BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-093107
Article Type:	Original research
Date Submitted by the Author:	31-Aug-2024
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Keywords:	Community-Based Participatory Research, Cross-Sectional Studies, Health Services for the Aged, MENTAL HEALTH, PUBLIC HEALTH, Social Support

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Influence of social support on technophobia in older adults in urban communities： the mediating role of self-efficacy and e-health literacy，a cross-sectional study

Abstract

Objectives To explore the chained mediating role of self-efficacy and e-health literacy in the association between social support and technophobia in older adults in urban communities.

Design A cross- sectional study design conducted from June 2023 - April 2024

Setting This study was conducted in three districts of Taiyuan City, Shanxi Province, China.

Participants The study enrolled 1658 older adults (> 60 years old) in urban communities in Taiyuan

Methods: The analyses included assessments using the technophobia, e-health, self-efficacy, and social support scales, and the mediating effects of these indices were investigated using Model 6 in SPSS 26.

Results: Self-efficacy and e-health literacy were found to play independent or chained mediating roles in the association between social support with technophobia. Social support had a significant direct effect on technophobia (β=-0.452, p<0.001), while social support had a significant positive effect on self-efficacy (β=0.142, p<0.001), and social support (β=0.245, p<0.001) and self-efficacy (β=0.132, p<0.001) had significantly positive effects on the e-health literacy of the older adults. On the other hand, technophobia was significantly negatively influenced by social support (β=-0.266, p<0.001), self-efficacy (β=-0.564, p<0.001), and e-health literacy (β=-0.4, p<0.001).

Conclusion: Social support was found to affect technophobia in older adults via the independent or chained mediating effects of self-efficacy and e-health literacy. These findings provide a reference for the mitigation of technophobia in older adults.

Key words: Older adults; technophobia; e-health literacy; social support; self-efficacy

Strengths and limitations of this study

⇒The study focused on the physical and mental health of older people in urban communities in Taiyuan, rather than the general population.

⇒This study explores the mediating role of self-efficacy and e-health literacy in the relationship between social support and technophobia

⇒This is a cross-sectional survey, and all participants have been informed that the study will be conducted via a questionnaire. The results rely on self-reporting by the participants, which may introduce a certain degree of bias.

⇒All participants were from urban communities in Taiyuan, Shanxi Province, China, which limited the generalization of the results.

Introduction

With global demographic changes and advances in digital technologies, technology-empowered smart care for older adults is an inevitable trend. Smart care services can help to not only enrich the lives of older adults and provide convenience but can also mitigate health-resource shortages, reduce social service costs, and improve service efficiency. However, existing intelligent health technologies have limited inclusiveness.[1] Older adults, as a specific group, often feel overwhelmed, anxious, and even frightened when faced with handling complex information such as texts, images, and sounds,[2] potentially leading to technophobia. As a phenomenon associated with technology and psychological issues associated with modern technology,[3] technophobia refers to an individual's irrational anxiety and fear of digital technologies, such as mobile communication devices, artificial intelligence (AI), and robots, and can even result in the avoidance of technology altogether.[4] Technophobia has been reported to be a risk factor for impeding health-promoting behaviors in older adults in the digital era.[5] In 1996, Celaya *et al.* reported that[6] 20–33% of Americans experienced technophobia, while a more recent study by Osiceanu *et al.*[7] reported the existence of technophobia in 50% of Americans of different ages, indicating that the number of people who experience technophobia is increasing, not decreasing, over time.

Social support is a form of social behavior whereby a certain social network provides free assistance and services, both material and psychological, to socially disadvantaged groups.[8] According to the social support theory, social support is closely associated with psychological health.[9] Social support is required to mitigate technophobia, which has been seen as a psychological problem. Indeed, social support plays a key role in maintaining good psychological health and alleviating psychological problems.[10] The present study thus proposed Hypothesis 1: social support has negative influences on technophobia in older adults.

E-health literacy refers to an individual's ability to filter, understand, and evaluate health information using electronic devices, and to apply the acquired knowledge to the handling of health issues.[11] It has been demonstrated that high levels of social support facilitate access of information resources, tools, and emotional support in older adults.[12] This led to the proposal of Hypothesis 2: social support has positive influences on the e-health literacy of older adults. Self-efficacy refers to an

individual's confidence or belief in their ability to complete a specific task or behavior, representing a subjective judgment.[13] Indeed, social support is closely related to self-efficacy,[14] in that older adults with good social support tend to be more confident and optimistic, accompanied by a belief that they have the ability to achieve their goals, which helps them cope with the stress of using digital health products. This led to the proposal of Hypothesis 3: social support has significantly positive influences on self-efficacy in older adults. Additionally, biochemical investigations have revealed that high self-efficacy can influence the release of physiological substances such as catecholamines which can activate the autonomic nervous system, thereby regulating an individual's immune function and neuropsychological state.[15] It can be inferred that self-efficacy may negatively affect technophobia in older adults, which led to the proposal of Hypothesis 4: self-efficacy has negative influences on technophobia in older adults. Additionally, older adults with high levels of e-health literacy are more comfortable with searching for health-related information online, allowing them to become better informed and engaged in health management. Therefore, Hypothesis 5 was proposed: social support can affect the technophobia of the elderly by modifying self-efficacy or e-health literacy.

Previous studies of technophobia in older adults have focused on the current situation and influencing factors.[16-20] Few studies have examined the mechanism by which social support affects technophobia in the elderly in urban communities. The present study aimed to verify the mediating role of self-efficacy and e-health literacy in the association between social support and technophobia in older adults and deepen an understanding of how social support influences technophobia in this demographic. This can provide a theoretical reference for improving the physical and mental health of older adults, thereby promoting the development of the care industry in China.

Methods

Study design and participants

From June 2023 - April 2024, field research was conducted on older adults in urban communities in Taiyuan, China. A multi-stage sampling method was used. First, three districts (Ying ze District, Jian cao ping District, and Jin yuan District) were randomly selected from six urban districts in Taiyuan, after which three communities were randomly selected from the selected districts using streets as the sampling unit, followed by convenience sampling of older adults aged 60 years and above from the selected communities.

Inclusion criteria: (1) aged 60 years and over; (2) have good hearing and vision, and able to

communicate; (3) willing to participate in the study; (4) have lived in the selected communities for three years or longer.

Exclusion criteria: (1) have severe organic diseases or mental disorders; (2) unable to communicate; (3) unwilling to participate in the study.

Calculation of the sample size required a ratio of sample size to observed variables of 10: 1-15: 1. The study included 18 variables (e.g., demographic variables). To ensure a 20% sample loss rate and the representativeness and accuracy of data, the sample size was calculated to be ≥216 cases.

Data collection

Professional training was provided to the survey personnel before conducting the questionnaire survey to ensure their familiarity with the survey methods. Before administering the questionnaires, the survey personnel explained the purpose of the survey and filling out the questionnaire to the older adults in the communities, and emphasized the anonymity and confidentiality of their responses. After obtaining informed consent from the participants, the survey personnel distributed questionnaires to them one-on-one. Those with the ability to read and write completed the questionnaire themselves, while for participants who were illiterate or had difficulty with completing the questionnaire, the survey personnel read the questions one-by-one and the participants chose their answers which were then recorded by the survey personnel. If the participants experienced difficulty in understanding the questions, the survey personnel provided neutral and accurate explanations and recorded the answers based on the responses. After the collection of the questionnaires, other survey personnel verified the data and checked for any missing information so that missing information could be filled out on-site. A total of 1801 older adults from urban communities were surveyed, of whom 143 were excluded due to missing information or voluntary withdrawal from the study. Finally, 1658 effective questionnaires were included in the analysis, with an effective recovery rate of 93.56%.

Measures

The survey tools used in this study included:

(1) Questionnaire on sociodemographic characteristics: This questionnaire comprised items on age, gender, marital status, residential situation, education level, monthly income, self-rated health, and frequency of using digital health products.

(2) Technophobia scale: This scale was developed by American research Khasawneh,[21] and was translated, back-translated, and cross-culturally adapted by Sun et al.[22] to the Chinese version,

comprising 13 items in 3 dimensions (fear of technology, anxiety about technology, and privacy concerns). The scale is scored using a 5-point Likert scale (5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree), with a total score of 13-65. A total score of ≥39 indicates a high level of technophobia, while a total score of <39 indicates a low technophobia level. The Cronbach's α of this scale is 0.911, with the Cronbach's α of factors ranging from 0.759 to 0.885 and a split-half reliability coefficient of 0.851. This indicates that this scale has good reliability and validity and was suitable for assessing technophobia in older adults in China.

(3) Questionnaire on e-health literacy: This questionnaire was developed by the Canadian researcher Norman,[23] and it was translated, back-translated, and cross-culturally adapted by Guo Junshuai et al.[24] to the Chinese version, which comprises 8 items in three dimensions (ability to apply online health information and services [5 items], critical thinking ability [2 items], and decision-making ability [1 item]). The scale essentially assesses an individual's ability to obtain, understand, and evaluate health information using electronic devices and to apply the acquired knowledge to handle health issues. It is also scored using a 5-point Likert scale, with a total score of 8-40. A higher total score indicates higher e-health literacy. A total score of 26 is the cutoff and scores <26 indicate lower levels of e-health literacy, while total scores ≥26 indicate high e-health literacy. The Cronbach's α is 0.966 and the factor analysis loading ranges from 0.754 to 0.856, indicating good reliability and validity.

(4) Self-efficacy scale: This scale was translated, back-translated, and cross-culturally adapted by Wang Caikang et al.[25] This scale comprises 10 items and is used to assess the confidence of individuals in overcoming difficulties. It is a 4-point scale, with a total score of 10-40, with scores of 10-20 denoting low self-efficacy, 21-30 indicating medium self-efficacy, and 31-40 representing high self-efficacy; thus higher scores indicating better self-efficacy. The Cronbach's α is 0.87.

(5) Social support scale: This scale was translated, back-translated, and cross-culturally adapted by Xiao Shuiyuan[26] in 1994. It is used to assess the types and degree of assistance and resources obtained from others. It comprises 10 items in 3 dimensions, with a total score of 12-65, with scores of 12-22 denoting low social support, 23-44 denoting medium social support, and 45-65 representing high social support; thus higher scores indicate higher levels of social support. The Cronbach's α is 0.73.

Statistical analysis

The data were imported into SPSS 26.0 for analysis. For descriptive statistics, number of cases (n) and percentage (%) were used to describe categorical data. In this study, differences between the levels

of various major variables in the overall data were examined. The major variables, namely, e-health literacy, technophobia, self-efficacy, and social support, were all essentially normally distributed and independent samples t-tests and one-way ANOVA were used for comparisons. Based on the literature, factors with statistical significance in the one-way ANOVA were used as control variables. Analyses were performed with Model 6 in SPSS 26. The significance level was set at α=0.05, and the data met the conditions for the methods used.

Patient and public involvement

None

Results

Demographic characteristics

The characteristics of the participants are summarized in Table 1. In terms of gender, 907 participants were male, accounting for 54.7%, while 751 participants were female, accounting for 45.3%. A total of 749 participants were aged between 60 and 70 years, accounting for 45.2%, while 641 (38.7%) were aged between 71 and 80 years. In terms of marital status, 679 participants were married, accounting for 41%, and 978 (59%) lived with their families. Overall, 713 (43%) of the older adults had a monthly income above 3000 yuan, with no significant differences in the numbers of participants with income levels of 1000-3000 and those below 1000. In terms of education level, 618 (36.3%) had an educational level of high school or above, while 530 participants were junior middle school graduates, accounting for 32% and 68 (4.1%) were illiterate. In terms of self-rated health, 716 (43.2%) rated their health as average, while 571 (34.4%) rated themselves as healthy, indicating that the health of the participants was generally good. In terms of frequency of using electronic devices, 683 (41.2%) electronic devices frequently, and 631 (38.1%) used such devices occasionally.

Table 1. Characteristics of the older adults in urban communities in Taiyuan, China.

