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How does online social capital influence health behaviours among older adults? — an analysis based on the mediating effect of health beliefs and structural equation modeling validation

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Abstract. Against the backdrop of China's deep aging population and widespread internet adoption, online channels have become an important avenue for optimizing health management among older adults. However, the persistent "digital divide" continues to limit the full realization of this potential. Existing studies often treat online social capital as a single overall variable and have not sufficiently examined the mediating role of health beliefs between two types of online social capital and older adults' health behaviours, leaving the underlying mechanisms unclear. Based on 465 valid nationwide survey responses and grounded in Bandura's Social Cognitive Theory, this paper analyzes the influence mechanisms of bonding and bridging online social capital and health beliefs (perceived susceptibility, severity, benefits, and barriers) on older adults' health behaviours. The study finds that neither type of online social capital has a significant direct effect on health behaviours; all four dimensions of health beliefs positively influence health behaviours (with perceived severity having the strongest effect); perceived susceptibility, severity, and benefits serve as significant mediators, while perceived barriers do not. This paper reveals relevant mechanisms and provides references for digital health interventions and age-friendly platform design for older adults.

Keywords: online social capital, health behaviours of older adults, health beliefs, social cognitive theory

1. Introduction

China's deepening population aging and the universal popularization of the internet have reshaped the health management landscape for older adults.According to data released by the National Bureau of Statistics, by the end of 2024, the population aged 60 and above reached 310.31 million, accounting for 22.0% of the total population. This demographic shift has made elderly health issues a prominent social concern. Actively promoting health behaviour adoptions among older adults—including regular physical examinations, balanced diets, regular exercise, and adherence to medical advice—is a key strategy to address the challenges of population aging, improve the quality of life for the elderly, and reduce the burden on public health services [1]. Meanwhile, the penetration and depth of internet and smart device use among older adults continue to

increase. More and more seniors engage in social interactions, obtain health information, and manage their health through online channels such as social media, online health communities, and health management apps. This creates new possibilities for expanding social connections and building health support networks for the elderly. However, compared to younger groups, older adults face a more pronounced "digital divide," encountering many obstacles in effectively accessing, understanding, and utilizing online health information and services [2].

Although social capital (both online and offline) is widely recognized as having an important impact on health behaviours [3], empirical research specifically on online social capital and older adults' health behaviours remains relatively scarce and inconclusive [4]. On the other hand, health beliefs, as key psychological antecedents of health behaviours, have a well-validated theoretical model encompassing four core dimensions: perceived severity, perceived susceptibility, perceived barriers, and perceived benefits [5]. However, the critical mediating role of health beliefs in the influence of social capital—especially online social capital—on older adults' health behaviours has not been fully tested or clearly explained.

Based on the above context, this study adopts Bandura's social cognitive theory as the core framework to analyze the multi-level mechanisms by which online social capital affects health behaviours among older adults. This theory emphasizes the triadic reciprocal interaction among environment, individual cognition, and behaviour, providing systematic support for exploring the pathway "online social capital → health beliefs → behaviour adoption" [6]. Online social capital, as a key environmental input, includes bonding and bridging capital. This social environment continuously shapes older adults' health cognition by providing social support, behavioural role models, and health norm information [7]. Health beliefs serve as the core cognitive mediator linking environment and behaviour; their four dimensions are both the cognitive outcomes of environmental stimuli and the direct psychological drivers of health behaviour change among older adults.

Based on this theoretical integration, this study proposes two core research questions: First, do bonding and bridging online social capital have differential effects on the four dimensions of health beliefs among older adults? Second, do health beliefs mediate the relationship between these two types of online social capital and older adults' adoption of health behaviours? Using 465 valid nationwide survey responses and structural equation modeling, this study aims to reveal the internal mechanisms by which online social capital influences health behaviour adoption among the elderly, providing supplementary insights and extensions for related research fields.

2. Literature review and research hypotheses

2.1. Online social capital and health behaviour adoption among older adults

As the internet becomes deeply integrated into the lives of older adults, online interactions have become an important means for them to expand social networks and obtain social support. Social capital theory posits that resources embedded in social networks—such as trust, norms, information, and support—can significantly influence individual health and behavioural choices by lowering the costs of health behaviours and enhancing self-efficacy [8]. Online social capital, as an extension of offline social capital into the digital space, specifically refers to the health-promoting social network resources that older adults accumulate through online platforms such as social media, online communities, and health apps. Its potential positive effects on health behaviours have been widely recognized theoretically. For example, older adults can conveniently access diverse health information, share disease management experiences, and receive emotional support and instrumental assistance (such as medical advice and medication reminders) from family, friends, and health

professionals via online platforms. These resources can motivate them to adopt and maintain health behaviours such as regular physical exams, balanced diets, and regular exercise.

Existing empirical research on online social capital and health behaviours among the elderly still faces two main limitations: First, the overall volume of research is relatively scarce, and the conclusions show significant discrepancies. Some studies focusing on elderly community groups have found that frequent online social interactions can effectively enhance older adults' health information literacy and self-efficacy regarding health behaviours, thereby significantly promoting the adoption of preventive health behaviours (such as vaccination and chronic disease screening) [9]. Conversely, research targeting very old and low-education elderly populations points out that the "digital divide" faced by older adults when using online resources—such as insufficient ability to discern information leading to believing false health information, limited skills in operating smart devices making it difficult to access effective resources, and low trust in online strangers resulting in refusal to accept online support—may weaken or even negate the positive effects of online social capital, ultimately showing no significant association between online interaction and health behaviours [10]. Second, most studies treat online social capital as a single, unified variable, neglecting its internal structural heterogeneity. Based on the strength of network connections and resource attributes of social capital, online social capital can be further divided into bonding online social capital and bridging online social capital [11]. This classification has been validated in studies on health behaviours among youth but has not yet been widely applied in research on elderly populations [12]. Bonding online social capital originates from highly homogeneous, close-knit online networks (such as family member groups or chat groups of old friends), with core resources including emotional comfort, tangible assistance, and high trust; bridging online social capital comes from heterogeneous, loosely connected weak-tie networks (such as cross-regional elderly health discussion groups or health blogger fan interaction areas), mainly providing novel health information, diverse health perspectives, and cross-group resource connections. The resource composition and functional logic of these two types of online social capital differ significantly, and ignoring this structural difference may cause existing research to fail to accurately identify the specific pathways through which online social capital influences elderly health behaviours, leading to conflicting conclusions.

