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LONG PAPER

Better safe than sorry: a study on older adults' credibility judgments and spreading of health misinformation

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Abstract
The online world is flooded with misinformation that puts older adults at risk, especially the misinformation about health and wellness. To understand older adults' vulnerability to online misinformation, this study examines how eye-catching headlines and emotional images impact their credibility judgments and spreading of health misinformation. Fifty-nine older adults aged between 58 and 83 years participated in this experiment. Firstly, participants intuitively chose an article for further reading among a bunch of headlines. Then they viewed the emotional images. Finally, they judged the credibility of health articles and decided whether to share these articles. On average, participants only successfully judged 41.38% of health articles. Attractive headlines not only attracted participants' clicks at first glance but also increased their credibility judgments on the content of health misinformation. Although participants were more willing to share an article they believed than not, 62.5% of the articles they want to share were falsehoods. Older adults in this study were notified of possible falsehoods in advance and were given enough time to discern misinformation before sharing. However, these efforts neither lead to a high judgment accuracy nor a high quality of information that they wanted to share. That may be on account of eye-catching headlines which misled participants into believing health misinformation. Besides, the most older adults in this study may follow the "better safe than sorry" principle when confronted with health misinformation, that is to say they would rather trust the misinformation to avoid health risks than doubt it.

Keywords Misinformation · Older adults · Judgment · Spreading · Health information

1 Introduction

Older adults are at risk when they face an online world flooded with misinformation. Misinformation is not only increasing in quantity—to the extent that most people will face more false information than true information by 2022 [1]—but also reaching more people and traveling much faster than the truth. For example, the speed of misinformation on Twitter reaching ten depths is nearly 20 times faster than that of accurate information [2]. When online misinformation comes to health and wellness, it might ruin people's trust in healthcare professionals and pose a threat to public health, so misinformation is one of the top two global health concerns rated by medical practitioners from 79 countries [3]. When confronted with this flood of misinformation, American older adults aged above 65 shared the most fake news on Facebook [4, 5]. Similarly, Chinese middle-aged and older adults aged above 50 rated misinformation as the biggest risk of using the Internet in a national survey, with 66.2% of those surveyed had been victims of online misinformation [6]. The declined cognitive ability [9] and increased emotional sensitivity [10] may make older adults more vulnerable to misinformation than other age groups. In addition, researchers found that some personal characteristics were associated with their vulnerability to misinformation, including interpersonal trust, extraversion, and need for cognition [7, 8]. What is not yet clear, however, is how the nature of misinformation impacts older adults' judgments of information credibility and spreading behaviours (for a review, see [11]).

Extensive studies on the emotion in the realms of health communication and marketing suggest that the strong

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emotion may contribute to the fast spread of misinformation and audiences' attitudinal or behavioural changes [e.g., 12, 13]. Viral marketing campaigns often use amusing or intriguing messages and advertisements to ensure wide accessibility among consumers and trigger referral behaviours [12, 15]. In order to persuade audiences to adopt self-protective actions, public health campaigns usually connect unhealthy behaviours with threatening or fearful outcomes [13]. Consistently, misinformation inspires curiosity and induces further engagements by using sensational headlines (e.g., clickbait [16]). The emotional strategy of misinformation is not limited to eye-catching headlines. The fearful images about disease or mortality in the content of misinformation [17] are used to evoke strong emotions (e.g., disgust [14] and fear [2]) and to boost the spread of misinformation. Given the diverse behaviours of social media users, for example, 59% of users shared tweets without clicking on its content [18], it is necessary to distinguish between the headline and content of misinformation when checking its nature.

Thus far, an amount of studies has examined the effects of source credibility, expert sources, attractive sources [19, 20], or message framing (i.e., description of the positive or negative outcomes of certain behaviours [21]) on audiences' judgments of health information. However, these studies failed to focus on older adults. With more and more older adults stepping into the digital world, 75% of American older adults aged above 65 accessed the Internet [44] and China has more than 100 million older netizens [51]. Older adults become the primary audiences of online health information [52]; meanwhile, they are the most vulnerable group to health misinformation [22]. Therefore, this study focuses on how older adults react to the health-related misinformation with eye-catching headlines and strong emotions. Knowledge about older adults' vulnerability to health misinformation and the potential reasons can provide insights into the interventions tailored to older adults. Specifically, this study investigates how accurately older adults identify health misinformation and how headlines' attractiveness and emotions (i.e., fear, disgust, and happiness) influence their credibility judgments on online health misinformation and their willingness to share it.