Variable	Option	Number of cases (n)	Percentage (%)
Gender	M	907	54.7
	F	751	45.3
Age	60-70	749	45.2
	71-80	641	38.7
	>80	268	16.2
Marital status	Married	679	41.0
	Single	455	27.4
	Divorced	199	12.0
	Widowed	325	19.6
Residential situation	Living with family	978	59.0

	Living alone	680	41.0
Monthly income	<1000	506	30.5
	1000-3000	439	26.5
	>3000	713	43.0
Education level	Illiteracy	68	4.1
	Elementary school graduates	442	26.7
	Middle school graduates	530	32.0
	High school graduates or above	618	37.3
Self-rated health	Not healthy	371	22.4
	Average	716	43.2
	Healthy	571	34.4
Use frequency of digital health products	Never	344	20.7
	Occasionally	631	38.1
	Often	683	41.2

Influences of demographic characteristics on different variables

The influences of gender, age, marital status, residential situation, monthly income, education level, self-rated health, the use frequency of electronic devices on technophobia, e-health literacy, self-efficacy, and social support of the older adults were investigated by one-way ANOVA. The results showed that age, residential situation, education level, health, and frequency of using electronic devices significantly influenced the incidence of technophobia in older adults, while age, marital status, residential situation, education level, health and frequency of using electronic devices significantly influenced e-health literacy, and age, residential situation, monthly income, and education level influenced self-efficacy, and age, marital status, residential situation, education level, self-rated health, and frequency of using electronic devices significantly influenced social support in the older adults (Table 2).

Table 2. Influences of demographic characteristics on different variables in older adults in urban communities in Taiyuan, China.

		Score			
	Number of cases	**Technophobia**	**E-health literacy**	**Self-efficacy**	**Social support**
Total sample	1658	40.31±12.26	23.18±6.81	23.65±6.74	29.42±9.60
Gender					
M	907	40.45±12.14	22.93±6.80	23.40±6.90	29.05±9.57
F	751	40.14±12.40	23.48±6.82	23.95±6.53	29.85±9.62
t		0.523	-1.625	-1.655	-1.686
P		0.601	0.104	0.098	0.092
Age					
60-70	756	39.5±12.85	23.59±6.76	24.24±6.61	29.59±9.70
71-80	634	40.09±12.01	23.01±6.97	23.60±6.64	29.85±10.03
>80	268	43.08±10.70	22.46±6.52	22.11±7.13	27.90±8.03
F		8.633	3.022	9.987	4.11
P		**<0.001**	**0.049**	**<0.001**	**0.017**
Marital status					
Married	679	40.47±12.52	23.38±6.85	23.26±6.60	30.10±10.10
Single	455	39.95±12.14	23.62±6.68	24.33±6.94	29.74±8.97
Divorced	199	39.73±8.74	21.59±6.36	23.70±6.46	26.36±9.01

Widowed	325	40.83±13.65	23.14±7.07	23.48±6.89	29.40±9.42
F		0.514	4.452	2.406	8.172
P		0.673	**0.004**	0.066	**<0.001**
Residential situation					
Living with family	978	39.03±12.39	24.13±6.62	24.05±6.77	30.48±9.76
Living alone	680	42.14±11.83	21.82±6.85	23.07±6.66	27.89±9.16
t		-5.122	6.889	2.939	5.438
P		**<0.001**	**<0.001**	**0.003**	**<0.001**
Monthly income					
<1000	506	40.05±12.84	23.43±6.86	23.20±6.96	29.88±9.64
1000-3000	439	39.84±11.88	22.91±7.06	22.91±7.17	29.19±9.14
>3000	713	40.79±12.06	23.17±6.62	24.42±6.22	29.22±9.85
F		0.986	0.691	8.564	0.866
P		0.373	0.501	**<0.001**	0.421
Education level					
Illiteracy	68	46.54±11.24	20.47±7.76	20.79±6.22	27.19±9.58
Elementary school graduates	442	39.32±14.17	23.66±6.83	24.74±6.34	29.65±8.92
Middle school graduates	530	38.16±12.32	23.28±6.87	24.67±6.82	30.22±10.76
High school graduates	618	42.17±10.19	23.06±6.58	22.31±6.70	28.80±8.95
F		17.553	4.461	20.727	3.414
P		**<0.001**	**0.004**	**<0.001**	**0.017**
Self-rated health					
Not healthy	371	40.89±13.21	22.68±7.00	23.05±5.96	29.89±10.17
Average	716	41.30±11.20	22.49±6.66	23.72±6.92	28.11±9.22
Healthy	571	38.68±12.73	24.38±6.72	23.94±6.98	30.74±9.50
F		7.86	13.78	2.08	12.698
P		**<0.001**	**<0.001**	0.125	**<0.001**
Use frequency of electronic devices					
Never	344	42.94±10.22	20.47±6.11	22.85±6.69	28.12±8.53
Occasionally	631	40.56±11.98	23.50±6.43	23.80±6.63	29.25±9.35
Often	683	38.75±13.19	24.25±7.12	23.91±6.85	30.23±10.25
F		13.806	38.159	3.102	5.721
P		**<0.001**	**<0.001**	0.045	**0.003**

Correlation analysis of technophobia, e-health literacy, self-efficacy, and e-health literacy

Correlation analysis is an important method to explore associations between different variables.[27] In this study, all the major variables were approximately normally distributed numerical variables. Therefore, Pearson correlation analysis was used for testing. As shown in Table 3, significant correlations were found. Specifically, e-health literacy, self-efficacy, and social support were significantly negatively correlated with technophobia. E-health literacy, self-efficacy, and social support showed significant positive correlations with each other. The absolute values of the correlation coefficients of each pair of variables ranged from 0.2 to 0.5, suggesting weak to moderate correlations between the variables.

Table 3. Correlation analysis of technophobia, e-health literacy, self-efficacy, and e-health literacy in older adults in urban communities in Taiyuan, China.

Variable	Technophobia	E-health literacy	Self-efficacy	Social support
Technophobia	1			

E-health literacy	-0.395**	1		
Self-efficacy	-0.416**	0.224**	1	
Social support	-0.377**	0.403**	0.216**	1

Note: **p<0.01

Hypothesis testing

Through correlation analysis, the correlations of variables were preliminarily tested. In this section, hypothesis testing was conducted for further examination of associations between variables. According to the correlation hypotheses proposed above, the direct impact of social support on technophobia was used as the main outcome. On this basis, the chained mediating effects of self-efficacy and e-health literacy were further examined in this model. Additionally, variables that showed significant effects on technophobia in the analysis (age, residential situation, education level, health, and use frequency of smart devices) were included in the model as control variables. Model 6 in SPSS 26 was used for testing. The testing results consisted of two parts, namely, the stepwise regression results and the results of the bootstrap random sampling mediating effect testing. A confidence interval (CI) of 95% was used as the threshold. The mediating effect was determined by observing whether the 95% CI includes 0. If the 95% CI did not include 0, the corresponding effect is significant; otherwise, it is non-significant.

Table 4 shows the mediating effect results obtained from the stepwise regression. In Model 1, social support had a significantly negative influence on technophobia (β=-0.452, p<0.001), suggesting that technophobia in older adults was negatively associated with social support. In Model 2, social support had a significant positive influence on self-efficacy (β=0.142, p<0.001). In Model 3, social support (β=0.245, p<0.001) and self-efficacy (β=0.132, p<0.001) both had significant positive influences on e-health literacy, while in Model 4, social support negatively affected technophobia (β=-0.266, p<0.001), as did self-efficacy (β=-0.564, p<0.001), and e-health literacy (β=-0.400, p<0.001). Overall, the coefficients were significant in all models. Overall, self-efficacy and e-health literacy had mediating effects as partial mediators (Table 4).

Table 4. Investigation of mediating effects using stepwise regression.

Model	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
Dependent variable	**technophobia**		**self-efficacy**		**e-health literacy**		**technophobia**	
Index	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**
Independent variable								
Social support	-0.452	-15.532***	0.142	8.396***	0.245	15.359***	-0.266	-9.227***

Mediating variable								
Self-efficacy					0.132	5.836***	-0.564	-14.499***
E-health literacy							-0.400	-9.585***
Control variable								
Age	1.221	3.208**	-0.934	-4.221***	-0.196	-0.957	0.567	1.628
Residential situation	1.626	2.851**	-0.445	-1.342	-1.386	-4.532***	0.797	1.527
Education level	0.447	1.445	-0.686	-3.816***	0.265	1.592	0.130	0.460
Health	-0.874	-2.337*	0.294	1.355	0.676	3.372**	-0.421	-1.235
use frequency of electronic devices	-1.496	-4.104***	0.266	1.255	1.393	7.131***	-0.774	-2.299*
R	0.407		0.261		0.474		0.558	
R^2	0.165		0.068		0.224		0.311	
F	54.485***		20.138***		68.193***		93.026***	

Note: *p<0.05, **p<0.01, ***p<0.001

According to the results of the mediating effect analyses shown in Table 5, the social support-self-efficacy-technophobia path had an effect value of -0.08 and its 95% CI did not include 0, suggesting that the indirect effects of self-efficacy were significant. Similarly, the path of social support-e-health literacy-technophobia had an effect value of -0.098 and its 95% CI did not include 0, suggesting that the indirect effects of e-health literacy were significant, and the path of social support-self-efficacy-e-health literacy-technophobia had an effect value of -0.008 and its 95% CI did not include 0, suggesting that both self-efficacy and e-health literacy had significant chained mediating effects. Additionally, significant results were observed for both total and direct effects, indicating simple and chained mediating effects of self-efficacy and e-health literacy in the models, and thus suggesting that the negative impact of social support on technophobia could be transmitted and realized through self-efficacy and e-health literacy. The mediating effect of self-efficacy was found to account for 17.7%, while the mediating effect of e-health literacy accounted for 21.7%, and the chained mediating effect accounted for 1.8% (Table 5 and Figure 1).

Table 5. Chained mediating role of self-efficacy and e-health literacy in the correlation of social support with technophobia in older adults in urban communities in Taiyuan, China.

Effects	Effect value	LLCI	ULCI	Percentage
Total effects	-0.452	-0.509	-0.395	100.0%
Direct effects	-0.266	-0.323	-0.210	58.8%
Indirect effects	-0.185	-0.219	-0.153	40.9%
Social support - self-efficacy - technophobia	-0.080	-0.101	-0.059	17.7%
Social support - e-health literacy - technophobia	-0.098	-0.124	-0.074	21.7%

Social support - self-efficacy - e-health literacy - technophobia	-0.008	-0.011	-0.004	1.8%

LLCI, Lower Level Confidence Interval; ULCI, Upper Level Confidence Interval.

Discussion

Influences of social support on technophobia in older adults in urban communities

The paths by which social support affected technophobia in older adults were explored using the chained mediating model. It was found that social support had a direct negative impact on the presence of technophobia in older adults, with greater social support associated with lower levels of technophobia, which is consistent with previous studies.[28] Social support can be classified in terms of the resources supplied into three types, namely, instrumental, emotional, and informational support.[29] Targeted social support can effectively enhance the health and well-being of older adults.[30] As people age, their need for health services increases.[31] However, older adults face inherent disadvantages when adopting new technologies. This can be partially attributed to the individuals themselves, in that as people age, their physiological functions and cognitive abilities tend to decline, together with deterioration in hearing, vision, and manual dexterity. This age-related decline creates a stereotype of poor technological competence, inducing feelings of being overwhelmed when confronted with digital health technology. Instrumental support (e.g., hearing aids, reading glasses, speech recognition devices) can mitigate the discomfort caused by deterioration in physiological function, thus reducing technophobia when faced with new technologies. Additionally, older adults are more prone to experience anxiety and depression than the general population.[32-34] Due to negative emotions experienced in their daily lives and prolonged social isolation, some older adults become indifferent to the changes resulting from technological advances, leading to increased anxiety and unease. The provision of emotional support can help to alleviate stress and psychological problems and improve their mental and physical health.[35] Additionally, the technology associated with health information can also induce technophobia. Smart health services are essentially targeted to all groups of society but the complex procedures and usage processes can discourage some older adults from using them. Furthermore, concerns about incurring high costs due to improper use of smart devices, products, or services can exacerbate feelings of loss of control and helplessness, further intensifying technophobia. The development of older adult-friendly products (both material and informational support) can effectively alleviate technophobia in this demographic.[36] Therefore, it can be deduced that timely and targeted social support can effectively relieve technophobia in older adults, thereby improving the

quality of life in their later years.