Based on the above analysis and considering the resource attributes of the two types of online social capital, it can be inferred that bonding online social capital provides emotional support and tangible help that can reduce the psychological resistance and actual costs for older adults in adopting health behaviours; bridging online social capital offers diverse health information that can fill knowledge gaps and enhance their recognition of the value of health behaviours. Accordingly, this study proposes the following hypotheses:

H1a: The degree of exposure to bonding online social capital has a positive effect on the adoption of health behaviours among older adults.

H1b: The degree of exposure to bridging online social capital has a positive effect on the adoption of health behaviours among older adults.

2.2. Health beliefs and the adoption of health behaviours among older adults

The adoption of health behaviours is influenced not only by external environmental resources but also results from individuals' decision-making based on cognitive evaluation. The Health Belief Model (HBM) posits that human behaviour is the outcome of psychological activity, and beliefs are the most direct psychological determinants of behaviour. Health beliefs mainly consist of four components: perceived severity, perceived susceptibility, perceived barriers, and perceived benefits. Previous research has explored the influencing factors and intervention effects on health behaviours from multiple dimensions. Path analysis based on HBM for hypertensive elderly individuals shows that perceived susceptibility and perceived severity significantly

and positively predict health behaviour adoption, perceived benefits also have a positive effect, while perceived barriers inhibit behaviour adoption [13]. In the context of the COVID-19 pandemic, studies on elderly willingness to receive booster vaccinations found that perceived susceptibility, perceived severity, and perceived benefits (internal/external rewards) significantly increase vaccination willingness, whereas perceived barriers negatively affect willingness. Regarding elderly acceptance of telehealth services, cross-national surveys indicate that perceived susceptibility, perceived severity, and perceived benefits positively promote the adoption of telehealth behaviours, while perceived barriers significantly inhibit adoption. In a community survey of elderly diabetic patients, perceived susceptibility, perceived severity, and perceived benefits positively correlated with health behaviour scores, whereas perceived barriers negatively correlated [14]. Research on media exposure's impact on elderly COVID-19 protective behaviours further confirms that perceived susceptibility and perceived severity play significant positive mediating roles between media information and protective behaviours, while perceived barriers reduce behavioural intention [15]. Studies on fraud prevention knowledge learning from a risk communication perspective show that perceived susceptibility, perceived severity, and perceived benefits promote learning behaviours, while perceived barriers significantly inhibit learning willingness and behaviour. These studies cover multiple health behaviour domains including chronic disease management, vaccination, telemedicine, health information acquisition, and fraud prevention, collectively providing consistent evidence that perceived susceptibility, perceived severity, and perceived benefits are positively correlated with elderly health behaviour adoption, whereas perceived barriers are negatively correlated.

For the elderly population, the formation and role of health beliefs have particular characteristics. Due to physiological decline and the prevalence of chronic diseases, older adults often have relatively high perceived susceptibility and perceived severity regarding health; however, constrained by physical condition, economic status, cognitive ability, or social support, they may face more and more significant perceived barriers when adopting health behaviours. Therefore, in-depth exploration of the specific mechanisms of the four dimensions of health beliefs in elderly health behaviour adoption holds important theoretical and practical significance.

Based on the Health Belief Model and evidence from elderly population studies, this research proposes the following hypotheses:

H2a: Perceived susceptibility is positively correlated with the adoption of health behaviours among older adults.

H2b: Perceived severity is positively correlated with the adoption of health behaviours among older adults.

H2c: Perceived benefits are positively correlated with the adoption of health behaviours among older adults.

H2d: Perceived barriers are negatively correlated with the adoption of health behaviours among older adults.

2.3. Online social capital and health beliefs

Cognitive processing theory posits that the individual's cognitive processing of external resources is key to the formation of beliefs. The health information, emotional support, and other resources that older adults obtain from bonding and bridging types of online social capital must undergo cognitive processing such as information screening and meaning interpretation before they can form perceptions of health behaviours (i.e., health beliefs). The role of bonding online social capital has been clearly validated in a study on the willingness to share health information based on strong-tie social networks. This study, framed by the Theory of Planned behaviour, the Health Belief Model, and Social Capital Theory, surveyed 391 users and employed both PLS-SEM and fsQCA methods for analysis. Results showed that emotional trust (a core element of

bonding capital) significantly increased perceived susceptibility, which in turn positively influenced the willingness to share health information; meanwhile, the activity level of bonding networks enhanced perceived severity and further promoted sharing behaviour through perceived benefits; regarding perceived barriers, high emotional trust in bonding networks significantly reduced users' perception of information acquisition costs, thereby increasing behavioural intention [16].

Secondly, bridging online social capital (i.e., cross-group, weak-tie network resources) is reflected in research on the impact of online information support on HPV vaccination willingness. This study regarded social support as an external resource of bridging capital and constructed a mediation model of health beliefs to examine the pathways through which online information support affects perceived susceptibility, perceived benefits, and perceived barriers. Empirical results indicated that cross-group information support significantly increased perceived susceptibility and perceived benefits and indirectly enhanced vaccination willingness by reducing perceived barriers, confirming the key role of bridging capital in enhancing perceived benefits and lowering perceived barriers [17]. At the same time, mismatches exist between types of social capital and health beliefs. For example, bonding capital has limited impact on perceived severity, as shown by the lowest perceived severity scores in breast cancer screening studies; bridging capital may even exacerbate perceived barriers due to information overload, such as mixed pandemic information [18].

In summary, the literature reviewed reveals that existing research has preliminarily uncovered associations between bonding and bridging online social capital and certain dimensions of health beliefs. However, significant gaps remain, and systematic conclusions have yet to be formed: existing studies mostly focus on general adult populations without adequately considering the particularities of older adults, such as physiological decline, cognitive differences, and the digital divide, making it difficult to directly infer the mechanisms by which these two types of online social capital affect older adults' health beliefs; the associations between the two types of capital and health belief dimensions are inconsistent and incomplete; moreover, the differentiated pathways through which these two types of capital influence various dimensions of health beliefs remain unclear. Based on the above, the following research question is proposed:

RQ1: What roles do Bridging Online Social Capital and Bonding Online Social Capita respectively play in older adults' perceived susceptibility, perceived severity, perceived barriers, and perceived benefits?

2.4. The mediating role of health beliefs

Based on Bandura's Social Cognitive Theory and its triadic reciprocal determinism of "environment-cognition-behaviour," this study focuses on the mechanism by which online social capital influences older adults' adoption of health behaviours. Bonding and bridging online social capital serve as key environmental inputs, providing specific social resources to older adults; health beliefs act as core cognitive factors that directly drive behavioural decisions; and health behaviour adoption is the target behaviour of interest. Social Cognitive Theory indicates that environmental factors indirectly affect behaviour through influencing individual cognitive mediation processes.

