

ORIGINAL RESEARCH

Relationship between attitudes toward aging and health literacy among Taiwanese older men

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Abstract

Background: Men's health issues often receive less attention in public health discussions than women's health. This study examines how older men's demographic characteristics influence their attitudes toward aging and health literacy. **Methods:** A cross-sectional study assessed 157 older men (mean age = 75.57, SD (Standard Deviation) = 7.10) from Tier-C stations. Participants completed the Health Literacy Questionnaire for Older Adults (HLQ-QA) and the Taiwan Attitude Toward Aging Questionnaire. *T*-tests compared aging perceptions and health literacy abilities, while regression analyses assessed the influence of attitudes on health literacy. **Results:** Mean positive and negative aging perception scores were 31.45 (SD = 4.18) and 18.23 (SD = 4.45), respectively. The average HLQ-QA score was 47.84 (SD = 6.59), with competency scores ranked as: appraising (M (mean) = 12.12, SD = 1.73), understanding (M = 12.03, SD = 1.91), accessing (M = 11.90, SD = 1.84), and applying (M = 11.80, SD = 2.04). Regression analyses showed that positive perceptions significantly improved health literacy ($\beta = 0.197, p = 0.013$), while negative perceptions reduced it ($\beta = -0.227, p = 0.005$). **Conclusions:** Positive attitudes toward aging enhance older men's health literacy, whereas negative perceptions hinder their ability to process health information. Community programs should focus on men with lower education levels, those living alone, and those without Internet access. Promoting positive attitudes and combating ageism are critical for improving health literacy and achieving healthy aging.

Keywords

Ageism; Attitude; Aging; Health literacy; Older men

1. Introduction

Men's health often receives less attention in public health discussions and literature compared to women's health. Globally, men have shorter lifespans than women, a disparity highlighted by the Coronavirus disease 2019 (COVID-19) pandemic. Biological (such as fetal vulnerability, genetic differences and weaker immune responses) coupled with social factors (including work stress, unhealthy behaviors and occupational hazards) contribute to higher mortality rate among male. Understanding these differences is crucial for developing gender-specific health policies [1, 2].

In Taiwan, 17.8% of the population is aged 65 or older, yielding in an aging index of 147.9 [3]. This indicates that the population of individuals aged 65 and above is approximately 1.5 times that of children aged 0–14. Therefore, Taiwan needs to address the social and economic challenges posed by its aging population. In 2022, the average life expectancy in Taiwan was 80.86 years, with men averaging 77.67 years and women 84.25 years. Moreover, compared to the global average, the life expectancy of Taiwanese men and women exceeds the global average by 7.5 years and 9.3 years, respectively

[4]. However, life expectancy for men, both in Taiwan and globally, remains lower than that of females, emphasizing the need for special attention to men's health issues.

In the 2016 Shanghai Declaration on Health Promotion, the World Health Organization recognized that health literacy is a critical determinant of health [5]. Evidently, health literacy has become a focal point for healthcare professionals and public health policy leaders working with older adults. Sørensen *et al.* [6] defined health literacy in relation to general literacy abilities, encompassing the "knowledge, motivation and competencies of access, understand, appraise and apply health-related information". These core competencies enable individuals to make informed judgments and decisions concerning healthcare, disease prevention, and health promotion to maintain or improve their quality of life throughout their lifespan. Health literacy is essential for individuals to making informed health-related decisions and actions, and it significantly impacts individual health outcomes [6]. However, low health literacy among older adults is prevalent [7]. Those with low health literacy often experience poor physical and mental health, with conditions such as diabetes and cardiovascular diseases adversely affecting their quality of life [8]. Further-

more, lower health literacy in older adults is strongly correlated with adverse health outcomes, including reduced adherence to medication regimens [9]. Poor health literacy is also associated with several negative health outcomes, such as the frequent use of acute medical services, higher healthcare costs, higher morbidity rates, poorer health status and increased mortality rates [10]. Therefore, ensuring adequate health literacy is crucial for enhancing equity and empowerment, and for achieving better health outcomes and sustainable development [6].