Roles of self-efficacy and e-health literacy in the correlation of social support with technophobia in older adults in urban communities

Social support can influence technophobia in older adults through self-efficacy. Compared with younger people, older adults are less comfortable with novelty and often feel less confident about using smart health technology, resulting in lower self-efficacy. Older adults who have less social support tend to have lower self-efficacy,[37] while in contrast, those with high self-efficacy are better able to adapt to new technologies and are more confident in terms of health beliefs, thereby reducing technophobia. Additionally, social support can influence technophobia in older adults through e-health literacy, which is consistent with previous studies.[38] This is because social support provides greater access to social networks, thus increasing the channels and abilities of older adults to access health resources through smart health technology and thus enhancing their e-health literacy, thereby reducing technophobia. Indeed, low e-health literacy is an obstacle for older adults in accessing e-health information,[39] as it can lead to technophobia and affect their willingness to use and accept new technologies.[40] Older adults with low e-health literacy have reduced abilities to understand, evaluate, and use digital information technology and cannot proactively adapt to new technologies. Inevitably, they feel more anxious when using digital technology. Several studies have attempted to enhance the self-efficacy of older adults by providing them with social support, showing that the overall mood and outlook of the older adults were significantly improved compared to the control group.[41] In other words, social support can significantly improve the mental health of older adults and their confidence in the utilization of information technologies. It has been demonstrated that the better the self-efficacy of older patients with chronic non-communicable diseases, the higher their e-health literacy.[42] Interventions to improve self-efficacy were found to be effective in enhancing the e-health literacy of college students during the COVID-19 epidemic.[43] However, e-health literacy was negatively correlated with technophobia.[44] [45] Overall, self-efficacy and e-health literacy were found to have chained mediating effects.

Factors influencing technophobia in older adults in urban communities

As shown in Table 2 and Table 3, there were high levels of technophobia in older adults in urban communities in Taiyuan, China. Multivariate regression analysis revealed the influences of age, residential situation, education level, health, and frequency of use of smart devices on technophobia in older adults in urban communities. As people age, their ability to understand and master novel things

diminishes, leading to a lack of confidence when using health information technology or digital health technology, leading to reduced self-efficacy. The conflict between high demand and low capability contributes to further anxiety, helplessness, and resistance, intensifying technophobia.[46] This aligns with the findings of Xi WY.[47] Therefore, measures should be taken to foster humanistic care for older adults and reduce technophobia, and thus enhance their quality of life.

Limitations and future directions

First, the study sample was limited to older adults in urban communities in Taiyuan, which may affect the generalizability of the research results. Second, due to the cross-sectional study design, all participants were informed that the study would investigate social support, self-efficacy, e-health literacy, and technophobia. Since the results relied on the self-reports of the participants, this may have introduced a degree of bias. Additionally, factors such as health conditions, traditional culture, and living habits may also have an impact on technophobia in older adults. Further investigations are needed for a comprehensive elucidation of the causes of technophobia in older adults.

Conclusion

The independent and chained mediating roles of self-efficacy and e-health literacy in the correlation of social support with technophobia of older adults in urban communities were demonstrated. On a theoretical level, these findings contribute to the understanding of the mechanisms by which social support affects technophobia in older adults, as well as providing new research directions for future studies and advancing research on the psychological health of older adults in the context of smart health. On a practical level, based on the proposed mechanisms, relevant stakeholders could provide targeted social support to older adults in urban communities to improve their self-efficacy. Additionally, the social health industry should focus on the health needs and realities of this demographic to develop older adult-friendly health products and offer user-friendly channels for obtaining health information, enhance the e-health literacy of this population, reduce their technophobia, and improve their overall health and well-being.

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Acknowledgements We would like to thank all the participants in the present study.

Contributors DL contributed to the conceptualisation, formal analysis and writing the original draft. JL and CW made contributions to the data curation and verification. YS and QG contributed to the writing, review and editing. GD acts as a guarantor for the final manuscript.

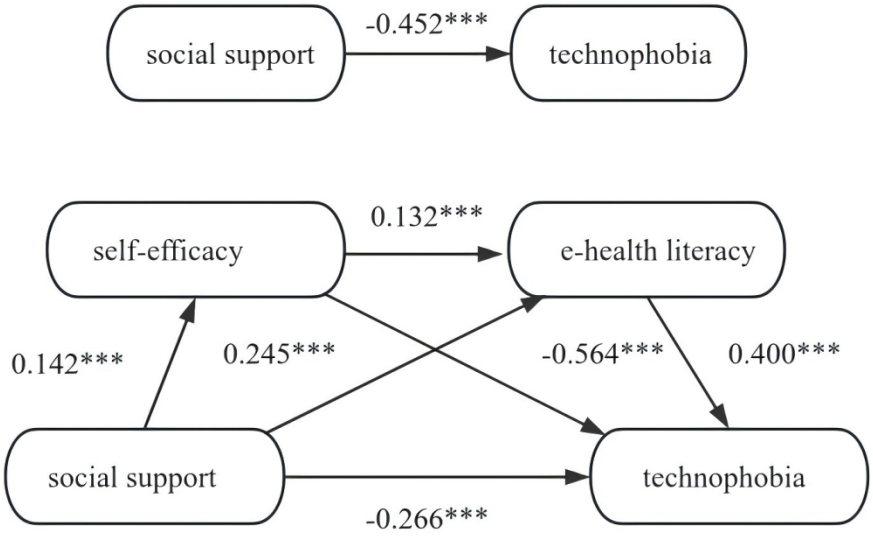
Funding This research received grants from the 2023-2024 Shanxi Province Large Health Industry high-quality development research project (No.:DJKZXKT2023001).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Patient consent for publication Not applicable.

Ethics approval This study was approved by the Ethics Committee of Shanxi Medical University (No. 2023007).

Figure 1. Paths of chained mediating effects in older adults in urban communities in Taiyuan, China.



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Influence of social support on technophobia in older adults in urban communities：the mediating role of self-efficacy and e-health literacy，a cross-sectional study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-093107.R1
Article Type:	Original research
Date Submitted by the Author:	19-Dec-2024
Complete List of Authors:	LUO, Dan; Shanxi Medical University, School of Humanities and Social Sciences Li, Jin; Shanxi Medical University, School of Humanities and Social Sciences Wang, Chen ; Shanxi Medical University, school of Humanities and Social Sciences Shi, Yan; Shanxi Medical University, School of Humanities and Social Sciences; Changzhi Medical College, Public Health and Preventive Medicine Guo, hua qing; Shanxi Medical University, School of Humanities and Social Sciences Duan, zhi guang; Shanxi Medical University, School of Humanities and Social Sciences
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Sociology, Public health, Mental health, Health policy, Geriatric medicine
Keywords:	Community-Based Participatory Research, Cross-Sectional Studies, Health Services for the Aged, MENTAL HEALTH, PUBLIC HEALTH, Social Support

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Influence of social support on technophobia in older adults in urban communities：the mediating role of self-efficacy and e-health literacy，a cross-sectional study

Abstract

Objectives To explore the chained mediating role of self-efficacy and e-health literacy in the association between social support and technophobia in older adults in urban communities.

Design A cross-sectional study conducted from June 2023 - April 2024

Setting This study was conducted in three districts of Taiyuan City, Shanxi Province, China.

Participants The study enrolled 1658 older adults (> 60 years old) in urban communities in Taiyuan

Methods: The analyses included assessments using the technophobia, e-health, self-efficacy, and social support scales, and the mediating effects of these indices were investigated using Model 6 in SPSS 26.

Results: Self-efficacy and e-health literacy were found to play independent or chained mediating roles in the association between social support with technophobia. Social support had a significant direct effect on technophobia (β=-0.452, p<0.001), while social support had a significant positive effect on self-efficacy (β=0.142, p<0.001), and social support (β=0.245, p<0.001) and self-efficacy (β=0.132, p<0.001) had significantly positive effects on the e-health literacy of the older adults. On the other hand, technophobia was significantly negatively influenced by social support (β=-0.266, p<0.001), self-efficacy (β=-0.564, p<0.001), and e-health literacy (β=-0.4, p<0.001).

Conclusion: Social support was found to affect technophobia in older adults via the independent or chained mediating effects of self-efficacy and e-health literacy. These findings provide a reference for the mitigation of technophobia in older adults.

Strengths and limitations of this study

⇒Through the construction of a chain mediation model, this study explores the relationship between social support and technophobia among older adults in urban communities, together with a assessment of the mediating roles played by electronic health literacy and self-efficacy.

⇒A multi-stage sampling method was used. Three districts were randomly selected from the six urban areas of Taiyuan, after which three neighbourhoods were randomly chosen from the districts using the street as the sampling unit, after which a convenience sample of older people aged 60 years and above was collected, resulting in the distribution of 1,658 questionnaires.

⇒Correlation analyses and a bootstrap sampling method were used to analyse the data and verify the

degree of fit of the intermediary model.

⇒Internationally recognized scales were used to assess the health status of the study participants; the results are, therefore, comparable to those of other studies.

⇒As the study is cross-sectional in design, it is weak in causal inference and carries the risk of reverse causality.

Introduction

With global demographic changes and advances in digital technologies, technology-empowered smart care for older adults is an inevitable trend. Smart care services can help to not only enrich the lives of older adults and provide convenience but can also mitigate health-resource shortages, reduce social service costs, and improve service efficiency. However, existing intelligent health technologies have limited inclusiveness.[1] Older adults, as a specific group, often feel overwhelmed, anxious, and even frightened when faced with handling complex information such as texts, images, and sounds,[2] potentially leading to technophobia. As a phenomenon associated with technology and psychological issues associated with modern technology,[3] technophobia refers to an individual's irrational anxiety and fear of digital technologies, such as mobile communication devices, artificial intelligence (AI), and robots, and can even result in the avoidance of technology altogether.[4] Technophobia has been reported to be a risk factor for impeding health-promoting behaviors in older adults in the digital era.[5] In 1996, Celaya *et al.*[6] reported that 20–33% of Americans experienced technophobia, while a more recent study by Osiceanu *et al.*[7] reported the existence of technophobia in 50% of Americans of different ages, indicating that the number of people who experience technophobia is increasing, not decreasing, over time. Moreover, research on technophobia in older adults has focused mainly on investigating the current situation and its influencing factors,[8-11] and with less investigation of the influence of social support on technophobia in older adults in urban communities. Social support represents an important means of anxiety alleviation among older adults in urban communities,[12] and research on its relationship and associated mechanisms with technophobia has received extensive attention in the fields of psychology and public health. The present study aims to explore the specific associations between social support and technophobia, and provide a theoretical and practical basis for improving the physical and mental health of older adults.

The relationship between social support and technophobia

The term social support indicates the social behaviour of a specific social network in providing unpaid

help and services to socially vulnerable groups by material or spiritual means and ways.[13] Social support network theory holds that the relationship network formed by individuals in social life can provide emotional support, material assistance, and information exchange, among other factors, and that these supports are of significant importance in enabling individuals to cope with stress and to improve their quality of life.[14] First, social support, as an available external resource, provides a buffering effect on stressed individuals through the internal cognitive system, alleviating the negative impacts of stressful events, which represents an important way of enhancing the health and well-being of older adults.[15] At the same time, encouragement from family, friends, and other members of the social network enables improved understanding of health-related information, allowing optimal health-related decision-making.[16] Research has shown that social support plays an important role in the achievement and maintenance of good mental health.[17] The stronger the social support network an individual has, the better they are able to cope with various challenges from their environment, directly reducing the individual's level of anxiety.[18] Technophobia represents a major problem for older adults and requires social support for its alleviation. Therefore, Hypothesis 1 of this study is proposed: Social support has a negative effect on technophobia in older adults.

The mediating role of self-efficacy

Self-efficacy represents a person's confidence or belief in their ability to perform a task or work behaviour, and is a subjective judgemental behaviour.[19] Social support theory states that social support is closely related to self-efficacy.[20] Social support perceived by individuals can increase their self-efficacy for emotion regulation.[21] This implies that when older adults in urban communities experience greater social support, they are more confident, optimistic, and believe in their ability to cope with stress arising from the use of digital health products. Additional research has found that self-efficacy can have a direct effect on technophobia. A study of teleworkers during COVID-19 pandemic showed that e-work self-efficacy buffered the positive effects of technology stressors on symptoms of depressed mood and anxiety.[22] At the same time, self-efficacy significantly influenced the perceptions and emotional responses to the use of technology.[23] Thus, self-efficacy can influence a person's evaluations and perceptions of their ability to use e-Health technology. In addition, biochemical experiments have shown that high self-efficacy can influence the production of substances, such as catecholamines, that activate the autonomic nervous system, which regulates both immune and neuropsychiatric functions.[24] It can thus be inferred that self-efficacy may negatively

influence the level of technophobia in older adults. Therefore, Hypothesis H2 is proposed: Self-efficacy mediates the relationship between social support and technophobia among older adults in urban communities.