Existing research has explored the mediating role of health beliefs across multiple populations and communication contexts: Zhang et al. found that exercise interventions partially mediate college students' psychological stress through health beliefs (rationality and control orientation) [19]. Wang et al.'s national survey showed that organizational communication indirectly influences protective behaviours through perceived susceptibility, perceived barriers, and perceived benefits; network communication only indirectly affects behaviour through perceived barriers; interpersonal and mass communication fail due to "negative masking" by perceived barriers [20]. Sun et al. pointed out that sports social media health communication and

adolescent sports behaviour mutually promote each other, with health beliefs playing a partial mediating role but direct effects being stronger; key dimensions involve health information transmission [21].

In the field of HPV vaccination, Guo et al. found that new media exposure (e.g., social media) positively influences female college students' vaccination intentions through mediating effects of perceived susceptibility and perceived benefits, with no significant effect on perceived barriers [22]; Jiang et al. showed that online information support can directly increase vaccination willingness and also form a dual mediation through perceived susceptibility and perceived benefits [17]. Both studies reveal differentiated mediating characteristics of health beliefs and channel adaptability.

A review reveals that although existing literature confirms the mediating value of health beliefs in promoting health behaviours across multiple populations, three major research gaps exist: research on the mediating mechanism of health beliefs under the context of online social capital among older adults is weak; the internal structural complexity of bonding and bridging online social capital is generally overlooked; and under older adults' online interaction contexts, the complex mediating pathways by which different dimensions of health beliefs influence the impact of different types of online social capital on health behaviours (such as the presence of negative masking or stronger direct effects) remain to be elucidated.

Based on the above theories and research practices, the following research question is proposed:

RQ2: In the process by which bonding and bridging online social capital influence older adults' adoption of health behaviours, do different dimensions of health beliefs (perceived susceptibility, perceived severity, perceived barriers, perceived benefits) play a mediating role? Through which specific health belief dimensions (i.e., which mediating pathways) do different types of online social capital affect health behaviours?

In summary, online social capital exposure (bonding and bridging), health beliefs (perceived susceptibility, perceived severity, perceived barriers, and perceived benefits) are important variables influencing older adults' adoption of health behaviours. These variables are integrated into the analytical framework and conceptual model of this study, as shown in Figure 1.

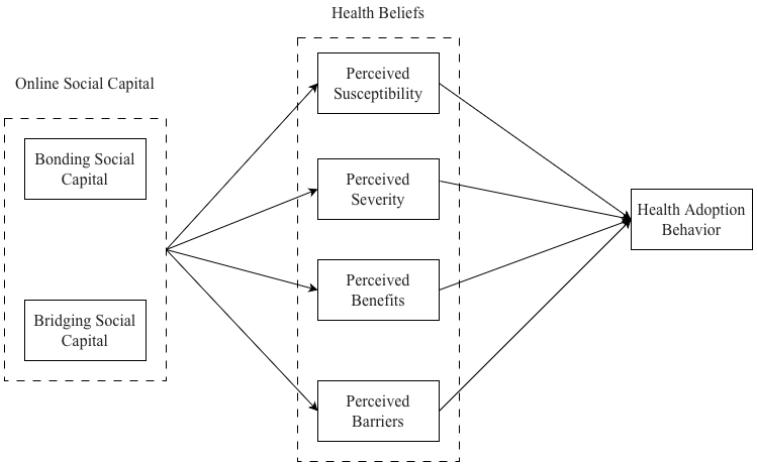

Figure 1. Model of online social capital, health beliefs, and health behavior adoption among older adults

3. Research design

3.1. Data collection

This study targeted elderly individuals aged 60 and above who possess self-awareness and independent thinking abilities. From April to August 2025, questionnaires were distributed through both online and offline

channels. Online distribution utilized Wenjuanxing to generate links, which were shared on social media platforms commonly used by older adults, such as WeChat, Douyin, and Kuaishou. Offline distribution involved visits to community senior activity centers, parks, and senior universities. To ensure that elderly participants understood the questionnaire content, researchers explained the meaning of each item and assisted with completion. A total of 500 questionnaires were collected; after excluding invalid responses due to age discrepancies, incorrect answers, or omissions, 465 valid questionnaires remained. The sample covered 30 provincial-level administrative regions across China.

3.2. Variable measurement

The questionnaire included three categories of variables: online social capital, health beliefs, and health behaviour adoption among older adults. Details are as follows:

3.2.1. Online social capital

This study measured online social capital based on the scale proposed by Williams [23], adjusted according to the research objectives and practical considerations. After conducting exploratory factor analysis on the questionnaire, and considering that the study context involved short video usage and needed to align with elderly language habits, slight modifications were made to the translated scale. The revised scale contains a total of 10 items: 5 items measuring online Bonding Online Social Capita and 5 items measuring online Bridging Online Social Capital. All items use a 5-point Likert scale, with higher scores indicating greater online social capital. The reliability coefficient Cronbach's Alpha was 0.849.

3.2.2. Health beliefs

For the design of items measuring perceived severity, perceived susceptibility, perceived barriers, and perceived benefits, the study mainly referenced questionnaires by Cui et al. [24] and Kamimura et al. [25]. Measurement was conducted through 16 items, with respondents rating from "strongly disagree" to "strongly agree" on a scale from 1 to 5. The reliability coefficient Cronbach's Alpha was 0.906.

3.2.3. Health behaviour adoption

In this study, health behavior adoption refers to the willingness of the elderly to adopt health information; the foundational research of this scale is mainly derived from Kamal et al. [26]. Developed on the basis of the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB), this scale is designed to measure individuals' willingness and inclination to adopt specific health behaviors such as disease prevention and health management, which, after simplification, comprises 4 items for respondents to answer, including "I will actively take health preventive measures", "I will actively browse health information", "I will publicize health knowledge to others" and "I will discuss health-related topics with others"; respondents choose corresponding scores according to their own feelings and actual situations, with higher scores indicating a stronger attitude towards the above behaviors, and the Cronbach's Alpha reliability coefficient of the scale is 0.795.

4. Empirical results

4.1. Measurement model analysis

This study employed structural equation modeling to test the reliability and validity of the measurement model. Results showed that all latent variables met academic standards, and the overall model fit was good. Regarding reliability, Cronbach's Alpha values for latent variables ranged from 0.857 to 0.893, and Composite Reliability (CR) ranged from 0.857 to 0.894, all well above the 0.7 threshold, indicating excellent internal

consistency and high stability in measuring latent variables. For validity, convergent validity tests showed standardized factor loadings of observed items ranged from 0.740 to 0.843, all exceeding the 0.7 standard; Average Variance Extracted (AVE) ranged from 0.600 to 0.661, all above the 0.5 cutoff, indicating strong associations between latent variables and their observed items and effective extraction of item information.As shown in Table 1, the factor loadings, Cronbach's Alpha, CR, and AVE values of all variables meet the evaluation criteria, confirming good convergent validity.