2 Literature review

2.1 Health misinformation on social media

Misinformation refers to the false information that is intentionally or inadvertently created and spread to cause harm [11]. Health misinformation has raised mounting concerns in recent years due to its viral spread and threatening consequences to individuals and organizations. More than once, the Journal of the American Medical Association calls for endeavours of researchers and journals to address this issue [23–25].

The prevalence and spread of health misinformation pose risks for public health. During the outbreak of COVID-19, near half of Americans have been exposed to fabricated information [26]. Worse, at least 75% of COVID-19 news that Thai people have been exposed to were falsehoods [27]. Furthermore, misinformation spreads faster than accurate information [2, 25]. Although social media allows immediate communications between patients and doctors [28], it allows pseudo experts directly to contact with their objects of fraud. The FBI [29] reported that more than $1 million losses involve internet healthcare frauds in 2019. Health misinformation not only leads to monetary losses but also challenges scientific authorities and threatens public health [30]. For instance, widespread anti-vaccination claims decreased immunization rates and increased vaccine-preventable diseases [31, 32]. The misperceptions (e.g., vaccine would cause autism) may also result in scepticism on science and governments [24]; for example, 21% of Americans expressed mistrust in scientists [33].

2.2 The role of emotions in health misinformation

The information society treats people's attention as limited resources [34]. Meanwhile, multiple studies suggested that the emotional content often functioned as an attention-grabber (e.g., [12, 35, 36]) and flooded social media [53]. Moreover, emotion may be responsible for the spread of misinformation. Emotion was extensively used to implement successful contagious marketing campaigns and persuasion to change unhealthy behaviours in the realms of marketing [37, 38] and public health [39] while varying in adept utilization of specific emotions. Dobele et al. [12] investigated responses of recipients who were exposed to successful viral marketing campaigns and found that surprise mixed with other emotions (e.g., disgust and fear) significantly predicted recipients' referral behaviours. Similarly, Berger and Milkman [35] analysed the content of Times articles in the "most emailed" list and found that the awe-inspiring and surprising content was the most popular. By contrast, public health messages often use fearful and disgusting content to evoke risk perception and give recipients actions with high efficacy to reduce the risk, thereby persuading people into taking healthy actions [13, 39, 40]. For example, exposure to the fear-inducing outcomes of AIDS promoted safer sexual behaviours, which resulted in a decline in HIV prevalence in Uganda [41]. With respect to health misinformation, Fitzgerald et al. [17] suggested that fear plays an important role in the consumption of fraudulent health products, especially for fear and disgust implying diseases and mortality. Similarly, strong emotions (i.e., fear, disgust, and surprise) were found to contribute to the viral spread of misinformation on social media [2]. Although these findings were consistent with the view that high-arousal emotions predict persuasion [42, 43], most related studies of health misinformation were based on the content analysis rather than recipients' responses (for a review [11]). Further experimental studies are needed to determine how recipients judge the health misinformation that filled with emotional elements (e.g., sensational headlines and content).

2.3 Older adults' vulnerability to health misinformation

Older adults showed high vulnerability to misinformation, especially for misinformation related to healthcare and well-being. They were more frequently exposed to misinformation and were more willing to share it, in comparison with other age groups [4–6]. In addition to spreading health misinformation, older adults were inclined to practice the unconfirmed alternative remedies and purchase fraudulent heath products [45]. In accordance with solved cases, healthcare fraud resulted in economic losses of more than $ 70 million during 2018 in China [46], let alone the losses of unsolved cases. Certain factors associated with older adults' susceptibility to health misinformation were suggested to the changes with people's aging. For example, cognitive abilities that are important to detect falsehoods, such as episodic memory and reasoning, decline with age, particularly with those aged between 60 and 65 years [47, 48]. Older adults also showed less sensitivity to untrustworthy strange faces than younger adults [49]. Moreover, according to socioemotional selectivity theory [10], older adults may be more motivated to pursue emotional satisfaction than to pursue what is truth. However, it is unclear how age-related declines and characteristics of misinformation jointly influence their credibility judgments and spreading of misinformation.