The mediating role of e-health literacy

E-health literacy indicates the ability of an individual to use electronic media to select, understand, and evaluate health-related information and to apply the knowledge gained to solve and manage health problems.[25] Research has demonstrated a positive association between the intensity of social software use and e-health literacy.[26] Increased online social support received by individuals through the use of electronic devices and social networking sites or software, contributes to e-health literacy. In turn, e-health literacy has been positively associated with health-related behaviours.[27] The ability of older people to access and use of health-related information is linked to the improvement of health perceptions, the development of health-related behaviours, and reduction in anxiety over physical health and the use of digital technology.[28] In addition, improving the level of e-health literacy can help older people in urban environments use health-related products and services, assist them in integrating into the digital health society and enjoying the benefits of smart healthcare services, thus reducing their anxiety surrounding the use of technology.[29] In summary, e-health literacy functions as a bridge and buffer between social support and technophobia. The positive effects of social support can be enhanced by increasing individual e-health literacy, which in turn alleviates technophobia and improves the quality of life as well as health behaviours of older people. Therefore, this study proposes Hypothesis H3: e-Health literacy mediates between social support and technophobia among older adults in urban communities.

The chain-mediating effect of self-efficacy and e-health literacy

According to Bandura's theory, individuals with a strong sense of self-efficacy are more inclined to take the initiative in meeting challenges, put in more effort, persevere longer, and be more resilient in the face of difficulties.[30] This self-regulatory ability enables individuals to set goals, observe behavioural performance, assess the gap between performance and goals, and adjust their behaviour accordingly in the process of improving e-health literacy, thus effectively improving e-health literacy. Therefore, increased support from urban communities enhances the self-efficacy and e-health literacy levels of older adults, reducing the level of technophobia. Therefore, this study proposes Hypothesis H4: Self-efficacy and e-health literacy play a chain-mediating role between social support and

technophobia.

Methods

Study design and participants

From June 2023 - April 2024, field research was conducted on older adults in urban communities in Taiyuan, China. A multi-stage sampling method was used. First, three districts (Ying ze District, Jian cao ping District, and Jin yuan District) were randomly selected from six urban districts in Taiyuan, after which three communities were randomly selected from the selected districts using streets as the sampling unit, followed by convenience sampling of older adults aged 60 years and above from the selected communities.

Inclusion criteria: (1) aged 60 years and over; (2) have good hearing and vision, and able to communicate; (3) willing to participate in the study; (4) have lived in the selected communities for three years or longer.

Exclusion criteria: (1) have severe organic diseases or mental disorders; (2) unable to communicate; (3) unwilling to participate in the study.

Calculation of the sample size required a ratio of sample size to observed variables of 10: 1-15: 1. The study included 18 variables (e.g., demographic variables). To ensure a 20% sample loss rate and the representativeness and accuracy of data, the sample size was calculated to be ⩾216 cases.

Data collection

Professional training was provided to the survey personnel before conducting the questionnaire survey to ensure their familiarity with the survey methods. Before administering the questionnaires, the survey personnel explained the purpose of the survey and filling out the questionnaire to the older adults in the communities, and emphasized the anonymity and confidentiality of their responses. After obtaining informed consent from the participants, the survey personnel distributed questionnaires to them one-on-one. Those with the ability to read and write completed the questionnaire themselves, while for participants who were illiterate or had difficulty with completing the questionnaire, the survey personnel read the questions one-by-one and the participants chose their answers which were then recorded by the survey personnel. If the participants experienced difficulty in understanding the questions, the survey personnel provided neutral and accurate explanations and recorded the answers based on the responses. After the collection of the questionnaires, other survey personnel verified the data and checked for any missing information so that missing information could be filled out on-site. A

total of 1801 older adults from urban communities were surveyed, of whom 143 were excluded due to missing information or voluntary withdrawal from the study. Finally, 1658 effective questionnaires were included in the analysis, with an effective recovery rate of 93.56%.

Measures

The survey tools used in this study included:

(1) Questionnaire on sociodemographic characteristics: This questionnaire comprised items on age, gender, marital status, residential situation, education level, monthly income, self-rated health, and frequency of using digital health products.

(2) Technophobia scale: This scale was developed by American research Khasawneh,[31] and was translated, back-translated, and cross-culturally adapted by Sun et al.[32] to the Chinese version, comprising 13 items in 3 dimensions (fear of technology, anxiety about technology, and privacy concerns). The scale is scored using a 5-point Likert scale (5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree), with a total score of 13-65. A total score of ≥39 indicates a high level of technophobia, while a total score of <39 indicates a low technophobia level. The Cronbach's α of this scale is 0.911, with the Cronbach's α of factors ranging from 0.759 to 0.885 and a split-half reliability coefficient of 0.851. This indicates that this scale has good reliability and validity and was suitable for assessing technophobia in older adults in China.

(3) Questionnaire on e-health literacy: This questionnaire was developed by the Canadian researcher Norman,[33] and it was translated, back-translated, and cross-culturally adapted by Guo Junshuai et al.[34] to the Chinese version, which comprises 8 items in three dimensions (ability to apply online health information and services [5 items], critical thinking ability [2 items], and decision-making ability [1 item]). The scale essentially assesses an individual's ability to obtain, understand, and evaluate health information using electronic devices and to apply the acquired knowledge to handle health issues. It is also scored using a 5-point Likert scale, with a total score of 8-40. A higher total score indicates higher e-health literacy. A total score of 26 is the cutoff and scores <26 indicate lower levels of e-health literacy, while total scores ≥26 indicate high e-health literacy. The Cronbach's α is 0.966 and the factor analysis loading ranges from 0.754 to 0.856, indicating good reliability and validity.

(4) Self-efficacy scale: This scale was translated, back-translated, and cross-culturally adapted by Wang Caikang et al.[35] This scale comprises 10 items and is used to assess the confidence of individuals in overcoming difficulties. It is a 4-point scale, with a total score of 10-40, with scores of 10-20

denoting low self-efficacy, 21-30 indicating medium self-efficacy, and 31-40 representing high self-efficacy; thus higher scores indicating better self-efficacy. The Cronbach's α is 0.87.

(5) Social support scale: This scale was translated, back-translated, and cross-culturally adapted by Xiao Shuiyuan[36] in 1994. It is used to assess the types and degree of assistance and resources obtained from others. It comprises 10 items in 3 dimensions, with a total score of 12-65, with scores of 12-22 denoting low social support, 23-44 denoting medium social support, and 45-65 representing high social support; thus higher scores indicate higher levels of social support. The Cronbach's α is 0.73.

Statistical analysis

The data were imported into SPSS 26.0 for analysis. For descriptive statistics, number of cases (n) and percentage (%) were used to describe categorical data. In this study, differences between the levels of various major variables in the overall data were examined. The major variables, namely, e-health literacy, technophobia, self-efficacy, and social support, were all essentially normally distributed and independent samples t-tests and one-way ANOVA were used for comparisons. Based on the literature, factors with statistical significance in the one-way ANOVA were used as control variables. Model 6 in SPSS 26.0 was used for analysis; this is specifically designed for the analysis of chained-mediation models, and enables the testing of multiple indirect effects, including indirect effects arising from M1, those arising from M2, and those arising from both M1 and M2 together. It allows the comparison of the effect sizes of different mediation paths and the assessment of their relative importance in the total effect. Moreover, the process plug-in uses the bootstrap method to test the function of the mediation effect, and uses a resampling technique to estimate the confidence interval of the indirect effect, enabling the assessment of the significance of mediation effect, which is a more robust statistical method.

Common method bias test

To reduce the self-reporting bias inherent in cross-sectional studies, a series of quality controls were conducted. Uniform training was provided to the investigators before conducting the survey to ensure standardisation and accuracy of the information and to avoid the possibility of measurement bias caused by staff differences. Furthermore, full anonymity of the information of the older adults was ensured to reduce the possibility of social desirability bias, and, before the formal survey, a small-scale pre-survey of 30 individuals was conducted. To enhance the understanding of the questionnaire by the participants, the wording of the questionnaire was amended to reduce self-reporting bias, and when

participants still had questions during the survey process, the investigator used neutral language to explain the questions and reduce the response bias formed by language induction. At the data-analysis stage, Harman one-way tests were used for examining the bias of the sample data, and exploratory factor analysis of the four-variable question revealed that 12 factors had an eigenvalue greater than 1. Of these, the first factor had a total variance that explained 34.80%, which is less than the 40% threshold and does not represent statistical bias.

Patient and public involvement

None

Results

Demographic characteristics

The characteristics of the participants are summarized in Table 1. In terms of gender, 907 participants were male, accounting for 54.7%, while 751 participants were female, accounting for 45.3%. A total of 749 participants were aged between 60 and 70 years, accounting for 45.2%, while 641 (38.7%) were aged between 71 and 80 years. In terms of marital status, 679 participants were married, accounting for 41%, and 978 (59%) lived with their families. Overall, 713 (43%) of the older adults had a monthly income above 3000 yuan, with no significant differences in the numbers of participants with income levels of 1000-3000 and those below 1000. In terms of education level, 618 (36.3%) had an educational level of high school or above, while 530 participants were junior middle school graduates, accounting for 32% and 68 (4.1%) were illiterate. In terms of self-rated health, 716 (43.2%) rated their health as average, while 571 (34.4%) rated themselves as healthy, indicating that the health of the participants was generally good. In terms of frequency of using electronic devices, 683 (41.2%) electronic devices frequently, and 631 (38.1%) used such devices occasionally.

Table 1. Characteristics of the older adults in urban communities in Taiyuan, China.

Variable	Option	Number of cases (n)	Percentage (%)
Gender	M	907	54.7
	F	751	45.3
Age	60-70	749	45.2
	71-80	641	38.7
	>80	268	16.2
Marital status	Married	679	41.0
	Single	455	27.4
	Divorced	199	12.0
	Widowed	325	19.6

Residential situation	Living with family	978	59.0
	Living alone	680	41.0
Monthly income	<1000	506	30.5
	1000-3000	439	26.5
	>3000	713	43.0
Education level	Illiteracy	68	4.1
	Elementary school graduates	442	26.7
	Middle school graduates	530	32.0
	High school graduates or above	618	37.3
Self-rated health	Not healthy	371	22.4
	Average	716	43.2
	Healthy	571	34.4
Use frequency of digital health products	Never	344	20.7
	Occasionally	631	38.1
	Often	683	41.2

Influences of demographic characteristics on different variables

The influences of gender, age, marital status, residential situation, monthly income, education level, self-rated health, the use frequency of electronic devices on technophobia, e-health literacy, self-efficacy, and social support of the older adults were investigated by one-way ANOVA. The results showed that age, residential situation, education level, health, and frequency of using electronic devices significantly influenced the incidence of technophobia in older adults, while age, marital status, residential situation, education level, health and frequency of using electronic devices significantly influenced e-health literacy, and age, residential situation, monthly income, and education level influenced self-efficacy, and age, marital status, residential situation, education level, self-rated health, and frequency of using electronic devices significantly influenced social support in the older adults (Table 2).

Table 2. Influences of demographic characteristics on different variables in older adults in urban communities in Taiyuan, China.