Table 1. Reliability analysis and convergent validity test

Variable	Observable quantity	Factor loading	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Bonding Online Social Capita (SA)	SA1	0.752	0.892	0.893	0.625
	SA2	0.815			
	SA3	0.742			
	SA4	0.798			
	SA5	0.842			
Bridging Online Capital (SB)	SB1	0.790	0.893	0.894	0.627
	SB2	0.780			
	SB3	0.789			
	SB4	0.794			
	SB5	0.804			
Perceived Susceptibility (PSU)	PSU1	0.818	0.873	0.873	0.632
	PSU2	0.789			
	PSU3	0.791			
	PSU4	0.782			
Perceived Severity (PSE)	PSE1	0.827	0.871	0.872	0.629
	PSE2	0.774			
	PSE3	0.805			
	PSE4	0.766			
Perceived Benefits (PBE)	PBE1	0.824	0.867	0.867	0.621
	PBE2	0.758			
	PBE3	0.777			
	PBE4	0.791			
Perceived Barriers (PBR)	PBA1	0.812	0.857	0.857	0.600
	PBA2	0.740			
	PBA3	0.780			
	PBA4	0.765			
Health Behaviour Adoption (HAB)	HAB1	0.788	0.886	0.886	0.661
	HAB2	0.843			
	HAB3	0.832			
	HAB4	0.788			

Discriminant validity is primarily assessed by comparing the square root of the AVE with the correlation coefficients between variables, as shown in Table 2. From Table 2, it can be seen that the square root values of the AVE for each variable are greater than the correlation coefficients between variables, indicating that the scale has good discriminant validity.

Table 2. Discriminant validity test

Variable	Bonding Online Social Capita	Bridging Online Social Capital	Perceived Susceptibility	Perceived severity	Perceived Benefits	Perceived Barriers	Health behaviour Adoption
Bonding Online Social Capita	0.791						
Bridging Online Social Capital	0.496	0.792					
Perceived Susceptibility	0.422	0.386	0.795				
Perceived severity	0.541	0.505	0.439	0.793			
Perceived Benefits	0.449	0.396	0.355	0.479	0.788		
Perceived Barriers	0.513	0.578	0.408	0.498	0.391	0.775	
Health behaviour Adoption	0.507	0.452	0.461	0.575	0.468	0.493	0.813

Note: The bold numbers on the diagonal are the square root of the AVE values.

4.2. Structural model analysis

4.2.1. Model fit analysis

This study conducted Structural Equation Modeling (SEM) using Amos 26.0 to fit the research model. The model fit was evaluated using three categories of indices: Absolute Fit Indices (χ^2/df, GFI, AGFI, RMSEA), Incremental Fit Indices (IFI, CFI, NFI, TLI), and Parsimonious Fit Indices (PGFI, PNFI). Among these, Wu Minglong considers RMSEA the core fit index. In this study, the RMSEA value is 0.017, which is well below the good fit threshold of 0.08 and even better than the excellent range of 0.05, indicating a very small approximation error. Other absolute fit indices include $\chi^2/df = 1.097$ (< 3), GFI = 0.924, and AGFI = 0.908, all above 0.9, demonstrating good absolute fit. The incremental fit indices IFI, CFI, and TLI are all 0.993, and NFI is 0.93, all exceeding the 0.9 standard, with the first three close to 1.0, indicating significant improvement over the baseline model. The parsimonious fit indices PGFI = 0.763 and PNFI = 0.821 are both above 0.5, balancing fit and parsimony. As shown in Table 3, all key indices meet the criteria, indicating a good model fit.

Table 3. Structural equation model fit

Indicator	Degrees of freedom for chi-square (χ^2)/*df*	GFI	PGFI	RMSEA	IFI	CFI	PNFI	AGFI	NFI	TLI
Criteria for judgment	< 3	> 0.9	> 0.5	< 0.10	> 0.9	> 0.9	> 0.5	> 0.9	> 0.9	> 0.9
Indicator value	1.097	0.924	0.763	0.017	0.993	0.993	0.821	0.908	0.93	0.993

4.2.2. Path analysis

Using AMOS 26.0 to process the model data, the statistical relationships among latent variables were obtained (Figure 2). The explanatory power of the variables for elderly health behaviour adoption is $R^2 = 42\%$.

4.2.2.1. Direct effects of bonding and bridging online social capital on health behaviour adoption

Path analysis results show that the direct path coefficient of bonding online social capital on health behaviour adoption is $\beta = 0.092$, $P = 0.201$, which is not significant; the direct path coefficient of bridging online social capital on health behaviour adoption is $\beta = 0.003$, $P = 0.965$, also not significant. This indicates that neither type of online social capital has a significant direct effect on elderly health behaviour adoption. Therefore, hypotheses H1a (the degree of bonding online social capital contact has a positive effect on elderly health behaviour adoption) and H1b (the degree of bridging online social capital contact has a positive effect on elderly health behaviour adoption) are not supported.

4.2.2.2. Effects of health beliefs on health behaviour adoption

The effects of the four dimensions of health beliefs on health behaviour adoption are as follows: perceived susceptibility ($\beta = 0.171$, $P = 0.003$) and perceived severity ($\beta = 0.305$, $P < 0.001$) have significant positive effects on health behaviour adoption, supporting hypotheses H2a and H2b; perceived benefits ($\beta = 0.173$, $P = 0.005$) also have a significant positive effect, supporting hypothesis H2c. However, perceived barriers ($\beta = 0.174$, $P = 0.024$) have a significant positive effect on health behaviour adoption, which is contrary to hypothesis H2d (which predicted a negative correlation between perceived barriers and health behaviour adoption), so H2d is not supported.

4.2.2.3. Effects of bonding and bridging online social capital on health beliefs

Research question RQ1 focuses on the effects of bridging and Bonding Online Social Capita on each dimension of health beliefs. Path analysis results are as follows: bonding online social capital has significant positive effects on perceived susceptibility ($\beta = 0.348$, $P < 0.001$), perceived severity ($\beta = 0.447$, $P < 0.001$), perceived benefits ($\beta = 0.371$, $P < 0.001$), and perceived barriers ($\beta = 0.336$, $P < 0.001$). This indicates that the higher the degree of bonding online social capital contact, the stronger the elderly's perceived susceptibility, perceived severity, perceived benefits, and perceived barriers. Bridging online social capital also has significant positive effects on perceived susceptibility ($\beta = 0.287$, $P < 0.001$), perceived severity ($\beta = 0.389$, $P < 0.001$), perceived benefits ($\beta = 0.272$, $P < 0.001$), and perceived barriers ($\beta = 0.501$, $P < 0.001$). This means that a higher degree of bridging online social capital contact similarly enhances all dimensions of health beliefs.