3 Method

3.1 Participants

Older adults were eligible for participation in the experiment if they were healthy, aged above 55, and could read Chinese characters, according to their self-reports. A total of 59 older adults (Mean age = 66, SD = 6.9) participated in this study and their characteristics are shown in Table 1. Participants were first approached through recruitment flyers on campus, communities near the campus, and the seniors' colleges. Additional participants were approached through snowball sampling. They were asked to bring corrective eyewear if they thought it would be necessary for their reading. The data were collected anonymously, and the ethics guidelines of the Chinese Ergonomics Society were met. Participants signed consent forms and were informed that they could drop out of the experiment at any time.

Table 1 Descriptive statistics of demographical characteristics and variables in the study

Characteristics	*n*	%	*M*	SD
Age			66.73	6.94
Gender				
Female	17	29.81%		
Male	42	71.19%		
Educational background				
Primary school	12	20.34%		
Middle school	35	59.32%		
College degree	12	20.34%		
Smartphone experience				
No smartphone experience	15	25.42		
Low level of smartphone experience	14	23.73		
High level of smartphone experience	29	49.15		
Experience of being cheated on				
Yes	15	25.42%		
No	44	74.58%		
Living conditions				
Living alone	9	15.25%		
Living with spouse or children	50	84.75%		
Income				
Between 1000 and1999 RMB	5	8.47%		
Between 2000 and 2999 RMB	40	67.80%		
Above 3000 RMB	14	23.73%		
Physical conditions				
Very bad	1	1.69%		
Bad	9	15.25%		
Fair	22	37.28%		
Good	11	18.64%		
Very good	16	27.12%		
Fear			6.14	1.24
Frequency of reported fear			17.43%	18.55%
Happiness			6.02	0.94
Frequency of reported happiness			49.55%	19.81%
Disgust			6.28	0.91
Frequency of reported disgust			26.98%	20.01%
Headline attractiveness			5.79	1.27

3.2 Experiment design

The three independent variables were fear, disgust, and happiness. Among them, happiness was selected in contrast to negative emotions. The three emotions were evoked by images in the content of health information. Researchers prepared ten images to induce these emotions. Since the emotion induced by a certain image may be varied by participants, the three independent variables were measured by participants' self-reported emotional perceptions rather than the images. For the measurement, participants indicated which words described their undergoing affective experience (category) and to what extent the experience was ranging from one (Not at all) to seven (An extreme amount), by using the adapted Discrete Emotions Questionnaire (DEQ) [50]. Noldus FaceReader was used for manipulation check.

The two dependent variables were older adults' judgment on the credibility of health information and their intention to share it. Participants judged the credibility of content on a seven-point scale ranging from one (Very unbelievable) to seven (Very believable). In order to understand why people rightly or wrongly judge the credibility of health information, the actual veracity of each article and participants' credibility judgments were contrasted. Thus, three measures were obtained: the rate of successful judgment, the frequency of Type I error (i.e., judging a rumour false when it is actually true, false-positive error), and the frequency of Type II error (i.e., judging a rumour true when it is actually false, false-negative error). The intention to share the health information was measured by a dichotomous question "Would you like to share this article with others?" (response options: yes/ no).

Ten covariates were considered, including headline attractiveness, veracity, age, education, income, gender, smartphone experience, the experience of being cheated on, living conditions, and physical conditions. Headline attractiveness was measured by asking "How attractive do you think of this headline?" on a seven-point scale ranging from one (Not at all) to seven (An extreme amount). Veracity referred to the authenticity (i.e., true or false) of articles, which was derived based on authoritative media (described further in the Materials and Equipment section). Considering the number of years that people used a smartphone and their frequency of per day use, smartphone experience was measured by two questions, "How long have you been using a smartphone?" and "How long do you use your smartphone every day on average?".

3.3 Materials and equipment

Health information included eight true articles (derived from peer-reviewed journals, Wikipedia, and official organizations) and twelve false articles (derived from the biggest platform to debunk online misinformation that was run by the National Internet Information Office of China). In addition, twenty health articles (including eight true and twelve false articles) were retained as backup and were used if participants had read any of the articles before. All of the articles focused on health and wellness.

Each article contained one affective image. The images were collected from online sources to represent happiness, fear, or disgust. The International Affective Picture System was not used, because this study wanted to use images contained in health rumours in practice. The fearful and disgusting images involved skin disease or scenes of anatomy but were unrelated to the content of health articles, and images of happiness depicted cute doges or older couples in a state of well-being. To check whether these images could evoke the three emotions, three graduate students independently evaluated these images. Noldus FaceReader was used to check the manipulation of emotions.