		Score			
	Number of cases	**Technophobia**	**E-health literacy**	**Self-efficacy**	**Social support**
Total sample	1658	40.31±12.26	23.18±6.81	23.65±6.74	29.42±9.60
Gender					
M	907	40.45±12.14	22.93±6.80	23.40±6.90	29.05±9.57
F	751	40.14±12.40	23.48±6.82	23.95±6.53	29.85±9.62
t		0.523	-1.625	-1.655	-1.686
P		0.601	0.104	0.098	0.092
Age					
60-70	756	39.5±12.85	23.59±6.76	24.24±6.61	29.59±9.70
71-80	634	40.09±12.01	23.01±6.97	23.60±6.64	29.85±10.03
>80	268	43.08±10.70	22.46±6.52	22.11±7.13	27.90±8.03
F		8.633	3.022	9.987	4.11
P		**<0.001**	**0.049**	**<0.001**	**0.017**
Marital status					
Married	679	40.47±12.52	23.38±6.85	23.26±6.60	30.10±10.10

Single	455	39.95±12.14	23.62±6.68	24.33±6.94	29.74±8.97
Divorced	199	39.73±8.74	21.59±6.36	23.70±6.46	26.36±9.01
Widowed	325	40.83±13.65	23.14±7.07	23.48±6.89	29.40±9.42
F		0.514	4.452	2.406	8.172
P		0.673	**0.004**	0.066	**<0.001**
Residential situation					
Living with family	978	39.03±12.39	24.13±6.62	24.05±6.77	30.48±9.76
Living alone	680	42.14±11.83	21.82±6.85	23.07±6.66	27.89±9.16
t		-5.122	6.889	2.939	5.438
P		**<0.001**	**<0.001**	**0.003**	**<0.001**
Monthly income					
<1000	506	40.05±12.84	23.43±6.86	23.20±6.96	29.88±9.64
1000-3000	439	39.84±11.88	22.91±7.06	22.91±7.17	29.19±9.14
>3000	713	40.79±12.06	23.17±6.62	24.42±6.22	29.22±9.85
F		0.986	0.691	8.564	0.866
P		0.373	0.501	**<0.001**	0.421
Education level					
Illiteracy	68	46.54±11.24	20.47±7.76	20.79±6.22	27.19±9.58
Elementary school graduates	442	39.32±14.17	23.66±6.83	24.74±6.34	29.65±8.92
Middle school graduates	530	38.16±12.32	23.28±6.87	24.67±6.82	30.22±10.76
High school graduates	618	42.17±10.19	23.06±6.58	22.31±6.70	28.80±8.95
F		17.553	4.461	20.727	3.414
P		**<0.001**	**0.004**	**<0.001**	**0.017**
Self-rated health					
Not healthy	371	40.89±13.21	22.68±7.00	23.05±5.96	29.89±10.17
Average	716	41.30±11.20	22.49±6.66	23.72±6.92	28.11±9.22
Healthy	571	38.68±12.73	24.38±6.72	23.94±6.98	30.74±9.50
F		7.86	13.78	2.08	12.698
P		**<0.001**	**<0.001**	0.125	**<0.001**
Use frequency of electronic devices					
Never	344	42.94±10.22	20.47±6.11	22.85±6.69	28.12±8.53
Occasionally	631	40.56±11.98	23.50±6.43	23.80±6.63	29.25±9.35
Often	683	38.75±13.19	24.25±7.12	23.91±6.85	30.23±10.25
F		13.806	38.159	3.102	5.721
P		**<0.001**	**<0.001**	0.045	**0.003**

Correlation analysis of technophobia, e-health literacy, self-efficacy, and e-health literacy

Correlation analysis is an important method to explore associations between different variables.[37] In this study, all the major variables were approximately normally distributed numerical variables. Therefore, Pearson correlation analysis was used for testing. As shown in Table 3, significant correlations were found. Specifically, e-health literacy, self-efficacy, and social support were significantly negatively correlated with technophobia. E-health literacy, self-efficacy, and social support showed significant positive correlations with each other. The absolute values of the correlation coefficients of each pair of variables ranged from 0.2 to 0.5, suggesting weak to moderate correlations between the variables.

Table 3. Correlation analysis of technophobia, e-health literacy, self-efficacy, and social support in older adults in urban communities in Taiyuan, China.

Variable	Technophobia	E-health literacy	Self-efficacy	Social support

Technophobia	1			
E-health literacy	-0.395**	1		
Self-efficacy	-0.416**	0.224**	1	
Social support	-0.377**	0.403**	0.216**	1

Note: **p<0.01

Hypothesis testing

Through correlation analysis, the correlations of variables were preliminarily tested. In this section, hypothesis testing was conducted for further examination of associations between variables. According to the correlation hypotheses proposed above, the direct impact of social support on technophobia was used as the main outcome. On this basis, the chained mediating effects of self-efficacy and e-health literacy were further examined in this model. Additionally, variables that showed significant effects on technophobia in the analysis (age, residential situation, education level, health, and use frequency of smart devices) were included in the model as control variables. Model 6 in SPSS 26 was used for testing. The testing results consisted of two parts, namely, the stepwise regression results and the results of the bootstrap random sampling mediating effect testing. A confidence interval (CI) of 95% was used as the threshold. The mediating effect was determined by observing whether the 95% CI includes 0. If the 95% CI did not include 0, the corresponding effect is significant; otherwise, it is non-significant.

Table 4 shows the mediating effect results obtained from the stepwise regression. In Model 1, social support had a significantly negative influence on technophobia (β=-0.452, p<0.001), suggesting that technophobia in older adults was negatively associated with social support. In Model 2, social support had a significant positive influence on self-efficacy (β=0.142, p<0.001). In Model 3, social support (β=0.245, p<0.001) and self-efficacy (β=0.132, p<0.001) both had significant positive influences on e-health literacy, while in Model 4, social support negatively affected technophobia (β=-0.266, p<0.001), as did self-efficacy (β=-0.564, p<0.001), and e-health literacy (β=-0.400, p<0.001). Overall, the coefficients were significant in all models. Overall, self-efficacy and e-health literacy had mediating effects as partial mediators (Table 4).

Table 4. Investigation of mediating effects using stepwise regression.

Model	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
Dependent variable	**technophobia**		**self-efficacy**		**e-health literacy**		**technophobia**	
Index	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**
Independent								

variable								
Social support	-0.452	-15.532***	0.142	8.396***	0.245	15.359***	-0.266	-9.227***
Mediating variable								
Self-efficacy					0.132	5.836***	-0.564	-14.499***
E-health literacy							-0.400	-9.585***
Control variable								
Age	1.221	3.208**	-0.934	-4.221***	-0.196	-0.957	0.567	1.628
Residential situation	1.626	2.851**	-0.445	-1.342	-1.386	-4.532***	0.797	1.527
Education level	0.447	1.445	-0.686	-3.816***	0.265	1.592	0.130	0.460
Health	-0.874	-2.337*	0.294	1.355	0.676	3.372**	-0.421	-1.235
use frequency of electronic devices	-1.496	-4.104***	0.266	1.255	1.393	7.131***	-0.774	-2.299*
R	0.407		0.261		0.474		0.558	
R^2	0.165		0.068		0.224		0.311	
F	54.485***		20.138***		68.193***		93.026***	

Note: *p<0.05, **p<0.01, ***p<0.001

According to the results of the mediating effect analyses shown in Table 5, the social support-self-efficacy-technophobia path had an effect value of -0.08 and its 95% CI did not include 0, suggesting that the indirect effects of self-efficacy were significant. Similarly, the path of social support-e-health literacy-technophobia had an effect value of -0.098 and its 95% CI did not include 0, suggesting that the indirect effects of e-health literacy were significant, and the path of social support-self-efficacy-e-health literacy-technophobia had an effect value of -0.008 and its 95% CI did not include 0, suggesting that both self-efficacy and e-health literacy had significant chained mediating effects. Additionally, significant results were observed for both total and direct effects, indicating simple and chained mediating effects of self-efficacy and e-health literacy in the models, and thus suggesting that the negative impact of social support on technophobia could be transmitted and realized through self-efficacy and e-health literacy. The mediating effect of self-efficacy was found to account for 17.7%, while the mediating effect of e-health literacy accounted for 21.7%, and the chained mediating effect accounted for 1.8% (Table 5 and Figure 1).

Table 5. Chained-mediating role of self-efficacy and e-health literacy in the correlation of social support with technophobia in older adults in urban communities in Taiyuan, China.

Effects	Effect value	LLCI	ULCI	Percentage
Total effects	-0.452	-0.509	-0.395	100.0%
Direct effects	-0.266	-0.323	-0.210	58.8%
Indirect effects	-0.185	-0.219	-0.153	40.9%
Social support - self-efficacy - technophobia	-0.080	-0.101	-0.059	17.7%
Social support - e-health literacy -	-0.098	-0.124	-0.074	21.7%

technophobia				
Social support - self-efficacy - e-health literacy - technophobia	-0.008	-0.011	-0.004	1.8%

LLCI, Lower Level Confidence Interval; ULCI, Upper Level Confidence Interval.

DISCUSSION AND ANALYSIS

Influences of social support on technophobia in older adults in urban communities

Our findings showed that social support had a direct negative effect on the level of technophobia in older adults, and that the higher the level of social support, the lower the level of technophobia in this population. Thus, Hypothesis 1 is well-supported, which is consistent with the research of Khasawneh et al[38]. Social support can directly alleviate technophobia in an individual[39]. The classic buffering hypothesis of social support suggests that social support can reduce technophobia by providing psychological and material resources that enhance an individual's ability to cope with stress and emotional distress[40]. Research has found that the demand for health services tends to increase as people age[41]. However, in reality, older people are at a 'natural disadvantage' in the application of emerging technologies. The encouragement and emotional support from family and friends in a timely manner may promote their psychological resilience, enable them to feel safe and confident, and thus reduce the risks of dealing with new or complex technologies. Greater levels of social support also implies an expansion of the individual's social networks[42], which can provide older people with access to a variety of resources through which individuals can enhance their skills and technical knowledge, thereby reducing the anxiety associated with unfamiliarity with or inability to master technology. Of course, social support can assist in changing older people's perceptions of technology[43]. For example, having experienced friends or family members around them can not only help older adults understand the value and use of technology, but also alter their originally negative cognitive patterns to be more positive when facing technological challenges, thus effectively reducing technophobia. In addition, social support in the form of instrumental support (such as hearing aids, presbyopes, and speech recognisers) can alleviate the discomfort that many older people experience as a result of their declining abilities, thus reducing the technophobia that arises when faced with new technology. Health IT itself is another trigger for technophobia in older people. Smart health services are often aimed at a wide range of social groups, and the complexity of the procedures discourages some older people. In addition to the fear of incurring large costs due to improper operation when using smart devices, products, or services, the 'loss of control' and 'powerlessness' of intelligence will further aggravate the

tendency toward technological anxiety. The development of age-friendly products (material and information support) can effectively alleviate the levels of technological anxiety in older individuals[44]. Therefore, there should be a greater focus on older adults. The provision of timely and accurate social support can effectively alleviate the level of technological anxiety in this demographic, thereby enhancing their overall quality of life.

Roles of self-efficacy and e-health literacy in the correlation of social support with technophobia in older adults in urban communities

The findings show that social support can influence the level of technophobia in older adults through self-efficacy. Thus, the more social support older adults receive, the greater their self-efficacy in using technology and the lower their level of anxiety about the technology, which is consistent with the inference of Hypothesis 2. This is consistent with the results of a study by Ginja et al. showing that the less social support received, the lower the level of self-efficacy and the higher the level of anxiety instead[45]. Self-efficacy is an important mediating variable in the influence of social support networks on the health of older adults[46]. Compared to younger age groups, older adults are less receptive to new things and often show a lack of self-confidence when faced with smart health technologies, resulting in lower levels of self-efficacy in the use of these applications. A study on the mental health of urban empty nesters found that social support had a significant negative effect on their psychological anxiety[47]. In contrast, older adults with higher self-efficacy were more adaptive and able to deal with new technologies, resulting in better health beliefs, which in turn reduced the level of technophobia. In addition, our findings support Hypothesis 3, namely, that social support can also influence technophobia through e-health literacy. Consistent with the findings of Piccirillo ML[48], the primary reason for this is that social support provides more social networks and increases older adults' ability to access health resources through smart health technologies, thus strengthening their level of e-Health literacy and ultimately reducing their level of technophobia. Indeed, low e-health literacy is an obstacle for older adults in accessing e-health information[49], as it can lead to technophobia and affect their willingness to use and accept new technologies[50]. Older adults with low e-health literacy have reduced abilities to understand, evaluate, and use digital information technology and cannot proactively adapt to new technologies. Inevitably, they feel more anxious when using digital technology. Several studies have attempted to enhance the self-efficacy of older adults by providing them with social support, showing that the overall mood and outlook of the older adults were significantly improved compared to

the control group[51]. In other words, social support can significantly improve the mental health of older adults and their confidence in the utilization of information technologies. It has been demonstrated that the better the self-efficacy of older patients with chronic non-communicable diseases, the higher their e-health literacy[52]. Interventions to improve self-efficacy were found to be effective in enhancing the e-health literacy of college students during the COVID-19 epidemic[53]. However, e-health literacy was negatively correlated with technophobia[54-55]. Overall, self-efficacy and e-health literacy were found to have chained mediating effects.

Factors influencing technophobia in older adults in urban communities

As shown in Table 2 and Table 3, there were high levels of technophobia in older adults in urban communities in Taiyuan, China. In addition to their influence by social support, self-efficacy, and e-health literacy, multiple regression analyses also showed that age, residence, educational level, health status, and frequency of smart device use were also important. The ability of older people to understand and master new things diminishes with age, leading to a lack of self-confidence and self-efficacy in the use of health IT or digital health technologies, with this contradiction between high demand and low competence further reinforcing feelings of nervousness, helplessness, and resistance and thus increasing the level of technological anxiety[56].This is consistent with the findings of the study by Xi WY et al[57]. Therefore, healthcare providers and policymakers could work with community organisations to improve the ability of older adults to operate smart applications through thematic training and education, and guide them in the use of novel technology and experiences using experiential learning and the trying out applications, enabling them to effectively access, utilise, and disseminate health resources. Secondly, according to the physiological characteristics of older adults, ageing-adapted transformation of Internet applications and intelligent terminal products could be promoted, for example, intelligent products for the elderly need to consider characteristics such as large screens, large fonts, and large volumes, while intelligent terminal products such as intelligent assistive devices and intelligent homes are being developed, enabling older adults to enjoy health services in a more humanistic manner.

