing refutation texts, and regulating individuals' emotional states. Future research can continue to innovate governance strategies for health rumors from the information lifecycle perspective, refine investigations into intervention methods for different types of rumors and susceptible populations, summarize and verify the application effects of various strategies in real-world contexts, and fully leverage the roles of behavioral science and online platforms in establishing a long-term mechanism for health rumor intervention.

Full Text

Intervention Strategies for Health Rumors: A Perspective Based on the Information Lifecycle Theory

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Abstract

How to effectively govern health rumors represents a major challenge in the social media era. The spread of health rumors is driven by factors at both the information level and the information-processing subject level. Based on information lifecycle theory, this process can be divided into three stages: generation, evaluation, and dissemination. This paper systematically summarizes and analyzes targeted intervention strategies for health rumors at different stages. The generation phase emphasizes prevention, focusing on psychological inoculation of the public and improving individual health literacy. The evaluation phase concerns individual agency, including focusing on information accuracy and promoting analytical processing. The dissemination phase achieves precise debunking by enhancing the credibility of refutation information, skillfully using refutation texts, and regulating individual emotional states. Future research should continue to innovate governance strategies for health rumors from the information lifecycle perspective, examining intervention methods in greater detail across different rumor types and susceptible populations. It should also summarize and validate the application effects of different strategies in the real world, fully leveraging behavioral science and online platforms to establish long-term mechanisms for health rumor intervention.

Keywords: health rumors, misinformation, online rumors, psychological inoculation, truth sandwiches

Introduction

Rumors are multidimensional concepts, generally referring to information statements that are being disseminated and remain unverified (Lai Kaisheng, Li Dan, 2022, pp. 569–570; Lin Hua, 2021, p. 29). Their spread can intensify social panic, trigger crises of trust, and endanger public safety (Chen & Wang, 2020; Lv et al., 2022). In recent years, highly related concepts have included misinformation and disinformation. Although these concepts overlap in meaning, their emphases differ. Rumors are unverified in authenticity and emphasize the disseminative nature and scope of information, whereas misinformation or disinformation have been confirmed as false and emphasize the veracity of information. Disinformation particularly refers to deliberately disseminated false messages for political or military purposes (Maertens et al., 2021). Health rumors, or rumors related to health, represent one of the most common types of rumors in online society (Yang et al., 2021). Especially during the COVID-19 pandemic, online health rumors proliferated and, together with other false information, created an "infodemic" (Dunn et al., 2023; Hernandez et al., 2021), becoming a prominent issue in global cyberspace governance. Given that existing governance technologies have not yet implemented differentiated interventions for health rumors, false health information, or fabricated health information (Chan et al., 2017; Liu & Qi, 2022), this paper collectively refers to them as health rumors.

Previous research has primarily focused on the generation and identification of health rumors, as well as their spread and control. Computer science typically employs machine learning or deep learning methods to explore health rumor identification (Shahsavari et al., 2020; Wang et al., 2019). Journalism and communication studies use case analysis or text analysis to examine the communication media of health rumors (Trotochaud et al., 2023). Statistics often establishes models to simulate optimal health rumor control systems (Tian et al., 2015). Evidently, health rumor research has attracted multidisciplinary attention, with varying research emphases. However, these discipline-based perspectives on health rumor governance have primarily focused on policy and organizational-level strategic improvements, neglecting individual differences and agency among rumor recipients and disseminators in information processing. Particularly with the development of internet and mobile terminal technologies, ordinary citizens often enter public spaces with private emotions, participating in public discussions and expressing demands to seek solutions (Scarantino et al., 2022; Zhong, 2021). Therefore, rumors also possess instrumental significance in constructing meaning to cope with threats in ambiguous situations. We cannot completely ignore the positive functions of group-based good intentions behind rumors and their role in alleviating public emotions and expressing social demands (Difangzuo, Bodia, 2021, p. 4; Guo Xiao'an, 2015, p. 227).