The text of twenty health articles was structured into the same format, in a way similar to official accounts on the most popular mobile social media in China, WeChat. Four headlines were listed on each page, from which participants could choose one article from each page to read. Prototypes were developed by Axure RP to represent health articles. They were presented on ThinkPage S1 Yoga with a 13.3-inch touch screen, which was suitable for older adults who were unfamiliar with the keyboard and mouse. The Morae Recorder was used to record on-screen activities.

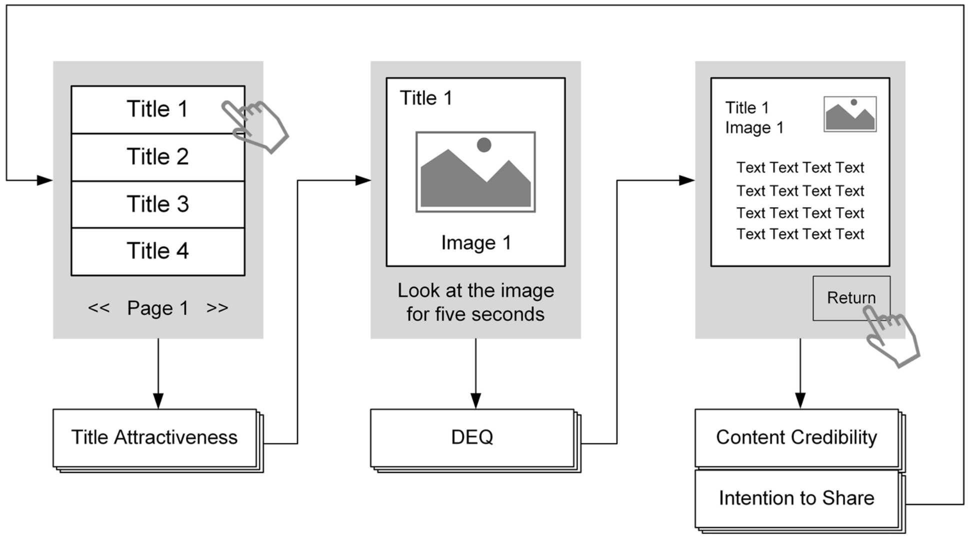
3.4 Procedure

Participants were briefed and then signed a consent form before the experiment. The procedure of the experiment is shown in Fig. 1. Firstly, headlines of health articles were presented, four headlines per page. Participants read the page of four headlines and checked whether they had read or felt familiar with any headline; if so, the page containing headlines and corresponding articles was excluded and the next page would be presented until all headlines were new for participants. Then, participants chose one out of four headlines of health articles on one page by intuition. They evaluated the attractiveness of the chosen headline. This operation aimed to simulate the actual scene in choosing multiple stories online. Thus, the order of presented articles depended on participants' choices. Next, participants were asked to look at an image that was automatically presented on the screen for five seconds and fill in the DEQ scale. Thus, the categories and frequency of participants confronted with these images also depended on participants' intuitive choices. After that, participants read the textual content of the chosen health article. Finally, they rated the credibility of the article and intention to share it. This process continued until they had read six health articles.

3.5 Data analysis

Participants' credibility judgments on the seven-point scale were coded as a dichotomous variable firstly, by marking one to three as "unbelievable" and five to seven as "believable". Thus "four" as the neutral judgment was excluded from the related analysis. Then researchers compared this

Fig. 1 The procedure of each trial



dichotomous variable with the actual veracity of articles to obtain three judgments, including successful judgment, Type I error, and Type II error. The frequency of each judgment was calculated. Besides, smartphone experience was divided into three levels, including no smartphone experience, low and high levels of smartphone experience. “No smartphone experience” refers to participants who have never used a smartphone. The low and high levels of smartphone experience were divided by the median of participants’ smartphone experience.