Limitations and future directions

First, the study sample was limited to older adults in urban communities in Taiyuan, which may affect the generalizability of the research results. Second, it is difficult to determine causal relationships between the study variables due to limitations inherent in the cross-sectional study design,and the level

of technophobia in the elderly is also affected by confounding factors such as the length of time spent using electronic devices, the level of sophistication of the electronic devices, and the elderly themselves. As a result, there may be some bias in the research results. In addition, all participants were informed that the study was investigating social support, self-efficacy, e-health literacy, and technophobia. Since the results relied on the self-reports of the participants, this may have introduced a degree of bias. Additionally, factors such as health conditions, traditional culture, and living habits may also influence technophobia in older adults. Further investigations are required for a comprehensive elucidation of the causes of technophobia in older adults.

Conclusion

This study is the first to intuitively demonstrate the mechanism by which social support influences technophobia among old adults in urban communities through the construction of a mediation effect model.The independent and chained mediating roles of self-efficacy and e-health literacy in the correlation of social support with technophobia of older adults in urban communities were demonstrated. On a theoretical level, these findings contribute to the understanding of the mechanisms by which social support affects technophobia in older adults, as well as providing new research directions for future studies and advancing research on the psychological health of older adults in the context of smart health. On a practical level, based on the proposed mechanisms, relevant stakeholders could provide targeted social support to older adults in urban communities to improve their self-efficacy. Additionally, the social health industry should focus on the health needs and realities of this demographic to develop older adult-friendly health products and offer user-friendly channels for obtaining health information, enhance the e-health literacy of this population, reduce their technophobia, and improve their overall health and well-being.

Acknowledgements We would like to thank all the participants in the present study.

Contributors DL contributed to the conceptualisation, formal analysis and writing the original draft. JL and CW made contributions to the data curation and verification. YS and QG contributed to the writing, review and editing. GD acts as a guarantor for the final manuscript.

Funding This research received grants from the 2023-2024 Shanxi Province Large Health Industry high-quality development research project (No.:DJKZXKT2023001).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Patient consent for publication Not applicable.

Ethics approval This study was approved by the Ethics Committee of Shanxi Medical University (No. 2023007).

Data availability statement Data are available on reasonable request.

Figure 1. Paths of chained mediating effects in older adults in urban communities in Taiyuan, China.

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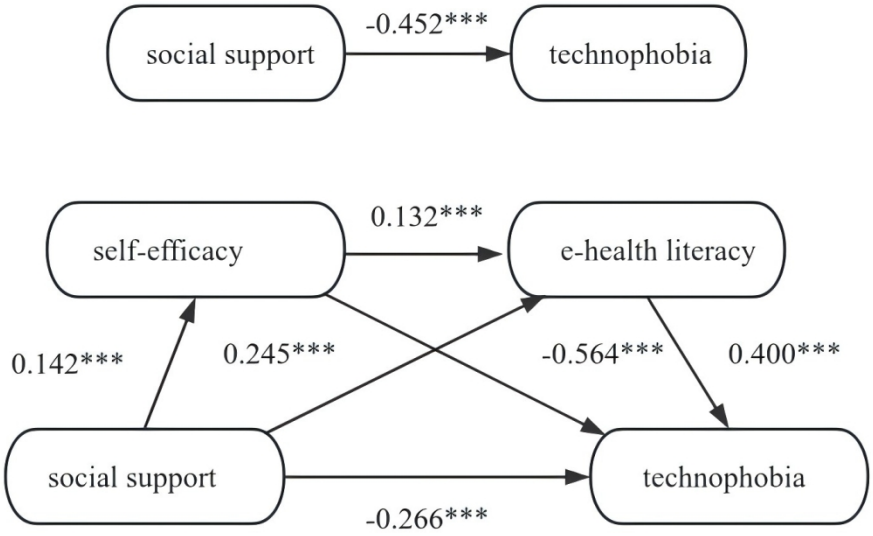

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-093107.R2
Article Type:	Original research
Date Submitted by the Author:	16-Jan-2025
Complete List of Authors:	LUO, Dan; Shanxi Medical University, School of Humanities and Social Sciences Li, Jin; Shanxi Medical University, School of Humanities and Social Sciences Wang, Chen ; Shanxi Medical University, school of Humanities and Social Sciences Shi, Yan; Shanxi Medical University, School of Humanities and Social Sciences; Changzhi Medical College, Public Health and Preventive Medicine Guo, hua qing; Shanxi Medical University, School of Humanities and Social Sciences Duan, zhi guang; Shanxi Medical University, School of Humanities and Social Sciences
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Sociology, Public health, Mental health, Health policy, Geriatric medicine
Keywords:	Community-Based Participatory Research, Cross-Sectional Studies, Health Services for the Aged, MENTAL HEALTH, PUBLIC HEALTH, Social Support

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Influence of social support on technophobia in older adults in urban communities：the mediating role of self-efficacy and e-health literacy，a cross-sectional study

Abstract

Objectives To explore the chained mediating role of self-efficacy and e-health literacy in the association between social support and technophobia in older adults in urban communities.

Design A cross-sectional study conducted from June 2023 - April 2024

Setting This study was conducted in three districts of Taiyuan City, Shanxi Province, China.

Participants The study enrolled 1658 older adults (> 60 years old) in urban communities in Taiyuan

Methods: The analyses included assessments using the technophobia, e-health, self-efficacy, and social support scales, and the mediating effects of these indices were investigated using Model 6 in SPSS 26.

Results: The level of technophobia in older adults was found to be moderately high. Technophobia was negatively correlated with social support, self-efficacy, and e-health literacy. Stepwise regression analysis showed that age, residential situation, health, and the frequency of electronic device use were risk factors for technophobia (p<0.05). Social support could influence technophobia directly (β=-0.266). In addition, self-efficacy (β=-0.080) and e-health literacy (β=-0.098) significantly mediated the relationship between social support and technophobia.

Conclusion: Social support was found to affect technophobia in older adults via the independent or chained mediating effects of self-efficacy and e-health literacy.

Strengths and limitations of this study

⇒This study explores the relationship between social support and technophobia among older adults in the community and its associated mechanisms, as well as the mediating roles of self-efficacy and e-health literacy, by constructing a chain mediation model.

⇒The use of survey data from only one region may limit the generalizability of the research results.

⇒As the study is cross-sectional in design, it is weak in causal inference and carries the risk of reverse causality.

Introduction

With global demographic changes and advances in digital technologies, technology-empowered smart care for older adults is an inevitable trend. Smart care services can help to not only enrich the lives of older adults and provide convenience but can also mitigate health-resource shortages, reduce social

service costs, and improve service efficiency. However, despite the advantages resulting from the development of digital technology, many older people still maintain traditional cultural concepts, are skeptical of new technologies in the outside world, and are even more worried about privacy leaks. In addition, existing intelligent health technologies have limited inclusiveness[1]. Due to declines in physical function, the elderly are easily overwhelmed and experience anxiety and fear when faced with the complex functions of smart devices and operating interfaces, potentially leading to technophobia[2]. As a phenomenon associated with technology and psychological issues associated with modern technology,[3] technophobia refers to an individual's irrational anxiety and fear of digital technologies, such as mobile communication devices, artificial intelligence (AI), and robots, and can even result in the avoidance of technology altogether.[4] Technophobia has been reported to be a risk factor for impeding health-promoting behaviors in older adults in the digital era.[5] In 1996, Celaya *et al.*[6] reported that 20–33% of Americans experienced technophobia, while a more recent study by Osiceanu *et al.*[7] reported the existence of technophobia in 50% of Americans of different ages, indicating that the number of people who experience technophobia is increasing, not decreasing, over time. Moreover, research on technophobia in older adults has focused mainly on investigating the current situation and its influencing factors,[8-11] and with few studies on the mechanisms by which social support can help overcome technophobia in older people in the communities. Social support represents an important means of anxiety alleviation among older adults in urban communities,[12] and research on its relationship and associated mechanisms with technophobia has received extensive attention in the fields of psychology and public health. The present study aims to explore the specific associations between social support and technophobia, and provide a theoretical and practical basis for improving the physical and mental health of older adults.

The relationship between social support and technophobia

The term social support indicates the social behaviour of a specific social network in providing unpaid help and services to socially vulnerable groups by material or spiritual means and ways.[13] Social support network theory holds that the relationship network formed by individuals in social life can provide emotional support, material assistance, and information exchange, among other factors, and that these supports are of significant importance in enabling individuals to cope with stress and to improve their quality of life.[14] First, social support, as an available external resource, provides a buffering effect on stressed individuals through the internal cognitive system, alleviating the negative

impacts of stressful events, which represents an important way of enhancing the health and well-being of older adults.[15] At the same time, encouragement from family, friends, and other members of the social network enables improved understanding of health-related information, allowing optimal health-related decision-making.[16] Research has shown that social support plays an important role in the achievement and maintenance of good mental health.[17] The stronger the social support network an individual has, the better they are able to cope with various challenges from their environment, directly reducing the individual's level of anxiety.[18] Technophobia represents a major problem for older adults and requires social support for its alleviation. Therefore, Hypothesis 1 of this study is proposed: Social support has a negative effect on technophobia in older adults.

The mediating role of self-efficacy

Self-efficacy represents a person's confidence or belief in their ability to perform a task or work behaviour, and is a subjective judgemental behaviour.[19] Social support theory states that social support is closely related to self-efficacy.[20] Social support perceived by individuals can increase their self-efficacy for emotion regulation.[21] Additional research has found that self-efficacy can have a direct effect on technophobia. A study of teleworkers during the COVID-19 pandemic showed that e-work self-efficacy buffered the positive effects of technology stressors on symptoms of depressed mood and anxiety.[22] At the same time, self-efficacy significantly influenced the perceptions and emotional responses to the use of technology.[23] Thus, self-efficacy can influence a person's evaluations and perceptions of their ability to use e-Health technology. In addition, biochemical experiments have shown that high self-efficacy can influence the production of substances, such as catecholamines, that activate the autonomic nervous system, which regulates both immune and neuropsychiatric functions.[24] It can thus be inferred that self-efficacy may negatively influence the level of technophobia in older adults. Therefore, Hypothesis H2 is proposed: Self-efficacy mediates the relationship between social support and technophobia among older adults in urban communities.

The mediating role of e-health literacy

E-health literacy indicates the ability of an individual to use electronic media to select, understand, and evaluate health-related information and to apply the knowledge gained to solve and manage health problems.[25] Research has demonstrated a positive association between the intensity of social software use and e-health literacy.[26] Increased online social support received by individuals through the use of electronic devices and social networking sites or software, contributes to e-health literacy. In turn,

e-health literacy has been positively associated with health-related behaviours.[27] The ability of older people to access and use of health-related information is linked to an improvement of health perceptions, the development of health-related behaviours, and reduction in anxiety over physical health and the use of digital technology.[28] In addition, improving the level of e-health literacy can help older people in urban environments use health-related products and services, assist them in integrating into the digital health society and enjoying the benefits of smart healthcare services, thus reducing their anxiety surrounding the use of technology.[29] In summary, e-health literacy functions as a bridge and buffer between social support and technophobia. The positive effects of social support can be enhanced by increasing individual e-health literacy, which in turn alleviates technophobia and improves the quality of life, as well as health behaviours of older people. Therefore, this study proposes Hypothesis H3: e-Health literacy mediates between social support and technophobia among older adults in urban communities.

The chain-mediating effect of self-efficacy and e-health literacy

According to Bandura's theory, individuals with a strong sense of self-efficacy are more inclined to take the initiative in meeting challenges, put in more effort, persevere longer, and be more resilient in the face of difficulties.[30] This self-regulatory ability enables individuals to set goals, observe behavioural performance, assess the gap between performance and goals, and adjust their behaviour accordingly in the process of improving e-health literacy, thus effectively improving e-health literacy. Therefore, increased support from urban communities enhances the self-efficacy and e-health literacy levels of older adults, reducing the level of technophobia. Therefore, this study proposes Hypothesis H4: Self-efficacy and e-health literacy play a chain-mediating role between social support and technophobia.