According to information lifecycle theory, implementing different management approaches and coping strategies for information with different characteristics at different stages can maximize the value obtained at each stage of the information lifecycle (Tan Tian et al., 2022; Wei & Zhang, 2019). This is the so-called lifecycle approach, which uses the concept of biological life cycles to view the research object as a complete life process from formation to demise (Cai et al., 2022). Research objects suitable for this method must meet two conditions: having life characteristics and finite existence (Zhu Xiaofeng, 2004). Health rumors naturally conform to the developmental patterns of the lifecycle due to their dynamic process from generation to decline, meeting the conditions for theoretical analysis and practical application using this method. Domestic and international research has attempted to use the lifecycle approach to divide rumor development stages, mostly based on time trends, though the division methods vary. These include three-stage models (Difangzuo, Bodia, 2021, p. 192), such as generation, evaluation, and dissemination phases; four-stage models (Liang Guanhua, Ju Yumei, 2018), such as incubation, outbreak, spread, and termination phases; and five-stage models (Herovic et al., 2020), such as pre-crisis, initial, maintenance, resolution, and evaluation phases. Although the specific stage divisions differ, these approaches all acknowledge that information dissemination varies significantly across different lifecycle stages and that corresponding interventions should be flexibly designed accordingly. How different types of rumor information and individual characteristics produce specific effects at different stages of rumor dissemination requires more comprehensive summarization and induction to provide theoretical foundations for developing systematic intervention strategies for health rumors.

Based on this, this paper first explores the psychological driving factors behind public belief and dissemination of rumors, attempting to analyze them from both information and individual levels. It then reviews existing intervention strategies for health rumors based on the information lifecycle perspective. Next, it clarifies the shortcomings of these preventive measures to provide references for researchers and practitioners in the health rumor field to develop precise intervention strategies. Finally, it points out directions for future research to explore and improve in terms of intervention strategy models and long-term mechanisms.

2 Psychological Factors Influencing Rumor Belief and Dissemination

There are numerous reasons why health rumors are prevalent and difficult to eradicate in the internet age. From a psychological perspective, existing research mostly summarizes influencing factors from two aspects: information characteristics and individual characteristics. Overall, the emotionally provocative presentation methods and causal explanatory narrative structures commonly used in health rumors make the public susceptible to rumor infection. Meanwhile, individuals' differential emotional experiences with different health rumors and their own levels of epistemic beliefs also make the spread of health rumors possible. Moreover, these two types of factors often interact and mutually enhance each other, making health rumors a social problem that spreads easily but is difficult to block.

2.1 Specific Characteristics of Health Rumor Information

Similar to other types of rumors, health rumors typically have high emotional provocativeness, which can easily lead to public belief and dissemination. This manifests in their frequent use of information features that can arouse individual emotions. For example, specific punctuation marks can make headlines emotional and make content expression more infectious (Liu Guo, Wang Xiaoya, 2020), with exclamation marks and question marks being commonly used expression symbols in health rumor headlines. This is because the use of exclamation marks makes headlines more intense in tone and triggers resonance, such as "Energy-saving lamps for home use can cause harm to the human body!" Question marks, on the other hand, can induce public curiosity, leading to more attention, such as "Can hot lemon water fight cancer?" (Jiang et al., 2020). Meanwhile, font size, style, and color also influence individuals' attitudes toward information (Bayer et al., 2012; MacKay et al., 2015).

Different types of health rumors also have different emotional characteristics. Compared with true rumors (rumors later confirmed to be true; Vosoughi et al., 2018), false rumors (later confirmed to be false) use more emotion-related terms and embed emotional words about trust, expectation, or anger (Pröllochs et al., 2021). Research has also found that analyzing the emotional characteristics of

health information can predict rumor authenticity, meaning that rumors without evoked positive or negative emotions and without calls to action are more likely to be true (Zhao et al., 2022). Maguire et al. (2019) further found that information with emotional coloring increases public fear and risk perception. Negative emotions such as anxiety and fear thus become common emotional expressions in health-related rumors (DiFonzo et al., 2012). The public tends to spread emotional rumors, and false rumors more frequently use emotional expressions. The interaction between these two factors makes false rumors more likely to spread widely.

In addition to emotional arousal functions, health rumor information also has cognitive fit functions. From a psychological drive perspective, individuals mostly search for and obtain information to reduce perceived uncertainty, and the narrative framework of health rumors can satisfy this cognitive need to some extent. Narrative frameworks mainly refer to story-based information formats (Kim & Nan, 2019; Pu et al., 2022), characterized by immersing individuals in logically coherent storylines, thereby reducing resistance to persuasive information (Chen & Tang, 2022). For example, compared with the complexity and uncertainty of facts, vaccine conspiracy-related rumors often provide simple causal explanations (Douglas et al., 2017; Schmid & Betsch, 2019; Vaidyanathan, 2020). Their structure is coherent and easily understood and remembered, satisfying the public's need for certainty and control. Rumors can thus provide a more powerful explanation of reality than facts themselves. Obviously, the "causal explanations" in rumors do not necessarily represent real causal relationships but may merely be coincidences in temporal sequence. However, mistakenly interpreting events that occur sequentially in time as causal events is a common cognitive bias among humans. For instance, research investigating the relationship between vaccination and autism found that the narrative structure "vaccination preceded the event, therefore vaccination caused the disease" aligns with the public's cognitive bias of seeking answers, making it more easily accepted by the public (Mohammed et al., 2022).