In addition to physical health, aging-related health issues among older individuals include those encompass psychological and cognitive concerns. Recent literature has increasingly focused on the impact of the attitude toward aging on the health of older adults [11, 12]. Attitude toward aging refers to individuals' self-assessment of their feelings, perceptions and expectations about the aging process. Earlier studies often approached attitudes toward aging as a single-dimensional assessment, ranging from positive to negative. For example, Levy *et al.* [13] used five aging-related items from Lawton's [14] Philadelphia Geriatric Center Morale Scale to assess an individual's attitude toward aging.

Research suggests that individuals often hold a negative attitude toward aging and related concepts, reflecting the prevalent issue of ageism [15]. Such discrimination fosters pessimistic views about aging, which can diminish motivation to engage in health-promoting behaviors. These negative attitudes attribute the challenges encountered during the aging process to age itself, thereby posing a major threat to individual health [12, 13, 16]. Additionally, negative attitudes toward aging are associated with an increased risk of mortality [11, 17], as well as psychological health issue including depression, among older individuals [11, 17, 18]. Furthermore, these attitudes are strongly correlating with cognitive decline [18, 19].

Recent studies have suggested that "attitude toward aging" is a broad and complex concept, with individuals often holding both positive and negative appraisals of aging simultaneously. These perspectives are not mutually exclusive. For instance, Wu *et al.* [20] proposed that individuals who perceive aging as having both "good and bad aspects" may have a more realistic understanding of their own aging process. Such individuals maintain a positive view of their aging experience while acknowledging the inevitable challenges. In addition, a positive attitude toward aging may encourage older adults to actively engage in learning and acquiring new knowledge, which can help them manage the challenges associated with older adult life [21].

The emergence of positive psychology has led researchers to examine the impact of a positive attitude toward aging on health throughout the aging process. Studies suggest that individuals with a positive self-attitude toward aging may live up to 7.5 years longer than those with a negative attitude [13]. Additionally, a positive attitude toward aging is also associated with better self-efficacy—the belief in an individual's ability to enhance social functioning and adaptability. This belief increases the motivation to participate in health-promoting behaviors thereby mitigating the risks associated with aging, and slowing declines in memory, intelligence, daily living skills and cognitive abilities [22]. Furthermore, a more positive attitude toward aging may reduce perceived

sensitivity to aging's negative impacts, thereby lowering the risk of depression. Adopting a proactive approach to adjust and respond to the impact of aging-related decline on negative self-perception helps reduce the likelihood of depression and other potential psychological issues [11, 17, 23].

Attitude toward aging and health literacy play important roles in an individual's aging process. Older individuals of different genders have diverse perspectives on aging and health literacy due to differences in social connections, gender roles and resource allocation. Ageism affects their attitudes toward aging. For men, the changes in power, dominance and status associated with aging can be more pronounced than for women, often leading to a more negative outlook on aging [23]. A positive attitude toward aging is significantly associated with health-promoting behaviors, making it an important predictor of engaging in such behaviors. However, research on attitude toward aging and health literacy among older adults, particularly older men, remains limited. Therefore, this study aims to examine how different demographic characteristics influence attitude toward aging and health literacy, with a specific focus on older men. It will also explore the relationship between these two variables. The findings are expected to provide valuable empirical insights for promoting health and enhancing positive attitudes toward aging among older men, thereby contributing to a more nuanced understanding of gender and aging issues.

2. Materials and methods

2.1 Study design

A cross-sectional study design employing convenience sampling was utilized to recruit participants from the city of Hsinchu, Taiwan. Researchers contacted each community-based long-term care facility and obtained approval before distributing five questionnaires at each location. To incentivize participation, each respondent received a gift card as compensation for their participation.