The specific path coefficients and significance levels are shown in Table 4.

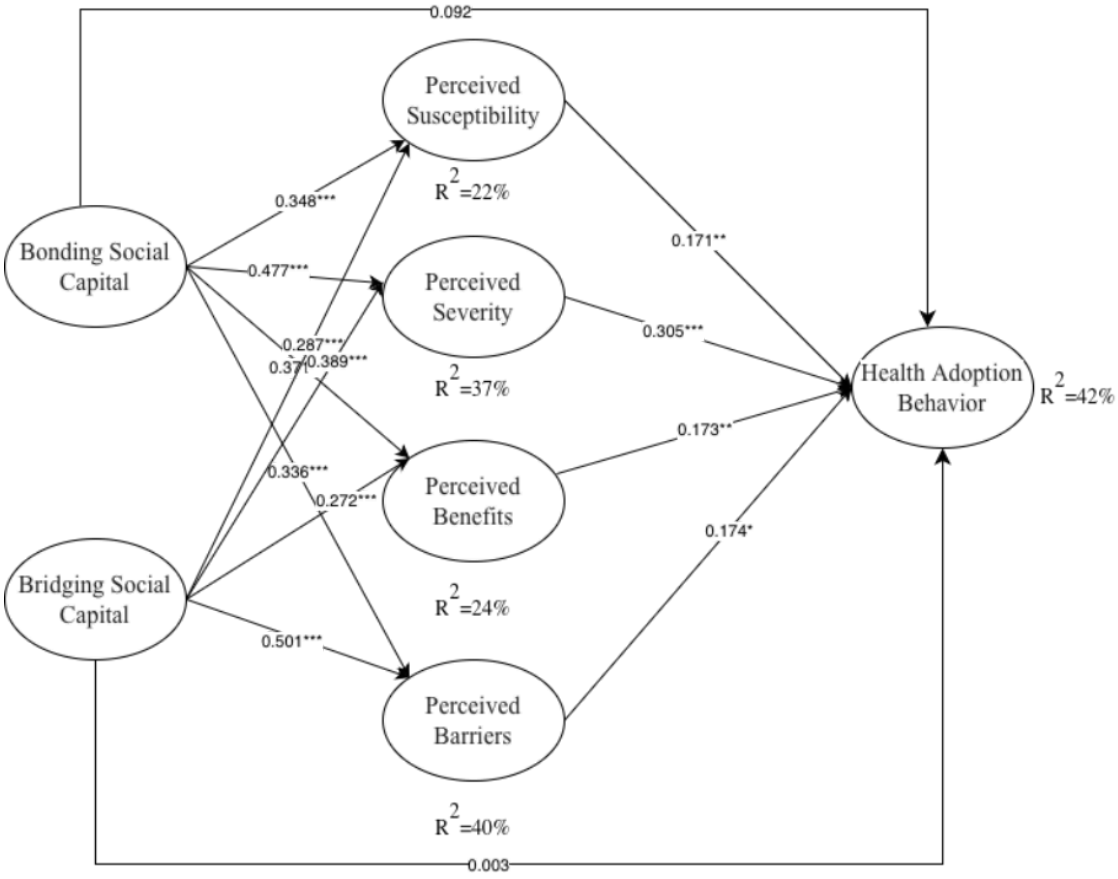

Figure 2. Model path coefficients and significance

Table 4. Path coefficients and significance test

Path	Path coefficient	S.E.	C.R.	*P*	Result
Bonding online social capital → Perceived susceptibility	0.348	0.056	6.177	***	Significant
Bonding online social capital → Perceived severity	0.447	0.054	8.238	***	Significant
Bonding online social capital → Perceived benefits	0.371	0.056	6.671	***	Significant
Bonding online social capital → Perceived barriers	0.336	0.05	6.781	***	Significant
Bridging online social capital → Perceived susceptibility	0.287	0.059	4.863	***	Significant
Bridging online social capital → Perceived severity	0.389	0.057	6.879	***	Significant
Bridging online social capital → Perceived benefits	0.272	0.057	4.772	***	Significant
Bridging online social capital → Perceived barriers	0.501	0.057	8.733	***	Significant
Bonding online social capital → healthy adoption behaviour	0.092	0.072	1.277	0.201	Not Significant
Bridging online social capital → health adoption behaviour	0.003	0.075	0.044	0.965	Not Significant
Perceived Susceptibility → Health Adoption behaviour	0.171	0.058	2.958	0.003	Significant
Perceived severity → Health adoption behaviour	0.305	0.071	4.323	***	Significant
Perceived benefits → Health adoption behaviour	0.173	0.062	2.788	0.005	Significant
Perceived Barriers → Health adoption behaviour	0.174	0.077	2.256	0.024	Significant

4.3. Mediation effect analysis

Compared to the three-step testing method proposed by Wen Zhonglin et al. in 2004, the improved Bootstrap method yields more reasonable and robust results. To further explore the influence mechanism of bonding and bridging types of online social capital on the adoption of health behaviours among the elderly, this study follows the recommendations of Zhao et al., using AMOS 24.0 software for analysis and employing the bias-corrected percentile Bootstrap method to test the mediating effects of various dimensions of health beliefs (perceived susceptibility, perceived severity, perceived barriers, perceived benefits) between the two types of online social capital and elderly health behaviour adoption. In the analysis, the Bootstrap sample size was set to 5,000, with a 95% confidence interval; if the confidence interval for the indirect effect does not include zero, the mediation effect is considered significant, thereby addressing research question RQ2.

4.3.1. Mediation path test for bonding online social capital

The specific test results show that among the effects of bonding online social capital on elderly health behaviour adoption, three dimensions of health beliefs play a significant mediating role, except for perceived barriers, which did not show a significant mediation effect: the mediation effect value for the path bonding online social capital → perceived susceptibility → health behaviour adoption is 0.059, with a 95% confidence interval of [0.005, 0.144], $p = 0.033$, and the confidence interval does not include zero; the mediation effect value for bonding online social capital → perceived severity → health behaviour adoption is 0.136, with a 95% confidence interval of [0.043, 0.290], $p = 0.002$, the confidence interval excludes zero, and this effect value is the largest among significant paths for this type of capital; the mediation effect value for bonding online social capital → perceived benefits → health behaviour adoption is 0.064, with a 95% confidence interval of [0.002, 0.161], $p = 0.044$, and the confidence interval excludes zero; however, the mediation effect value for bonding online social capital → perceived barriers → health behaviour adoption is 0.058, with a 95% confidence interval of [-0.010, 0.161], $p = 0.097$, and the confidence interval includes zero, indicating a non-significant mediation effect.