2.2 Individual Differences Among Audiences

Different types of health rumors interact with the public's own emotional experiences, subsequently producing differential behavioral decisions. The importance of health leads people to frequently search online for and share advice about physical health (Ning et al., 2021). Research shows that compared with hope health rumors, the public more easily notices and shares fear health rumors (Chen et al., 2021; Pal et al., 2017). This phenomenon can be explained by negativity bias theory, which posits that people generally accept positive messages, while fear health rumors cause individuals to experience correspondingly higher anxiety, leading to high attention and sharing (Chua & Banerjee, 2018; Locke & Robinson, 2021). However, research on health rumors under true/false categories found that regardless of information veracity, enhanced emotion increases individuals' trust and sharing intentions toward health rumors (Li et al., 2022).

Political rumor research has found different results, where inducing enhanced current emotion or emotional dependence predicts greater trust in fake news compared with true political news (Martel et al., 2020). A possible explanation for this differential result is that COVID-19-related health rumors usually advise individuals on effective protection, and emotionally aroused people showing more belief and sharing intentions toward such information (regardless of truth) may represent a self-protective behavior of the organism. Evidently, individual emotional states play a pivotal role in rumor dissemination, with even greater impact on health-related rumors.

The easy spread of health rumors is also related to individuals' epistemic belief levels. Epistemic belief refers to individuals' views and beliefs about the nature of truth and knowledge (Salehinejad et al., 2021). Both original beliefs and differential levels affect individuals' final decisions. Information that denies one's original epistemic beliefs may be ineffective or counterproductive (Swire-Thompson et al., 2022; Trevors & Duffy, 2020). The echo chamber effect and backfire effect are often used to explain this influence mechanism. Individuals in echo chambers more easily filter out information that contradicts their own views, tending to reinforce existing opinions and thus creating cognitive closure (Dubois & Blank, 2018; Wang & Qian, 2021). The backfire effect often manifests as information causing audiences to believe the rumor more when it threatens their original beliefs (Ecker et al., 2023). Moreover, most health rumor dissemination results from gullible sharing due to low epistemic belief levels rather than deliberately malicious rumor-mongering or intentional dissemination. Chua and Banerjee (2017) found that individuals with low epistemic beliefs are more likely to share health rumors than those with high epistemic beliefs. Individuals with high epistemic belief levels are cognitively flexible and vigilant, tending to maintain a questioning attitude when searching for and verifying information (Mokhtari, 2014). In other words, differences in cognitive levels among different individuals regarding the same health information affect their sharing behavior.

In summary, the driving factors clarified above based on information and individual levels all involve emotional investment and cognitive processing. The influence of these factors on individuals' health rumor sharing intentions can be further explained by behavioral decision theory. This theory posits that individuals' decisions to engage in specific behaviors are typically guided by two systems: one is the emotional impulsive system, and the other is the reflective system related to reasoning and executive functions (Schiebener & Brand, 2015). The former is based on rapid responses to stimuli and is emotion-driven; the latter is based on slow, controlled cognition (Pennycook et al., 2018). These two systems do not exist in parallel, and different individuals have specific biases when using them, thus driving different decisions (Chick, 2019; Trendel & Werle, 2016). As a special type of health information, the public's differential reactions to health rumors are also influenced by their habitual decision-making behaviors. Therefore, the development of corresponding intervention strategies needs to deeply consider these driving factors, taking into account the charac-

teristics of human dual-system processing and potential conflicts within it, to achieve substantive refined intervention.

3 Intervention Strategies for Health Rumors

Considering the comprehensive summary and fit of existing intervention measures, the following sections adopt the aforementioned three-stage lifecycle division based on generation, evaluation, and dissemination to review and summarize existing targeted intervention strategies for health rumors (see Figure 1 [Figure 1: see original paper]), aiming to provide references for further developing health rumor intervention strategies.