For analysis, in order to determine the potential influencers of dependent variables, Pearson’s correlation coefficients, univariate logistic regression, and univariate linear regression were used first. Then the statistically significant variables were included in the multivariate linear and logistic regression models to analyse their particular impacts on dependent variables. Assumptions of corresponding regression models have been tested. The multivariate linear regression models of credibility judgments and Type II error rate met the assumptions of linear regression; relevant statistics are shown in Tables 2 and 3. The multivariate logistics regression model was used to predict the intention to share health information, which violated the assumption of independent errors. Thus, the generalized estimating equation (GEE) was used to correct the intra-individual influence [54]. In GEE analysis, the correlations among the binary responses were modelled as unstructured. This study reported the results derived from both the multivariate logistic model and GEE, while its discussion was based on the GEE results. The study reported the regression coefficient (*B*), adjusted R^2 and pseudo R^2, standardized beta (β), and odds ratio of models.

Table 2 Results of multiple regression analysis for predicting credibility judgments

	B	SE	*t*	*β*	*p*	VIF
Constant	4.202	0.592	7.102	0.000	< 0.0001***	
Veracity false (ref.)						
Veracity true	**0.529**	0.160	3.297	0.165	**0.0011****	1.052
Headline attractiveness	**0.392**	0.065	6.067	0.330	**< 0.0001*****	1.247
Gender female (ref.)						
Gender male	−0.220	0.199	−1.106	−0.066	0.270	1.502
Income	−0.004	0.165	−0.027	−0.002	0.979	1.552
Education	**−0.321**	0.144	−2.227	−0.134	**0.027***	1.529
Living with others (ref.)						
Living alone	0.323	0.211	1.530	0.077	0.127	1.057
Physical condition	−0.085	0.071	−1.206	−0.061	0.229	1.074
Experience of smartphone	−0.050	0.108	−0.462	−0.027	0.644	1.495

F(8,324) = 12.33, $p < 0.0001$, adjusted $R^2 = 0.215$. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The multiple regression model excluded two outliers according to the leverage plot. The data met the assumption of independent errors (Durbin-Watson statistic = 1.908, $p = 0.25$)

Table 3 Results of multiple regression analysis for predicting the frequency of Type II error

	B	SE	β	t	p	VIF
Constant	0.040	0.174		0.231	0.818	
Headline attractiveness	**0.014**	0.005	0.390	2.890	**0.0056****	**1.335**
Gender female (ref.)						
Gender male	−0.097	0.063	−0.207	−1.530	0.132	1.335

$F(2,53) = 10.1$, $p = 0.0002$, adjusted $R^2 = 0.249$. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The multiple regression model excluded two outliers according to the leverage plot. The data met the assumption of independent errors (Durbin-Watson statistic = 1.755, $p = 0.312$)

Welch's *t*-test was used for the post hoc test. All analyses were conducted using R (version 4.0.3).

4 Results and discussion

In total, 81.36% of participants finished all six trials. Among the rest of participants, one participant finished three trials; one participant finished four trials; and nine participants finished five trials. The descriptive statistics are shown in Table 1. Although the experiment had prepared eight true articles and twelve false articles, participants were exposed to false articles ($M = 66.95\%$, SD = 15.1%) approximately twice as often as true articles ($M = 33.05\%$, SD = 15.1%) due to their intuitive choices. Most participants were exposed to both true and false articles except two participants who only encountered false articles. Meanwhile, the frequency of the three emotions participants reported was varied. To ensure the reliability of self-reported emotions measured by the scales, the Chi-squared test was conducted to contrast the self-reported data with the data recorded by the FaceReader for the manipulation check. The results indicated that the happiness, fear, and disgust measured by DEQ and FaceReader were comparable ($\chi^2(187) = 190$, $p = 0.405$).

4.1 Credibility judgment

Participants on average judged health articles as believable ($M = 5.56$, SD = 1.53). The multivariate regression model is shown in Table 2. The results indicate that participants seemly judged the credibility of a health article based on its actual veracity. The actual true articles ($M = 6.05$, SD = 1.23) received a higher credibility score than false ones ($M = 5.33$, SD = 1.59, $t(404) = -60.88$, $p < 0.001$). However, the credibility of false articles was still overestimated, exceeding the threshold of "unbelievable" on the seven-point scale. Participants also depended on the degree of headline attractiveness to judge the credibility of health articles. The more attractive the headline was, the more believable the article participants perceived. Moreover, participants with better education were seemly cautious when judging the credibility of health information. Participants with primary education rated the highest ($M = 6.03$, SD = 1.38) on heath articles' credibility, followed by those with middle education ($M = 5.61$, SD = 1.54) and college education ($M = 5.06$, SD = 1.42).