4.3.2. Mediation path test for bridging online social capital

The mediation paths for bridging online social capital show similar characteristics to those of Bonding Online Social Capita, with three health belief dimensions demonstrating significant mediation effects, while perceived barriers did not reach significance: the mediation effect value for bridging online social capital → perceived susceptibility → health behaviour adoption is 0.049, with a 95% confidence interval of [0.003, 0.122], $p = 0.036$, and the confidence interval excludes zero; the mediation effect value for bridging online social capital → perceived severity → health behaviour adoption is 0.119, with a 95% confidence interval of [0.039, 0.261], $p = 0.002$, the confidence interval excludes zero, and this effect value is the highest among significant paths for this type of capital; the mediation effect value for bridging online social capital → perceived benefits → health behaviour adoption is 0.047, with a 95% confidence interval of [0.001, 0.140], $p = 0.043$, and the confidence interval excludes zero; the mediation effect value for bridging online social capital → perceived barriers → health behaviour adoption is 0.087, with a 95% confidence interval of [-0.017, 0.205], $p = 0.090$, and the confidence interval includes zero, indicating a non-significant mediation effect. Based on the above results, research question RQ2 can be clearly answered.The specific mediation effect test results are shown in Table 5.

Table 5. Mediation effect test results

Path	Effect value	Bias-corrected 95% Confidence interval		*P*
		Lower limit	Upper limit	
Bonding online social capital → Perceived susceptibility → Health adoption behaviour	0.059	0.005	0.144	0.033
Bonding online social capital → Perceived severity → Health adoption behaviour	0.136	0.043	0.29	0.002
Bonding online social capital → Perceived benefits → Health adoption behaviour	0.064	0.002	0.161	0.044
Bonding online social capital → Perceived barriers → Health adoption behaviour	0.058	-0.01	0.161	0.097
Bridging Online Social Capital → Perceived Susceptibility → Health Adoption behaviour	0.049	0.003	0.122	0.036
Bridging online social capital → Perceived severity → Health adoption behaviour	0.119	0.039	0.261	0.002
Bridge-type online social capital → Perceived benefits → Health adoption behaviour	0.047	0.001	0.14	0.043
Bridging online social capital → Perceived barriers → Health adoption behaviour	0.087	-0.017	0.205	0.09

5. Conclusions and implications

5.1. Main research conclusions

Based on Social Cognitive Theory, this study constructs a model examining the impact of online social capital (bonding and bridging types), health beliefs (perceived susceptibility, perceived severity, perceived benefits, perceived barriers), and health behaviour adoption among the elderly. Using 465 valid nationwide survey responses, structural equation modeling and Bootstrap mediation tests were employed for empirical analysis, leading to the following key conclusions:

5.1.1. The impact of online social capital on health behaviour adoption

Neither bonding nor bridging online social capital has a significant effect on elderly health behaviour adoption, contradicting hypotheses H1a and H1b. This outcome can be analyzed from two perspectives: First, deficiencies in the quality of online interactions weaken the core functions of social capital. Research shows that elderly individuals' online interactions mostly involve browsing information or occasional superficial socializing, lacking sustained, deep emotional exchanges. This makes it difficult to build bonding social relationships based on intimate trust and emotional support in cyberspace [27]. Such shallow interactions not only diminish the emotional maintenance role of bonding social capital but also hinder the transmission of health information through highly trusted close relationships, reducing elderly acceptance and willingness to act on health information. Although bridging online social capital can provide diverse health information, the

elderly's limited ability to discern information and low trust in weak-tie networks restrict the effectiveness of information dissemination. Second, the breakdown of the health behaviour transformation chain obstructs the transmission of effects. Health behaviour adoption requires a complete "cognition–motivation–action" transformation process, but both types of online social capital only influence the "cognitive level" and cannot effectively promote subsequent stages. Regarding cognition to motivation, elderly health behaviour motivation is more dependent on "real health threats (e.g., personal or close ones' illness experience)" or "immediate feedback (e.g., noticeable improvement after exercise)," while indirect health information from online social capital (e.g., others' shared health experiences, popular science articles) fails to strongly stimulate motivation [4]. Regarding motivation to action, online social capital lacks critical offline supervision and practical support: for example, even if elderly individuals develop motivation for "regular exercise" encouraged by online communities, without offline accompaniment by family or neighbors or suitable exercise venues, motivation gradually fades; moreover, online check-in supervision may cause psychological burdens due to unfamiliarity with smart devices (e.g., inability to upload check-in records) or fear of negative evaluation for missed check-ins, thereby inhibiting actual health behaviour implementation. This "cognition–motivation–action" chain breakage prevents online social capital from effectively driving health behaviour from "intention" to "practice," resulting in no significant impact on elderly health behaviour adoption.

5.1.2. The impact of health beliefs on health behaviour adoption

The four dimensions of health beliefs show differentiated effects on elderly health behaviour adoption: perceived susceptibility, perceived severity, and perceived benefits all have significant positive effects, consistent with hypotheses; however, perceived barriers also show a significant positive effect, differing from the hypothesis. Detailed analysis is as follows:

Regarding perceived susceptibility, hypothesis H2a posited a positive correlation with elderly health behaviour adoption, which is supported. With aging, physiological decline and reduced immunity increase exposure to health risks compared to other age groups. When elderly individuals clearly perceive their susceptibility to health risks, it breaks the cognitive bias of "stable personal health," raising alertness to health risks. This alertness further transforms into motivation to proactively avoid risks, promoting adoption of regular check-ups, exercise, and other health behaviours to reduce risk exposure , aligning with the health belief model's core logic that "individual risk perception is the initial driver of behaviour change" .

For perceived severity, hypothesis H2b's positive correlation is also confirmed. Consistent with prior studies, perceived severity strongly drives health behaviours in elderly health fields such as hypertension management and dementia prevention [28]. When health education clearly emphasizes that uncontrolled hypertension may cause fatal outcomes like heart disease or stroke, elderly patients' medication adherence and lifestyle improvement willingness significantly increase [29]. When elderly individuals recognize that diseases may lead to long-term bedridden status, loss of self-care ability, increased burden on children, or death, their motivation for preventive behaviours is greatly strengthened. Concern over severe consequences highlights the value of health behaviours; for example, elderly people aware that diabetes can cause blindness or amputation are more willing to control diet and monitor blood sugar than those who view diabetes merely as "high blood sugar."