Methods

Study design and participants

From June 2023 - April 2024, field research was conducted on older adults in urban communities in Taiyuan, China. A multi-stage sampling method was used. First, three districts (Ying ze District, Jian cao ping District, and Jin yuan District) were randomly selected from six urban districts in Taiyuan, after which three communities were randomly selected from the selected districts using streets as the sampling unit, followed by convenience sampling of older adults aged 60 years and above from the selected communities.

Inclusion criteria: (1) aged 60 years and over; (2) have good hearing and vision, and able to communicate; (3) willing to participate in the study; (4) have lived in the selected communities for three years or longer.

Exclusion criteria: (1) have severe organic diseases or mental disorders; (2) unable to communicate; (3) unwilling to participate in the study.

Calculation of the sample size required a ratio of sample size to observed variables of 10: 1-15: 1. The study included 18 variables (e.g., demographic variables). To ensure a 20% sample loss rate and the representativeness and accuracy of data, the sample size was calculated to be ≥216 cases.

Data collection

Professional training was provided to the survey personnel before conducting the questionnaire survey to ensure their familiarity with the survey methods. Before administering the questionnaires, the survey personnel explained the purpose of the survey and filling out the questionnaire to the older adults in the communities, and emphasized the anonymity and confidentiality of their responses. After obtaining informed consent from the participants, the survey personnel distributed questionnaires to them one-on-one. Those with the ability to read and write completed the questionnaire themselves, while for participants who were illiterate or had difficulty with completing the questionnaire, the survey personnel read the questions one-by-one and the participants chose their answers which were then recorded by the survey personnel. If the participants experienced difficulty in understanding the questions, the survey personnel provided neutral and accurate explanations and recorded the answers based on the responses. After the collection of the questionnaires, other survey personnel verified the data and checked for any missing information so that missing information could be filled out on-site. A total of 1801 older adults from urban communities were surveyed, of whom 143 were excluded due to missing information or voluntary withdrawal from the study. Finally, 1658 effective questionnaires were included in the analysis, with an effective recovery rate of 93.56%.

Measures

The survey tools used in this study included:

(1) Questionnaire on sociodemographic characteristics: This questionnaire comprised items on age, gender, marital status, residential situation, education level, monthly income, self-rated health, and frequency of using digital health products.

(2) Technophobia scale: This scale was developed by American research Khasawneh,[31] and was

translated, back-translated, and cross-culturally adapted by Sun et al.[32] to the Chinese version, comprising 13 items in 3 dimensions (fear of technology, anxiety about technology, and privacy concerns). The scale is scored using a 5-point Likert scale (5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree), with a total score of 13-65. A total score of ≥39 indicates a high level of technophobia, while a total score of <39 indicates a low technophobia level. The Cronbach's α of this scale is 0.911, with the Cronbach's α of factors ranging from 0.759 to 0.885 and a split-half reliability coefficient of 0.851. This indicates that this scale has good reliability and validity and was suitable for assessing technophobia in older adults in China.

(3) Questionnaire on e-health literacy: This questionnaire was developed by the Canadian researcher Norman,[33] and it was translated, back-translated, and cross-culturally adapted by Guo Junshuai et al.[34] to the Chinese version, which comprises 8 items in three dimensions (ability to apply online health information and services [5 items], critical thinking ability [2 items], and decision-making ability [1 item]). The scale essentially assesses an individual's ability to obtain, understand, and evaluate health information using electronic devices and to apply the acquired knowledge to handle health issues. It is also scored using a 5-point Likert scale, with a total score of 8-40. A higher total score indicates higher e-health literacy. A total score of 26 is the cutoff and scores <26 indicate lower levels of e-health literacy, while total scores ≥26 indicate high e-health literacy. The Cronbach's α is 0.966 and the factor analysis loading ranges from 0.754 to 0.856, indicating good reliability and validity.

(4) Self-efficacy scale: This scale was translated, back-translated, and cross-culturally adapted by Wang Caikang et al.[35] This scale comprises 10 items and is used to assess the confidence of individuals in overcoming difficulties. It is a 4-point scale, with a total score of 10-40, with scores of 10-20 denoting low self-efficacy, 21-30 indicating medium self-efficacy, and 31-40 representing high self-efficacy; thus higher scores indicating better self-efficacy. The Cronbach's α is 0.87.

(5) Social support scale: This scale was translated, back-translated, and cross-culturally adapted by Xiao Shuiyuan[36] in 1994. It is used to assess the types and degree of assistance and resources obtained from others. It comprises 10 items in 3 dimensions, with a total score of 12-65, with scores of 12-22 denoting low social support, 23-44 denoting medium social support, and 45-65 representing high social support; thus higher scores indicate higher levels of social support. The Cronbach's α is 0.73.

Statistical analysis

The data were imported into SPSS 26.0 for analysis. For descriptive statistics, number of cases (n)

and percentage (%) were used to describe categorical data. In this study, differences between the levels of various major variables in the overall data were examined. The major variables, namely, e-health literacy, technophobia, self-efficacy, and social support, were all essentially normally distributed and independent samples t-tests and one-way ANOVA were used for comparisons. Based on the literature, factors with statistical significance in the one-way ANOVA were used as control variables. Model 6 in SPSS 26.0 was used for analysis; this is specifically designed for the analysis of chained-mediation models, and enables the testing of multiple indirect effects, including indirect effects arising from M1, those arising from M2, and those arising from both M1 and M2 together. It allows the comparison of the effect sizes of different mediation paths and the assessment of their relative importance in the total effect. Moreover, the process plug-in uses the bootstrap method to test the function of the mediation effect, and uses a resampling technique to estimate the confidence interval of the indirect effect, enabling the assessment of the significance of mediation effect, which is a more robust statistical method.

Common method bias test

At the data-analysis stage, Harman one-way tests were used for examining the bias of the sample data, and exploratory factor analysis of the four-variable question revealed that 12 factors had an eigenvalue greater than 1. Of these, the first factor had a total variance that explained 34.80%, which is less than the 40% threshold and does not represent statistical bias.

Patient and public involvement

None

Results

Demographic characteristics

The characteristics of the participants are shown that in terms of gender, 907 participants were male, accounting for 54.7%, while 751 participants were female, accounting for 45.3%. A total of 749 participants were aged between 60 and 70 years, accounting for 45.2%, while 641 (38.7%) were aged between 71 and 80 years. In terms of marital status, 679 participants were married, accounting for 41%, and 978 (59%) lived with their families. Overall, 713 (43%) of the older adults had a monthly income above 3000 yuan, with no significant differences in the numbers of participants with income levels of 1000-3000 and those below 1000. In terms of education level, 618 (36.3%) had an educational level of

high school or above, while 530 participants were junior middle school graduates, accounting for 32% and 68 (4.1%) were illiterate. In terms of self-rated health, 716 (43.2%) rated their health as average, while 571 (34.4%) rated themselves as healthy, indicating that the health of the participants was generally good. In terms of frequency of using electronic devices, 683 (41.2%) electronic devices frequently, and 631 (38.1%) used such devices occasionally.

Influences of demographic characteristics on different variables

As can be seen from Table 1, the results of the one-way ANOVA showed that age, residential situation, education level, health, and frequency of using electronic devices significantly influenced the incidence of technophobia in older adults, while age, marital status, residential situation, education level, health and frequency of using electronic devices significantly influenced e-health literacy, and age, residential situation, monthly income, and education level influenced self-efficacy, and age, marital status, residential situation, education level, self-rated health, and frequency of using electronic devices significantly influenced social support in the older adults

Table 1. Influences of demographic characteristics on different variables in older adults

		Score			
	Number of cases	**Technophobia**	**E-health literacy**	**Self-efficacy**	**Social support**
Total sample	1658	40.31±12.26	23.18±6.81	23.65±6.74	29.42±9.60
Gender					
M	907	40.45±12.14	22.93±6.80	23.40±6.90	29.05±9.57
F	751	40.14±12.40	23.48±6.82	23.95±6.53	29.85±9.62
t		0.523	-1.625	-1.655	-1.686
P		0.601	0.104	0.098	0.092
Age					
60-70	756	39.5±12.85	23.59±6.76	24.24±6.61	29.59±9.70
71-80	634	40.09±12.01	23.01±6.97	23.60±6.64	29.85±10.03
>80	268	43.08±10.70	22.46±6.52	22.11±7.13	27.90±8.03
F		8.633	3.022	9.987	4.11
P		**<0.001**	**0.049**	**<0.001**	**0.017**
Marital status					
Married	679	40.47±12.52	23.38±6.85	23.26±6.60	30.10±10.10
Single	455	39.95±12.14	23.62±6.68	24.33±6.94	29.74±8.97
Divorced	199	39.73±8.74	21.59±6.36	23.70±6.46	26.36±9.01
Widowed	325	40.83±13.65	23.14±7.07	23.48±6.89	29.40±9.42
F		0.514	4.452	2.406	8.172
P		0.673	**0.004**	0.066	**<0.001**
Residential situation					
Living with family	978	39.03±12.39	24.13±6.62	24.05±6.77	30.48±9.76
Living alone	680	42.14±11.83	21.82±6.85	23.07±6.66	27.89±9.16
t		-5.122	6.889	2.939	5.438
P		**<0.001**	**<0.001**	**0.003**	**<0.001**
Monthly income					
<1000	506	40.05±12.84	23.43±6.86	23.20±6.96	29.88±9.64
1000-3000	439	39.84±11.88	22.91±7.06	22.91±7.17	29.19±9.14
>3000	713	40.79±12.06	23.17±6.62	24.42±6.22	29.22±9.85
F		0.986	0.691	8.564	0.866
P		0.373	0.501	**<0.001**	0.421
Education level					
Illiteracy	68	46.54±11.24	20.47±7.76	20.79±6.22	27.19±9.58

Elementary school graduates	442	39.32±14.17	23.66±6.83	24.74±6.34	29.65±8.92
Middle school graduates	530	38.16±12.32	23.28±6.87	24.67±6.82	30.22±10.76
High school graduates	618	42.17±10.19	23.06±6.58	22.31±6.70	28.80±8.95
F		17.553	4.461	20.727	3.414
P		**<0.001**	**0.004**	**<0.001**	**0.017**
Self-rated health					
Not healthy	371	40.89±13.21	22.68±7.00	23.05±5.96	29.89±10.17
Average	716	41.30±11.20	22.49±6.66	23.72±6.92	28.11±9.22
Healthy	571	38.68±12.73	24.38±6.72	23.94±6.98	30.74±9.50
F		7.86	13.78	2.08	12.698
P		**<0.001**	**<0.001**	0.125	**<0.001**
Use frequency of electronic devices					
Never	344	42.94±10.22	20.47±6.11	22.85±6.69	28.12±8.53
Occasionally	631	40.56±11.98	23.50±6.43	23.80±6.63	29.25±9.35
Often	683	38.75±13.19	24.25±7.12	23.91±6.85	30.23±10.25
F		13.806	38.159	3.102	5.721
P		**<0.001**	**<0.001**	0.045	**0.003**

Correlation analysis of technophobia, e-health literacy, self-efficacy, and e-health literacy

As shown in table 2, there is a significant correlation between social support, self-efficacy, e-health literacy, and technophobia. Technophobia was negatively correlated with e-health literacy ($r = -0.395$, $p<0.01$), self-efficacy ($r = -0.416$, $p<0.01$), and social support ($r =-0.377$, $p<0.01$).

Table 2. Correlation analysis of technophobia, e-health literacy, self-efficacy, and social support in older adults

Variable	Technophobia	E-health literacy	Self-efficacy	Social support
Technophobia	1			
E-health literacy	-0.395**	1		
Self-efficacy	-0.416**	0.224**	1	
Social support	-0.377**	0.403**	0.216**	1

Note: **p<0.01

Hypothesis testing

Through correlation analysis, the correlations of variables were preliminarily tested. In this section, hypothesis testing was conducted for further examination of associations between variables. According to the correlation hypotheses proposed above, the direct impact of social support on technophobia was used as the main outcome. On this basis, the chained mediating effects of self-efficacy and e-health literacy were further examined in this model. Additionally, variables that showed significant effects on technophobia in the analysis (age, residential situation, education level, health, and use frequency of smart devices) were included in the model as control variables. Model 6 in SPSS 26 was used for testing. The testing results consisted of two parts, namely, the stepwise regression results and the

results of the bootstrap random sampling mediating effect testing. A confidence interval (CI) of 95% was used as the threshold. The mediating effect was determined by observing whether the 95% CI includes 0. If the 95% CI did not include 0, the corresponding effect is significant; otherwise, it is non-significant.