Overall, older adults were inclined to overrate the credibility of health information they read. The inclination usually works in daily life. According to the Bayesian model of cognition, it is rational for people to assume that a statement is true at first and not to call it false until new evidence appears [58]. The first default phase is always easy, but the second phase of unbelieving needs cognitive efforts. Due to the age-related decline in semantic memory, notable impairment was seen as a key predictor of illusory truth and fluency [59]. Moreover, it has been suggested that older adults are less motivated to identify the authenticity of information because their life goals have changed [7, 11]. Older adults in this study might thus have found it challenging to identify falsehoods due to age-related decline in cognitive abilities.

In order to further explore why participants rightly or wrongly judged the credibility of health articles, we analyzed predictors of the frequency of the three judgments, including successful judgment, Type I error, and Type II error. Although older adults in this study had a considerable time to read the content of each health article ($M = 1.36$ min, SD = 0.80 min, range = 0.18–4.16 min), they successfully discerned 41.38% (SD = 21.00%) of health articles on average. None of the factors was found to significantly impact the successful judgment rate. Given that participants were not influenced by the three emotions, they seemed to be "rational" to judge whether a health article is true. Ironically, the quality of their "rational" judgment did not turn out to be better than chance. That is, an older adult who thinks he or she has put great effort into judging health articles may be worse at credibility judgments than another older adult who just randomly guesses the credibility. On the contrary, the result may also imply that the way of older adults distinguishing health misinformation is irrational and does not rely on any characteristics of the information.

For the incorrect judgments, participants on average made 2.03% Type I errors (SD = 5.61%, i.e., judging a rumour as false when it is actually true) and 47.46% Type II errors (SD = 23.57%, i.e., judging a rumour as true when it is actually false). Articles that were perceived to be true by participants tended to be falsehoods. The occurrence of more false negative errors than false positive errors implied that the most older adults seemed to follow the principle "better safe than sorry." They would rather trust health misinformation to avoid health risks than doubt it to avoid fraud risks.

Only seven participants made a Type I error, which would decrease the statistical power of hypothesis testing. For Type II error rate, the results of multiple regression analysis are shown in Table 3. The results indicate that the attractiveness of headline of health misinformation significantly misled participants' trust in it. With the increasing attractiveness of the headline of misinformation, more participants trust in it. Taking a closer look at the headlines, it can be seen that the top three health articles that received the highest number of clicks were: "These three home-cooked dishes are the natural enemies of arteriosclerosis," "Never eat these five fruits and vegetables with peel!" and "Wolfberry and another thing, of which cancer cells are most afraid!" All of them are falsehoods. Among the top ten health articles, only two of them are true: "Physical symptoms of arteriosclerosis you should pay attention to, otherwise the blood vessels will burst" and "Notes to maintain kidney health and to prevent kidney disease." Therefore, an eye-catching headline might not only be the first step to draw the attention of older adults in this study, but also might increase their likelihood of judging it to be believable after reading its content. The preference for eye-catching headlines is not a surprise [57]. However, many studies found that clickbait often decreased audiences' perceptions of journalistic credibility and quality after reading the content of news articles (e.g., [55, 56, 60]); because the mismatch between the headline and content of misinformation would fail audiences' expectation. These studies mainly focused on younger adults who may be sensitive to or even tired of the strategies for grabbing attention. By contrast, older adults may be unaware that the eye-catching headline is a strategy to entice them because they are immigrants of the digital world [61].

4.2 Intention to share health information

On average, older adults were willing to share 78.76% (SD = 23.46%) of health articles they have been exposed to. Table 4 presents the multiple regression analysis for predicting the intention to share health information. As the result indicated, the main rationale of participants deciding whether to share the health article was how credible they thought of it. Older adults seemed more reasonable than those who shared information based on what they want to share rather than what is true [62]. However, the inclination of overtrusting health information may result in mistakenly sharing more misinformation. In this study, 62.5% of health articles that older adults want to share were falsehoods.