Figure 1 Framework of Health Rumor Spread and Intervention

3.1 Before Rumor Spread: Prevention Strategies During the Generation Phase

Health rumors often originate from the emergence of a sudden event. During this phase, health rumors have not yet spread to the public, so intervention strategies focus on prevention. The main strategies include psychological inoculation of the public and improving individual health literacy. The former focuses on the information itself, while the latter emphasizes individual proactive prevention.

3.1.1 Psychological Inoculation "Psychological inoculation" uses the metaphor of vaccination, emphasizing the cultivation of the public's "psychological antibodies" against rumors (van der Linden et al., 2020). This can not only reduce public susceptibility to rumors but also improve their resistance to various rumors on social media (Lewandowsky & van der Linden, 2021; Pilditch et al., 2022). This technique generally involves two elements: preemptive warning and exposure to trace amounts of erroneous information while pointing out its fallacies (Ecker, et al., 2022). For example, individuals can be warned that many claims about drug use during the pandemic are incorrect and that much data actually originates from conspiracy theories. In addition to this inoculation method that refutes specific arguments, focusing on rumor manipulation techniques can significantly improve the potential scalability of inoculation interventions, as different rumors often use the same basic metaphors. Roozenbeek et al. (2022) used videos of different manipulation techniques as inoculation intervention stimuli to explore their impact on individuals' ability to resist rumors. The study produced five short videos covering manipulation techniques commonly used in rumors: emotional language, incoherence, false dichotomy, scapegoating, and ad hominem attacks. The results showed that this inoculation technique significantly improved individuals' ability to identify manipulation techniques, distinguish credible from non-credible content, and make sharing decisions. The actual impact of these techniques on health rumors still requires more empirical research for confirmation.

Additional recent research has found that many traditional inoculation techniques are often discontinuous or discrete psychological inoculations, namely pulse inoculation (pulse refers to the phenomenon where the system state suddenly changes or is disrupted for a short time due to some reason, and then the motion trajectory changes abruptly; Huo & Ma, 2017). However, when people receive information, they usually first judge its truthfulness before deciding whether to share it. This process takes time, meaning that rumor spread involves a certain time delay (Zhu et al., 2020). Combining the time-delay characteristics of rumor spread with the pulsing nature of psychological inoculation to fit data models, some studies have found that increasing the proportion of pulse inoculation, shortening its cycle, or extending its duration helps inhibit rumor spread (Cheng et al., 2022). In other words, long-term, regular, and quantitative information popularization based on psychological inoculation is more effective than short-term, continuous information popularization in reducing individuals' willingness and behavior to share rumors.

3.1.2 Enhancing Health Literacy Consciously improving health literacy can enhance people's ability to identify rumors. Although clear experimental evidence for improving health literacy is still lacking, strengthening self-efficacy has been proven to significantly affect individual health literacy levels. Health literacy refers to individuals' ability to obtain, understand, and use health information to promote their own health (Sørensen et al., 2012). Its improvement can effectively help people identify the falsity of health rumors (Xue & Taylor, 2023). Some studies have found that individuals' health literacy and health-related social media use affect their health behavior intentions by acting on self-efficacy (Niu et al., 2021). A meta-analysis also found a moderately significant positive correlation between self-efficacy and online health information-seeking behavior, indicating that the higher the individual's self-efficacy level, the more frequent their online health information-seeking behavior (Zeng Runxi, Li You, 2023). He et al. further analyzed the moderating effect of individual self-efficacy on health literacy and rumor belief, with results showing that improving self-efficacy can strengthen the relationship between scientific literacy and rumor belief, effectively preventing people from believing health rumors (He et al., 2021). Developing feasible plans and providing positive feedback promote health literacy by enhancing self-efficacy. Research has confirmed that developing appropriate educational learning plans helps the public cultivate good health habits and subsequently conduct more careful analysis of online health information (Battineni et al., 2020; Nepps et al., 2023). Positive feedback can reinforce people's repetition of positive health behaviors and enhance their self-efficacy. This positive cycle helps form healthy habits and behavior patterns (van de Ridder et al., 2015).

3.2 During Rumor Spread: Evaluation Strategies During the Assessment Phase

Evaluation strategies during the assessment phase primarily target individuals themselves, focusing on individual agency. During this phase, the public can access certain new health rumors, and different evaluation methods of the same rumor may lead individuals to handle it completely differently. Therefore, this phase emphasizes focusing on information accuracy and promoting analytical processing. These two strategies significantly influence individuals' information processing methods and behavioral decisions.