Table 3 shows the mediating effect results obtained from the stepwise regression. In Model 1, social support had a significantly negative influence on technophobia (β=-0.452, p<0.001), suggesting that technophobia in older adults was negatively associated with social support. In Model 2, social support had a significant positive influence on self-efficacy (β=0.142, p<0.001). In Model 3, social support (β=0.245, p<0.001) and self-efficacy (β=0.132, p<0.001) both had significant positive influences on e-health literacy, while in Model 4, social support negatively affected technophobia (β=-0.266, p<0.001), as did self-efficacy (β=-0.564, p<0.001), and e-health literacy (β=-0.400, p<0.001). Overall, the coefficients were significant in all models. Overall, self-efficacy and e-health literacy had mediating effects as partial mediators .

Table 3. Investigation of mediating effects using stepwise regression.

Model	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
Dependent variable	**technophobia**		**self-efficacy**		**e-health literacy**		**technophobia**	
Index	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**
Independent variable								
Social support	-0.452	-15.532***	0.142	8.396***	0.245	15.359***	-0.266	-9.227***
Mediating variable								
Self-efficacy					0.132	5.836***	-0.564	-14.499***
E-health literacy							-0.400	-9.585***
Control variable								
Age	1.221	3.208**	-0.934	-4.221***	-0.196	-0.957	0.567	1.628
Residential situation	1.626	2.851**	-0.445	-1.342	-1.386	-4.532***	0.797	1.527
Education level	0.447	1.445	-0.686	-3.816***	0.265	1.592	0.130	0.460
Health	-0.874	-2.337*	0.294	1.355	0.676	3.372**	-0.421	-1.235
use frequency of electronic devices	-1.496	-4.104***	0.266	1.255	1.393	7.131***	-0.774	-2.299*
R	0.407		0.261		0.474		0.558	
R^2	0.165		0.068		0.224		0.311	
F	54.485***		20.138***		68.193***		93.026***	

Note: *p<0.05, **p<0.01, ***p<0.001

Chain intermediary path analysis

As can be seen from Table 4, the indirect effect of the path 'social support self-efficacy-technophobia' was -0.080, and the 95% CI (-0.101, -0.059) does not include 0. The indirect effect was significant and accounted for 17.7% of the total effect. Self-efficacy thus partially mediated the effect of social support and technophobia. The indirect effect of the path 'social support-e-health literacy-technology fear' was

-0.098, and the 95% CI (-0.124, -0.074) does not include 0. The indirect effect was significant, accounting for 21.7% of the total effect. E-health literacy thus partially mediated the effect of social support and technophobia. The indirect effect of the path 'social support-self-efficacy-e-health literacy-technophobia' was -0.008, and the 95% CI (-0.011, -0.004) did not include 0, indicating a significant mediating effect, accounting for 1.8% of the total effect. As shown in Figure 1, self-efficacy and e-health literacy played a chain mediating role between social support and technophobia.

Table 4. Chained-mediating role of self-efficacy and e-health literacy in the correlation of social support with technophobia in older adults

Effects	Effect value	LLCI	ULCI	Percentage
Total effects	-0.452	-0.509	-0.395	100.0%
Direct effects	-0.266	-0.323	-0.210	58.8%
Indirect effects	-0.185	-0.219	-0.153	40.9%
Social support - self-efficacy - technophobia	-0.080	-0.101	-0.059	17.7%
Social support - e-health literacy - technophobia	-0.098	-0.124	-0.074	21.7%
Social support - self-efficacy - e-health literacy - technophobia	-0.008	-0.011	-0.004	1.8%

LLCI, Lower Level Confidence Interval; ULCI, Upper Level Confidence Interval.

DISCUSSION AND ANALYSIS

The direct influence of social support on technophobia in older adults in urban communities

Our study found that social support is a direct negative predictor of technophobia. The classic buffering hypothesis of social support holds that social support can enhance an individual's ability to cope with stress and emotional distress by providing psychological, emotional, informational, and material resources. The psychological resilience of older adults can be enhanced through encouragement and emotional support from family members and friends, which will enable them to be more independent in the use of digital technology and will reduce their fear and unease when facing complex systems.Greater levels of social support also implies an expansion of the individual's social networks[37], which can provide older people with access to a variety of resources through which individuals can enhance their skills and technical knowledge, thereby reducing the anxiety associated with unfamiliarity with or inability to master technology. Of course, social support can assist in changing older people's perceptions of technology[38]. For example, having experienced friends or family

members around them can not only help older adults understand the value and use of technology, but also alter their originally negative cognitive patterns to be more positive when facing technological challenges, thus effectively reducing technophobia. In addition, social support in the form of instrumental support (such as hearing aids, presbyopes, and speech recognisers) can alleviate the discomfort that many older people experience as a result of their declining abilities, thus reducing the technophobia that arises when faced with new technology. In addition, instrumental support (such as hearing aids, reading glasses, and speech recognition devices) can alleviate the difficulties caused by reductions in physical capability in the elderly. At the same time, social material support, such as smart devices with simple procedures, can effectively reduce the likelihood of intelligent 'out of control' during use, potentially alleviating levels of technophobia in older adults. It can be seen that social support can thus directly reduce the levels of technophobia in older adults through different forms.

Roles of self-efficacy and e-health literacy in the correlation of social support with technophobia in older adults in urban communities

Our findings show that social support can influence the level of technophobia in older adults through self-efficacy. This is consistent with the results of a study by Ginja et al[39]. showing that the less social support received, the lower the level of self-efficacy and the higher the level of anxiety instead. Self-efficacy is an important mediating variable in the influence of social support networks on the health of older adults[40]. Compared to younger age groups, older adults are less receptive to new things and often show a lack of self-confidence when faced with smart health technologies, resulting in lower levels of self-efficacy in the use of these applications. A study on the mental health of urban empty nesters found that social support had a significant negative effect on their psychological anxiety[41]. In contrast, older adults with higher self-efficacy were more adaptive and able to deal with new technologies, resulting in better health beliefs, which in turn reduced the level of technophobia. In addition, our findings support that social support can also influence technophobia through e-health literacy. Consistent with the findings of Piccirillo ML[42], the primary reason for this is that social support provides more social networks and increases older adults' ability to access health resources through smart health technologies, thus strengthening their level of e-Health literacy and ultimately reducing their level of technophobia. Indeed, low e-health literacy is an obstacle for older adults in accessing e-health information[43], as it can lead to technophobia and affect their willingness to use and accept new technologies[44]. Several studies have attempted to enhance the self-efficacy of older adults

by providing them with social support, showing that the overall mood and outlook of the older adults were significantly improved compared to the control group[45]. In other words, social support can significantly improve the mental health of older adults and their confidence in the utilization of information technologies. Interventions to improve self-efficacy were found to be effective in enhancing the e-health literacy of college students during the COVID-19 epidemic[46]. However, e-health literacy was negatively correlated with technophobia[47-48]. Overall, self-efficacy and e-health literacy were found to have chained mediating effects.

Factors influencing technophobia in older adults in urban communities

Our study showed that there were high to moderate levels of technophobia in older adults in urban communities in Taiyuan, China. This is consistent with the findings of previous studies.[49] As they age, older people's demand for social services increases, while their ability to understand and master new things gradually weakens. They are thus less capable of using digital technology, and the conflict between high demand and low ability further intensifies their feelings of tension, helplessness, and resistance, leading to increased technophobia.[50] Compared with older adults who live with family, the level of technophobia in elderly people living alone is significantly higher. Lacking emotional and material support, these people may feel unprepared when faced with new technology. In addition, educational attainment provides a knowledge base for the understanding and and use of new technology, while health status determines whether an individual can successfully perform the physical and cognitive activities associated with smart devices. Frequency of use also has a direct effect on the proficiency and confidence of the elderly in using smart devices. These factors work together to affect older adults' acceptance of new technology and their level of technophobia.

Recommendations

Firstly, the government should implement specific plans to address the difficulties faced by the elderly in using intelligent technology, clarify the responsibilities of each department, and ensure that the elderly can enjoy intelligent services equally and conveniently. Relevant laws and regulations should be improved to safeguard the privacy rights and security of personal information of older adults when using intelligent technologies. Secondly, social enterprises should promote the aging-friendly transformation of intelligent terminal products, in terms of manufacturing them with large screens, large fonts, high volume, large battery capacities, and enabling simple operation, that would assist the elderly. In addition, the community could promote knowledge about intelligent technology to the

elderly through various means, such as graphics, videos, or audio, to increase their confidence and willingness to use it. Volunteers and professional organizations could be organized to provide training on the use of smart devices for the elderly, helping them master basic operational skills. At the same time, family members should spend more time with the elderly and discuss their experiences and feelings about using smart devices, thus enhancing their willingness and confidence in using them and thereby reducing the digital divide and enabling the elderly to enjoy the convenience and benefits associated with technology.

Limitations

In our study sample was limited to older adults in urban communities in Taiyuan, which may affect the generalizability of the research results. It is difficult to determine causal relationships between the study variables due to limitations inherent in the cross-sectional study design,and the level of technophobia in the elderly was also affected by confounding factors such as the length of time spent using electronic devices, the level of sophistication of the electronic devices, and the elderly themselves. As a result, there may be some bias in the research results. In addition, all participants were informed that the study was investigating social support, self-efficacy, e-health literacy, and technophobia. Since the results relied on the self-reports of the participants, this may have introduced a degree of bias. Additionally, factors such as health conditions, traditional culture, and living habits may also influence technophobia in older adults. Further investigations are required for a comprehensive elucidation of the causes of technophobia in older adults.

Conclusion

This study visually demonstrates the mechanism by which social support influences technophobia among old adults in urban communities through the construction of a mediation effect model.The independent and chained mediating roles of self-efficacy and e-health literacy in the correlation of social support with technophobia of older adults in urban communities were demonstrated. On a theoretical level, these findings contribute to the understanding of the mechanisms by which social support affects technophobia in older adults, as well as providing new research directions for future studies and advancing research on the psychological health of older adults in the context of smart health. On a practical level, based on the findings of this study, research institutions and social and government agencies, among others, should strengthen cooperation and provide targeted services to older adults in the community to improve their health and well-being.

Acknowledgements We would like to thank all the participants in the present study.

Contributors DL contributed to the conceptualisation, formal analysis and writing the original draft. JL and CW made contributions to the data curation and verification. YS and QG contributed to the writing, review and editing. GD acts as a guarantor for the final manuscript.

Funding This research received grants from the 2023-2024 Shanxi Province Large Health Industry high-quality development research project (No.:DJKZXKT2023001).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research. Patient consent for publication Not applicable.

Ethics approval This study was approved by the Ethics Committee of Shanxi Medical University (No. 2023007).

Data availability statement Data are available on reasonable request.

Figure 1. Paths of chained mediating effects in older adults in urban communities in Taiyuan, China.

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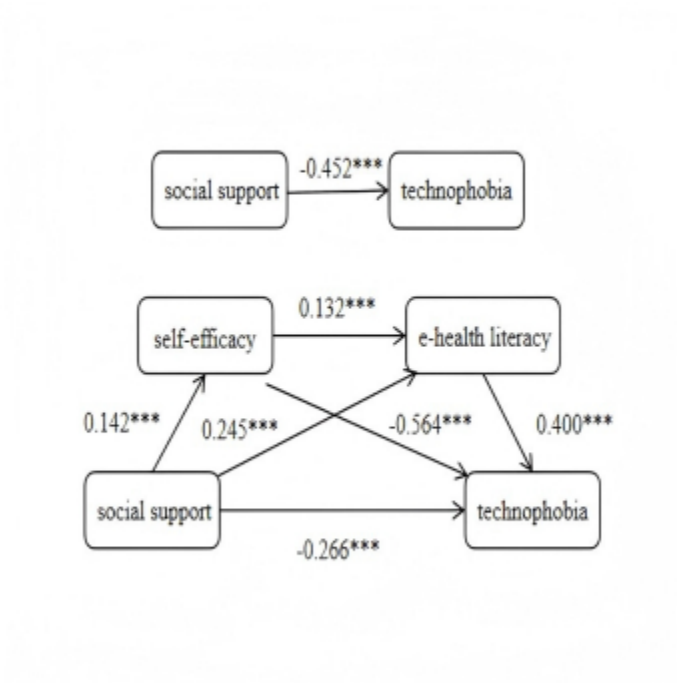

Figure 1 The chain mediation effect model diagram.***p<0.001.

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