Regarding perceived benefits, hypothesis H2c's positive effect is significant and consistent with previous research. A core strategy in health belief model interventions is to clearly and concretely communicate the benefits of health behaviours. In osteoporosis prevention studies, elderly women who believe calcium supplementation and weight-bearing exercise significantly improve bone density and reduce fracture risk show higher behaviour adoption rates [30]. Elderly individuals are willing to exert effort only when they recognize that specific health behaviours bring expected health benefits; if behaviours are perceived as ineffective or

minimally beneficial, even high risk perception does not lead to proactive adoption. Essentially, this reflects a rational cost-benefit analysis focusing on the "benefit side."

The positive correlation between perceived barriers and elderly health behaviour adoption differs from the classic health belief model assumption that perceived barriers negatively affect behaviour adoption (H2d). This peculiarity may stem from the elderly's decision-making logic: perceived barriers can indirectly strengthen action cues by activating an "information gap," thereby promoting health behaviour adoption. When elderly individuals realize difficulties in adopting health behaviours (e.g., complicated procedures, economic costs, physical limitations), they develop a "gap cognition" regarding relevant information or support. This drives active seeking of external resources such as consulting healthcare providers, asking children for help, or reviewing health education materials. Studies confirm that perceived barriers significantly increase individuals' willingness to search for health information, and the information search process forms clear action cues that ultimately promote health behaviour adoption [31]. This mechanism is especially evident among the elderly, who rely more on external support and information supplementation in health decisions.

5.1.3. The impact of online social capital on health beliefs

The two types of online social capital (bonding and bridging) show differentiated effects on the four dimensions of elderly health beliefs (perceived susceptibility, severity, benefits, barriers). Specifically:

Bonding online social capital significantly positively influences all four dimensions. It affects elderly health beliefs through multiple pathways, thereby influencing health behaviour decisions. At the perceived susceptibility level, bonding social capital relies on strong-tie groups such as family members and close friends. Due to high group homogeneity and solid trust, health information transmitted is more readily recognized and accepted by the elderly [32]. Compared to information from strangers, "nearby health stories" shared by family or old friends evoke stronger empathy, directly triggering elderly individuals' associations with their own health risks, thus enhancing perceived susceptibility [33]. At the perceived severity level, emotional support and social norms from friends and family in bonding networks amplify disease consequence awareness. Concerns and advice from acquaintances about functional decline and quality of life deterioration caused by illness, combined with information credibility and emotional resonance, deepen elderly individuals' understanding of health problem severity, increasing perceived severity [34]. At the perceived benefits level, reliable health information, success stories, and operational guides provided by strong-tie networks help elderly clearly perceive the specific benefits of preventive or treatment behaviours. Encouragement and positive feedback from friends further strengthen positive behavioural expectations. Resource sharing (e.g., health app usage tips, online check-up channels) lowers behavioural costs, making health behaviours easier to view as beneficial choices, thus enhancing perceived benefits. At the perceived barriers level, bonding online social capital reduces perceived complexity and cost of adopting health behaviours through emotional support, mutual assistance commitments, and information sharing. Guidance on operations, technical help, and resource access provided by acquaintances significantly enhance self-efficacy, lowering perceived barriers and creating conditions for actual health behaviour adoption.

Bridging online social capital significantly positively affects perceived susceptibility, severity, and benefits, while significantly negatively affecting perceived barriers. Leveraging its characteristic of spanning different groups and connecting heterogeneous resources, it influences elderly health beliefs multidimensionally. At perceived susceptibility, bridging networks break elderly individuals' limited social circles, enabling access to health information from diverse age, occupation, and regional groups, covering a wider variety of diseases, affected populations, and risk factors. This heterogeneous information input broadens elderly individuals' understanding that health risks are not confined to familiar circles but exist in broader life contexts, significantly increasing perceived susceptibility [35]. Regarding perceived severity, bridging social capital

connects professional groups (e.g., healthcare workers, health science communicators) and users with different disease experiences, providing more professional and comprehensive information on disease consequences, including long-term physiological damage, impact on social participation, and medical cost burdens. Compared to the more emotional consequence descriptions in familiar circles, information in bridging networks is more systematic and authoritative, helping elderly overcome one-sided views and deepen understanding of health problem severity. At perceived benefits, bridging social capital connects elderly individuals to broader resource networks (e.g., online health courses, telemedicine platforms), allowing them to tangibly perceive the benefits of preventive or treatment behaviours. Diverse positive cases and success stories enable elderly to anticipate health improvements and quality of life enhancements, while positive feedback and encouragement from heterogeneous groups further strengthen positive expectations, jointly promoting perceived benefits. At perceived barriers, bridging social capital provides targeted support by connecting groups with different knowledge backgrounds and skill levels: tech-savvy individuals guide health app use and online consultation processes, reducing digital tool usage barriers; those with similar health issues share medical resource channels and reimbursement experiences, lowering concerns about service costs and procedures. This multifaceted support effectively alleviates elderly concerns about adopting health behaviours, reducing perceived barriers. Studies show that elderly technology anxiety significantly inhibits health self-care behaviours, while bridging social capital can reduce this anxiety by improving digital health literacy and providing direct operational assistance [36].

5.1.4. The mediating role of health beliefs

Perceived susceptibility significantly mediates the relationship between both types of online social capital and elderly health behaviour adoption, with differing mechanisms. The mediating effect of perceived susceptibility is stronger between bonding online social capital and health behaviour. Bonding social capital, relying on strong-tie networks of family and close friends, triggers emotional resonance by sharing "nearby health risk cases" and targeted health reminders, enabling elderly individuals to intuitively associate with their own health status and quickly strengthen the perception that risks are nearby. This emotionally based risk awakening more directly promotes the transformation from perceived susceptibility to health behaviour [37]. Bridging online social capital, through diverse risk information and professional popular science content from heterogeneous groups, helps elderly break the cognitive limitation that "health risks only exist in familiar circles" [38], understanding the universality of health risks in broader social contexts, thereby enhancing perceived susceptibility. However, due to weaker emotional ties in weak-tie networks, the conversion from risk perception to behaviour is slightly less strong than bonding capital. Thus, perceived susceptibility serves as a key bridge connecting online social capital and health behaviour, effectively transforming network resources into actual health actions among the elderly, making it a core psychological mechanism to focus on in elderly health promotion interventions [20].