3.2.1 Focusing on Information Accuracy Shifting attention to information accuracy is an effective strategy for reducing individuals' sharing intentions. A task investigating the accuracy of COVID-19-related rumors and individuals' sharing intentions found that participants did not specifically pay attention to information accuracy when facing information, meaning there was a disconnect between sharing behavior and accuracy judgment. However, when experimental tasks guided participants to shift their attention to accuracy, their willingness to share false information decreased (Epstein et al., 2021). Current experimental operations encouraging participants to focus on information accuracy mainly involve two approaches. The first is asking participants to judge the accuracy of information, such as by asking "To your knowledge, how accurate is the claim in the above epidemic-related headline?" (Pennycook et al., 2020). A recent study further explored the role of accuracy motivation in true/fake news judgment by providing economic incentives for correctly identifying headline accuracy (Rathje et al., 2023). The second approach requires participants to evaluate the importance of information accuracy, such as asking "How important is it to you to only share accurate news articles on social media?" in Pennycook et al.'s (2021) study on political rumors. These studies have yielded consistent results: accuracy prompts can increase individuals' attention to information accuracy and significantly reduce their sharing intentions for fake news. Moreover, the significant effect of this accuracy prompt intervention, which occurs before the sharing task, does not differ significantly depending on headline type (political or epidemic-related news) (Pennycook & Rand, 2022). Therefore, increasing public emphasis on information accuracy can improve individuals' information processing methods. This can actually serve as an intervention method—by improving individuals' judgment of information accuracy, it can reduce their willingness to share false information and achieve the goal of blocking rumor spread.

3.2.2 Promoting Analytical Processing Adopting a thoughtful thinking approach can weaken the harmful role of one's own epistemic beliefs in rumor spread. Individuals often tend to believe personal intuition and prior experience when processing information (Xiong Yan, 2019; van der Linden, 2022) rather than engaging in careful deliberation. However, research shows that people who are more prudent by nature can better identify false information, regard-

less of whether the content aligns with their own beliefs (Pennycook & Rand, 2020). This is because thoughtful thinking can override and correct intuitive error-based reactions, promoting individuals to use their critical thinking and thus form correct beliefs (Pennycook & Rand, 2019). When people attempt analytical processing, they usually update their prior beliefs, which is more conducive to discovering the truth. One study required participants to pause and think about some questions (such as explaining how they knew whether news headlines were true or false) before evaluating their likelihood of sharing the headlines they saw. The results found that forcing people to pause for analytical processing could effectively reduce the proportion of the public sharing false information compared with real headlines (Fazio, 2020). Similarly, Bago et al. (2020) concluded that if participants are given an opportunity to rethink after quickly evaluating information, without limiting specific response time, and then asked to decide whether to act, it would effectively reduce individuals' trust in and willingness to share rumors. Some studies have deeply examined the impact of specific components of this deliberative cognitive style on health rumor beliefs, finding that active open-mindedness and need for evidence reduce public belief in health rumors, and that interventions activating deliberative cognitive styles can promote correct evaluation of rumors (Lee et al., 2023). These findings provide hope for potential intervention measures.

3.3 After Rumor Spread: Debunking Strategies During the Dissemination Phase

Health rumor debunking strategies emphasize precise intervention in already-spread rumors. Intervention methods in this phase include enhancing the credibility of debunking information, skillfully using refutation texts, and regulating emotional states. The first two target the setting of debunking information, while the latter focuses on individual emotional regulation.

3.3.1 Enhancing Credibility of Debunking Information The credibility of information content and sources affects rumor spread. Providing additional information and professional sources can improve information credibility. Credibility reflects the degree to which individuals are willing to accept accurate information (Pornpitakpan, 2004). When debunking rumors, credibility is often more persuasive than professional knowledge itself (Ecker et al., 2011; Pluviano et al., 2020). Some studies have found that besides the text information itself, additional information is a key variable in users' trust and sharing of health information (Chua et al., 2016). For example, adding warnings below health rumors can reduce users' sharing intentions (Wang Yuyu, 2022). Deng and Fu (2018) selected three dimensions of additional information in social media rumors—images, verification, and links—and conducted empirical research on health rumors in social media through situational experiments and interviews. The results showed that for trust levels, identity verification and links significantly improved users' trust compared with images, with verification having the largest effect. For sharing intentions, only identity verification had a significant

impact on users' sharing intentions.