Older adults were unable to avoid spreading more health misinformation than true information in this study, although they had tried to discern what is true or false before sharing. Multiple researchers suggested that the lack of credibility judgment mainly accounted for the spreading of misinformation on social media (e.g., [63–65]). Furthermore, Pennycook et al. [66] found that requiring participants to judge the accuracy of COVID-19 news before sharing increased the quality of shared news twice to three times, in comparison with the condition only requiring participants to decide whether to share the news. This experimental manipulation had evolved into an intervention—an email to nudge people into attending on the accuracy of online information; and its effectiveness had been validated among 5379 real Twitter users [67]. However, this study did not find the expected effectiveness. The possible reason is that the interested populations in the above studies are almost younger adults

Table 4 Results of logistic regression model and generalized estimating equation for predicting the intention to share health information

	Logistic regression model			Generalized estimating equation		
	B	SE	Odds ratio [95% CI]	B	SE	Odds ratio [95% CI]
Constant	−3.189**	1.089	0.041 [0.005, 0.341]	−2.799*	1.418	0.061 [0.004, 0.981]
Credibility judgment	**1.178*** **	0.145	3.249 [2.490, 4.399]	**1.338*** **	0.196	3.810 [2.595, 5.595]
Headline attractiveness	0.035	0.151	1.035 [0.768, 1.394]	−0.131	0.193	0.878 [0.601, 1.281]
Education primary school (ref.)						
Education middle school	−1.442*	0.672	0.236 [0.056, 0.801]	−1.486	0.847	0.226 [0.043, 1.192]
Education college degree	−1.677*	0.725	0.187 [0.040, 0.711]	−1.609	0.910	0.200 [0.034, 1.190]
Gender female (ref.)						
Gender male	−0.588	0.412	0.556 [0.248, 1.255]	−0.811	0.459	0.444 [0.181, 1.092]

The logistic regression model fits significantly better than an empty model, $\chi^2(5) = 146.12$, $p < 0.0001$; the Nagelkerke pseudo R^2 of the logistic regression model is 0.543. The data met the assumption of collinearity (VIFs < 1.254) but violated the assumption of independent errors (Durbin-Watson statistic = 1.594, $p < 0.0001$). Thus the study discussed based on the results of GEE. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. CI = Confidence interval for odds ratio; ref. = Reference category who may be more skilled at using social media and discerning online misinformation than older adults. By contrast, the interested population in this study is older adults who showed poorer discernment even worse than guesses. Therefore, it is far from enough for older adults to resist misinformation by only nudging them into judging the credibility of online information. The intervention boosting older adults' ability of successful judgment is also needed [68].

4.3 Limitations

Six limitations of this study should be noted. First, the null effect of emotion on credibility judgments and intention to share health information may be on account of the experimental manipulation. The emotional images used to induce emotions were unassociated with the content of articles, so these images may be hard to influence how participants judge the content of articles. Second, participants' preexisting knowledge and cognitive abilities were not examined. Third, the number of articles presented to participants was limited and the composition of true and false articles was not balanced, so the base rate might have influenced their judgment accuracy. Fourth, possible interactions among the headline, the image, and the text content might exist and call for further studies. Fifth, sharing misinformation in this study lacked feedback from other people, which might be different from real-time interactions on social media. Finally, this study focused on Chinese older adults, and possible cultural differences should be considered before generalizing the findings of this study to other countries.

5 Conclusion

This study explored the factors influencing older adults' judgments on the credibility of online health articles and the factors influencing their intention to share these articles. Although participants were notified of possible falsehoods in advance, they were generally not good at identifying the misinformation presented in this study. First, participants were exposed to health misinformation approximately twice as often as true information because they choose articles for furthering reading based on headlines alone. Eye-catching headlines not only attracted more clicks at first glance but also given rise to participants' misjudging false content as truths. As a result, participants only successfully judged 41.38% of health articles on average, although they had enough time to discern misinformation. In addition, participants' willingness to share a health article depended on its credibility they perceived. However, participants would rather trust and regret than doubt and regret, which led to the result that 62.5% of health articles they want to share were falsehoods.

These findings further stress the threats of online health misinformation to older adults. Interventions to help older adults effectively resist misinformation are urgently needed and should consider two things. First, the eye-catching headline is crucial for enticing clicks and increasing older adults' credibility perceptions on misinformation. Thus, reducing the use of malicious eye-catching headlines may contribute to reducing older adults' exposure to and trust in misinformation. Second, it is not sufficient to decrease older adults' spreading of misinformation just by nudging them into considering the accuracy of information. The intervention should also strengthen older adults' ability to successfully discern falsehoods.

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Declarations

Conflicts of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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