Perceived severity also significantly mediates the relationship between both types of online social capital and elderly health behaviour adoption, with a stronger mediating effect for bonding online social capital. This mediation path shows the highest effect strength among significant mediation paths, indicating perceived severity is a core mediator linking online social capital and elderly health behaviour adoption. Bonding social capital, relying on emotional descriptions within strong ties, amplifies elderly attention to disease consequences through emotional resonance, more easily converting into action motivation. Bridging social capital deepens rational understanding of disease severity through systematic information and authoritative popular science from professional groups, but weaker emotional ties result in slightly lower behavioural activation. Empirical studies show perceived severity positively influences elderly willingness to learn health knowledge on social media, indicating it directly promotes health information adoption [39]. Additionally, risk

perception research finds that after elderly obtain health information via online media, perceived severity significantly mediates between information exposure and disease prevention behaviour intention, highlighting perceived severity as a key psychological mechanism converting information channels into actual behaviour [20]. This demonstrates perceived severity's core mediating value in elderly health behaviour interventions, operating through "emotional resonance amplifying consequence awareness" in strong-tie networks and "professional information deepening rational cognition" in weak-tie networks, with the former showing stronger behaviour conversion efficacy.

Perceived benefits significantly mediate the relationship between both types of online social capital and elderly health behaviour adoption, with a more prominent mediating effect for bonding online social capital. Notably, the mediation of perceived benefits depends more on constructing "behavioural value recognition," and the two types of online social capital differ markedly in this pathway. Specifically, bonding social capital relies on concrete success cases and emotional trust within strong ties, allowing elderly individuals to intuitively perceive behaviour benefits. This benefit perception based on familiar experiences more easily converts into "behaviour usefulness" value recognition, promoting health behaviour adoption. In contrast, bridging online social capital provides diverse benefit information from heterogeneous groups, helping elderly understand health behaviour value from a broader perspective, but weaker emotional ties result in slightly less effective value recognition construction [40]. Meanwhile, elderly tend to perceive "benefits" as "visible, accessible actual changes," and cases shared within strong-tie networks better fit their cognitive habits, further enhancing mediation effectiveness [41]. Studies confirm perceived benefits significantly mediate between information acquisition and behaviour adoption, enabling online social capital's influence to be realized through the "perceived benefits–behaviour adoption" pathway [42].

Therefore, elderly health promotion interventions should emphasize strengthening the mediating role of perceived benefits: for bonding online social capital, encourage regular sharing of health behaviour outcomes among family and friends; for bridging online social capital, translate professional benefit information into concrete, easily understandable content to enhance elderly recognition of health behaviour value.

Perceived barriers do not show significant mediation effects between either type of online social capital and elderly health behaviour adoption. This result is closely related to the "support compensation effect" of the two types of online social capital: online social capital does not influence through perceived barriers mediation but directly alleviates perceived barriers via resource provision [43]. When external support is sufficient, elderly rely more on direct help from online social capital rather than overcoming digital technology concerns independently, leading to insignificant mediation effects of perceived barriers in statistical models [44]. Therefore, policy should strengthen resource provision and precise support mechanisms on online platforms: for bonding online social capital, encourage family, friends, and neighbors to participate in elderly health management, focusing on practical assistance and emotional support; for bridging online social capital, further optimize cross-community technical support networks and health resource connection platforms, simplify operation processes, and directly reduce various perceived barriers to health behaviour adoption through differentiated support.

5.2. Research implications

Based on Bandura's Social Cognitive Theory, this study constructs an analytical framework of "online social capital–health beliefs–elderly health behaviour adoption," providing three theoretical contributions to elderly digital health research. First, it overcomes the limitation of treating online social capital as a single whole by clarifying differentiated pathways of the two types of capital on health beliefs—bonding capital strengthens health cognition through strong-tie emotional resonance, while bridging capital expands cognitive boundaries

via weak-tie diverse resources—enriching the theoretical system linking online social capital subdimensions and elderly health behaviour. Second, it expands the application boundary of the health belief model in elderly populations, verifying the positive mediating roles of perceived susceptibility, severity, and benefits, while identifying the peculiarity of perceived barriers' positive effect, refining differentiated mediation mechanisms of health belief dimensions in digital health contexts. Third, it empirically tests the applicability of the "environment–cognition–behaviour" triadic reciprocal interaction mechanism in elderly health, confirming that online social capital must mediate through health beliefs to transform into health behaviour, providing new empirical support for applying Social Cognitive Theory in elderly digital health research.

Based on the findings, practical advancement in elderly digital health promotion and online social capital cultivation can proceed in three ways. First, stratified cultivation of online social capital: for bonding capital, build family and friend health-sharing communities, encourage children to assist elderly in sharing nearby health cases and providing emotional support, strengthening trust in health information within strong-tie networks; for bridging capital, collaborate with medical institutions to offer "Silver Digital Classes" guiding elderly in using health apps and joining professional health communities, helping them access diverse professional health resources. Second, focus on optimizing guidance strategies for core mediating dimensions: strengthen perceived severity by concretizing disease consequences through complication case videos and harm science popularization graphics to stimulate behaviour motivation; enhance perceived benefits by translating professional benefit information into "easy-to-understand" content, e.g., "Walking 30 minutes daily reduces stroke risk by 20%"; awaken perceived susceptibility with bonding scenarios emphasizing "nearby risk reminders" and bridging scenarios focusing on "universal risk popularization." Third, resolve perceived barrier dilemmas: leverage the "support compensation effect" of both capitals—at the bonding capital level, encourage family and friends to provide practical assistance such as helping with online check-up appointments and health app operation guidance; at the bridging capital level, establish professional technical teams offering "one-click" health service functions to simplify processes; simultaneously coordinate with community health service institutions to provide offline support, filling gaps in online assistance.

This study has three limitations to be addressed in future research. First, sample representativeness is insufficient, with selection bias: offline samples concentrate on elderly with better physical condition and social skills, lacking coverage of very old, disabled, and digitally illiterate groups. Cross-sectional data cannot capture dynamic causal relationships among variables. Future studies should expand sample coverage to nursing homes and rural areas and incorporate longitudinal designs to enhance reliability and causal inference. Second, variable measurement precision needs improvement: "health behaviour adoption" only measures subjective intention, lacking objective data such as medical records or exercise logs; "online social capital" does not distinguish platform heterogeneity (e.g., WeChat strong ties vs. TikTok weak ties) or interaction quality dimensions. Future research should supplement objective behavioural indicators to deepen measurement accuracy. Third, mechanism exploration is incomplete: moderating variables such as digital health literacy, age stratification, and chronic disease types are not included, and endogeneity issues in causal inference remain unresolved (e.g., proactive health behaviour individuals may more actively build online social capital). Future work can introduce moderators to build more complex theoretical models and combine experimental studies or propensity score matching to verify causal relationships, further enriching theoretical depth and practical value.

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