Evidently, debunking information from transparent identities significantly affects public trust and sharing behavior, with information sources representing official and professional identities having a more obvious impact on information credibility. People tend to trust and share messages on authoritative official platforms (Wood et al., 2023). Compared with information sources from ordinary users and friends, warnings from experts more significantly reduce the public's willingness to share health rumors (Wang Yuyu, 2022). Unlike other types of rumors, the substitutability of health rumor debunking subjects is weak, requiring professional medical backgrounds and knowledge as guarantees (Zhou et al., 2020). Demonstrating the credibility of medical experts during information correction may produce multiple beneficial outcomes. These phenomena can be explained by persuasion theory, which examines how persuasive techniques affect individuals' attitudes, behaviors, and decisions. This theory emphasizes examining information content to determine which messages are more persuasive, and the credibility and authority of persuaders significantly affect the public's perception of received information (Adaji, 2023). In summary, the public pays attention to debunking content with additional information and trusts information sources representing authority and professionalism, providing references for regulatory departments to explore improving the credibility of correction information.

3.3.2 Skillful Use of Refutation Texts After health rumors have spread widely, to effectively weaken rather than accidentally strengthen the public's existing consensus, debunking departments must also improve the content quality of correction information (Paynter et al., 2019). Traditional correction methods focus on using corrective content to refute and clarify health rumors (Ecker et al., 2020; Pulido et al., 2020). Refutation content typically includes fact-based corrections and providing alternative explanations (Ecker et al., 2022). This correction method often repeats the original rumor too much without focusing on the structure of the debunking text, limiting debunking effectiveness. Dechêne et al. (2010) explained why people are easily influenced by rumors, calling this phenomenon the "illusory truth effect"—repeating a claim makes individuals more likely to judge it as true compared with not repeating it. Yet media, government, and other institutions often repeat rumors many times for debunking purposes. A study examining the relationship between information repetition and cognitive load pointed out that rumor repetition makes debunking difficult possibly because cognitive load hinders the integration of corrections, subsequently reducing debunking effectiveness (Sanderson et al., 2023).

Considering that presenting or repeating rumors at the beginning or end of correction information may backfire and strengthen belief in rumors due to primacy and recency effects (Brydges et al., 2020; Kenix & Manickam, 2021), debunking texts must be carefully considered. In this regard, "truth sandwiches" can serve as an effective text structure for debunking information. This text

format consists of three information blocks: first providing facts, second pointing out the misinformation and fallacies, and finally providing facts again (Anderson et al., 2019). Research has found that the "truth sandwich" text structure can effectively reduce public agreement with health rumors, thereby achieving the goal of correcting health rumors (König, 2023). Kotz et al. (2023) further compared the debunking effects of the "truth sandwich" text structure with the bottom-heavy text structure (i.e., providing facts only at the end of correction information) and concluded that both structures were significantly effective with no difference between them. The reason for this result may be that in the two text structures currently applied, the tail information—that is, the recency effect—may be more helpful for individuals to remember factual information. These studies provide new ideas for effective debunking text formats.

3.3.3 Regulating Emotional States Regulating emotional states can significantly reduce rumor belief and dissemination behaviors caused by one's own emotional arousal. Sufficient regulation of emotional states first requires individuals to be aware of how consistency between before-and-after emotions affects their own behavior (Dong et al., 2020). A study exploring the relationship between rumors and emotional consistency presented different coping methods for a fictional epidemic called New Respiratory Syndrome (properly handled control condition vs. incompetent response anger condition) to induce corresponding emotional experiences in participants, then presented health rumors with different valences and asked participants to evaluate their trust in them (Na et al., 2018). The results found that consistency between individuals' emotional states and the emotions evoked by rumors led people to believe the rumors more than in inconsistent conditions. Therefore, if the public's own emotional states are stable, they can effectively avoid being incited by the emotional expressions of health rumors. There are many methods for self-controlling and regulating emotions, such as using cognitive reappraisal to assign positive meaning to current situations (Ma et al., 2019; Mohammed et al., 2021), using mindfulness practice to alleviate one's own emotional arousal (Fazia et al., 2020; Kral et al., 2018), or seeking emotional support and external help through positive communication with others to restore one's own emotional state to normal levels. The direct application of these methods in the field of health rumors, which tend to arouse negative public emotions, will also be an important practical issue requiring more accumulation of empirical research evidence.

4 Summary and Outlook

The design of intervention strategies and comprehensive governance models for health rumors has been a research focus in recent years. To further improve the effectiveness of health rumor interventions, it is necessary to more deeply clarify the driving factors of health rumors from a psychological perspective, summarize evidence-based intervention strategies, and then construct more systematic health rumor intervention models. This paper has sorted out the driving factors of health rumor spread from information and individual levels and summarized

specific intervention strategies based on the lifecycle perspective. This division can not only help relevant entities quickly locate measures that can be taken at different stages, reducing time and trial-and-error costs, but also provide a framework for developing and verifying precise health rumor intervention technologies.

Existing health rumor intervention strategies also have some shortcomings. First, the classification of health rumor types is still not refined enough. For example, current research mostly defaults to treating them as information whose authenticity has been officially confirmed as false, without differentiating between true and false rumors during intervention, only processing them uniformly, thus limiting intervention effectiveness. Second, current strategies have not deeply distinguished the psychological characteristics of different susceptible populations or adopted targeted treatments, limiting the breadth of intervention methods and correction effects. Finally, the application effects of different health rumor intervention strategies in the real world have not been considered. Current treatment methods have different emphases and slightly different intervention effects, and the intervention process lacks interactivity and linkage among various entities, leading to information asymmetry between intervention strategies.

Health rumor intervention strategies actually involve two major levels: development and application. The first is developing new strategies based on the information lifecycle perspective and verifying their preliminary effects, which often relies on many decentralized, small-scale laboratory studies or field experiments. The second is large-scale application of these strategies in the real world by organizations such as governments and online platforms to explore optimal combinations and thus establish effective long-term intervention mechanisms. Future research can focus on these two themes.

4.1 Innovating Health Rumor Intervention Strategies from the Information Lifecycle Perspective

Health rumors can be divided into different types according to different standards and correspond to different susceptible populations. Therefore, it is necessary to develop more refined intervention strategies. More refined divisions can be achieved for health rumors according to different standards. Based on individual emotional tendencies, they can be divided into fear rumors and hope rumors. Based on rumor truthfulness, they can be divided into true rumors and false rumors. In fact, they can also be divided into food safety, health preservation, public health emergencies, medical health, and doctor-patient relationship rumors according to the nature of health rumors (Li Ning, 2018; Chang et al., 2022; Ehrenreich, 2018; Malik et al., 2023; Riedl & Schüßler, 2017). Future research can further enrich existing intervention strategies by considering the characteristics of each stage of the information lifecycle and combining these classification standards under interactive combinations of different themes, emotional tendencies, and truth levels.

Different susceptible populations have differential manifestations at different stages of rumors. For example, gender differences in rumor susceptibility are a common controversial topic. Some research suggests that women's rumor creation/dissemination rates are significantly higher than men's (Zong Qianjin et al., 2017), while Chen (2015) found completely opposite results. The relationship between this rate difference and the rumor period, rumor type, and other influencing factors still needs further clarification. For instance, compared with men, women may be more emotional and more susceptible to rumors during the outbreak period, while men may be more enthusiastic about considering rumor types when deciding whether to spread rumors. However, this still requires more survey data for verification and more refined experimental research to explore the role of psychological factors beyond gender.

People generally consider the elderly to be a susceptible population for health rumors (Scherer & Pennycook, 2020). This may be due to their limited cognitive abilities (Hess et al., 2016), which subsequently affect rumor identification. However, whether there is a causal relationship between cognitive ability and susceptibility and what factors moderate the strength of this relationship still need further confirmation. Some studies have found that cognitive characteristics such as analytical thinking help individuals identify rumors, thereby reducing susceptibility (Lee et al., 2020). However, other research suggests that cognitive ability is not the primary determinant of rumor susceptibility. Individuals need to mobilize complex cognitive abilities when processing health rumors, and motivation and anxiety affect susceptibility by influencing the elaboration of information (Cao Yaning, Ke Qing, 2023). Therefore, whether other factors play a moderating role when cognitive ability predicts rumor susceptibility still needs in-depth exploration and scientific evidence at the neural level. Brain regions such as the frontal lobe, right inferior parietal lobule, and orbitofrontal cortex are significantly activated in tasks related to cognitive functions (De Baene et al., 2012; Fellows & Farah, 2003), which may provide a basis for future exploration of the cognitive and neural mechanisms of susceptible populations in health rumor identification.

In addition to dividing susceptible populations based on gender, age, and cognitive ability, demographic characteristics such as regional differences, education level, and living standards also have obvious influences on groups' health concepts and lifestyles, easily creating health rumor spread characteristics in specific populations. Other types of rumor research have found that people are more likely to spread rumors with regional stereotypes (such as online "regional attacks" targeting certain geographical groups) (Blank et al., 2019), and low-income individuals and rural residents are also more susceptible to rumors (Faure et al., 2022). The role of these factors in shaping group susceptibility to health rumors at different stages is also worth exploring.

4.2 Validating the Application Effects of Different Health Rumor Intervention Strategies in the Real World

The effectiveness of health rumor governance is not only reflected in developing effective strategies themselves but more importantly in the practical effects of applying these strategies. This requires linkage between health rumor governance entities (such as scientific organizations and information recipients) and consideration of effective interaction between policy tools and public reactions, leveraging the unique roles of each entity at different rumor stages to achieve optimal governance effectiveness.

How exactly effective the precise application of different strategies is still needs to be confirmed and summarized in rumor intervention practice. The comprehensive use of these strategies also involves public compliance with corresponding policies or recommendations. In this regard, behavioral public policy research has revealed some more general promotion strategies and has had more comprehensive practice in combating COVID-19 (Zhang Ning, Zhang Shuwei, 2020; Guo Mengqian, Zhang Ning, 2022). For example, in governance effectiveness on COVID-19 rumors, personal behavior rumors are easier to govern than epidemic development rumors, and rapid-response debunking works better than non-rapid-response debunking. In governing personal behavior rumors, boosting tools work better under rapid-response conditions, while under non-rapid-response conditions, nudging tools work better than boosting tools for rumor governance (Fu et al., 2023). Other research has found that creating positive norms where most people actively comply with public health policies, valuing the behavior of proximal groups, and increasing behavior visibility can more effectively stimulate individuals' corresponding compliance behaviors (Zhang et al., 2022). This provides beneficial insights for further verifying the practical effects of health debunking technologies. Future research can consider how different types of debunking strategies can be combined with insights from behavioral science to improve debunking effects, exploring the effects of forms such as increasing the visibility of debunking behavior, reminding people of the value of debunking for close relatives and friends, and indicating how many people around them participate in health debunking to promote participation in debunking behavior.

Finally, cyberspace has become the main space for health rumor spread, and health rumor governance needs to leverage the enabling role of online platform governance. This also raises many new research questions for future research. For example, the design of many debunking technologies abroad has begun to adopt the form of digital nudging to directly affect netizens (Gwiaździński et al., 2023; Indu & Thampi, 2022). Domestically, there is more reliance on establishing integrated internet debunking platforms, such as the China Internet Joint Debunking Platform and Tencent's Jiaozhen mini-program, to conduct thematic debunking of relevant rumors, with netizens still needing to actively search for rumor verification. Different countries' different online debunking models are limited by their political systems, ethical norms, and public attitudes, and how

to explore appropriate governance tools still requires further discussion through surveys and experiments. In addition, health rumors are often combined with political rumors, becoming major carriers of various political conspiracy theories (such as "COVID-19 lab origin theory" and "COVID-19 vaccine and genocide"), and their disseminators involve not only real netizens but also many social bot accounts driven by artificial intelligence and controlled by specific state agencies, which greatly increases the difficulty of global health rumor governance. Further innovation in platform debunking methods is needed to enable netizens to more effectively distinguish between social bots and real netizens and separate political information from health information in rumors. Particularly noteworthy is that ChatGPT and similar AI technologies, which have attracted much attention and controversy since late 2022, may not be able to play an active role in health rumor debunking in the near future but should play a positive role in promoting health knowledge Q&A and sharing. This provides new opportunities for more effectively promoting netizens' active sharing of correct health information, as how to promote ordinary netizens' active sharing of correct health information is an important means of effectively countering health rumors (Fu et al., 2022). However, the deep utilization of these technologies also involves deep social psychological issues such as human acceptance of AI and the maintenance of human morality and values (Yu Feng, 2022). The new developments and problems of health rumors in cyberspace will also promote in-depth research on health rumor intervention.

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Note: Figure translations are in progress. See original paper for figures.