2.2 Participants

Participants who met specific criteria were invited to participate in the study. Inclusion criteria included fluency in Chinese or Taiwanese, full cognitive competence, the ability to independently read the questionnaire, willingness to participate, and being male adults aged 65 or older. Exclusion criteria encompassed illiteracy and communication challenges due to hearing impairment. Overall, 400 questionnaires were distributed and collected between March and September 2022. However, due to the COVID-19 pandemic, some long-term care stations were temporarily closed, which affected data collection. Hence, 157 questionnaires were finally collected, yielding a response rate of 39.25%.

2.3 Data Collection

Data collection was conducted using a structured survey that incorporated questionnaires developed by Taiwanese researchers. The research instruments included demographic data, the Health Literacy Questionnaire for Older Adults

(HLQ-QA), and the Taiwan Attitude toward Aging Questionnaire (TAAQ).

2.3.1 Demographic data

Demographic data included age, marital status, educational level, residence, self-assessed health status, perceived financial status, and ability to use the Internet.

2.3.2 Taiwan attitude toward aging questionnaire

This study used the TAAQ developed by Wu *et al.* [20], which contains two subscales. The first is “Positive Self-Perception of Aging”, comprising eight items, such as “I have time to do things I’m interested in” and “I enjoy my current life”. This subscale is measured using a five-point Likert scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). Higher total scores indicate a more positive attitude toward aging. The second subscale is “Negative Self-Perception of Aging”, also consisting of eight items, including “I feel that I’m old” and “I can’t take care of myself”. This subscale is similarly measured using a five-point Likert scale, ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). Higher total scores indicate a more negative attitude toward aging.

2.3.3 Health literacy questionnaire for older adults

We used the HLQ-OA developed by Kuo and Liang [24]. This questionnaire comprises four dimensions: “accessing”, “understanding”, “appraising” and “applying” health information. Each dimension contains four questions, resulting in a total of 16 questions. A four-point Likert scale, ranging from 1 (“very difficult”) to 4 (“very easy”), was used to measure responses. A higher cumulative score signifies a higher level of health literacy.

2.4 Statistical analysis

Descriptive statistics, including the frequency distribution and mean, were used to present the sociodemographic and personal characteristics of the sample. Subsequently, independent sample *t*-tests were used to examine differences in positive and negative perceptions in terms of the attitude toward aging among older men. Paired sample *t*-tests were employed to analyze the differences in various dimensions of health literacy among older men. A one-way analysis of variance (ANOVA) analysis was conducted to assess the differences in health literacy and attitude toward aging across different demographic characteristics of older men. Finally, a hierarchical regression analysis was performed to identify key factors influencing the attitude toward aging and health literacy among older men, as well as to explore the relationship between these two variables. All analyses were conducted using SPSS for Windows, version 28 (IBM Corp., Armonk, NY, USA) with *p*-values reported as two-sided.

3. Results

Overall, the study included 157 participants, with a mean age of 75.57 (SD = 7.10; range: 65–99). The majority participants

were either married (80.1%), or lived with their children or grandchildren (55.1%). The most common highest level of education achieved was elementary school (29.9%). Most participants accessed the Internet through mobile phones or computers (45.5%), while 30.1% either did not use or were unfamiliar with using the Internet. Most participants health ratings were predominantly “excellent” (42.7%) or “good” (34.4%), and nearly half described their financial status as “satisfactory” (41.4%) or “very satisfied” (42%) (Table 1).

3.1 Attitude toward aging among older men

The average total score for positive attitudes was 31.452 (SD = 4.177, Standard Error (SE) = 0.333), with a mean score of 3.931 (SD = 0.522, SE = 0.041) per item. On a five-point scale, this score was close to the “agree” option (4 points), suggesting that respondents generally agreed with the statements reflecting positive attitudes. Conversely, the average total score for negative attitudes was 18.229 (SD = 4.453, SE = 0.355), with a mean score of 2.278 (SD = 0.556, SE = 0.044) per item. On a five-point scale this score was close to the “disagree” option (2 points) indicating that the respondents generally disagreed with the statements reflecting negative attitudes (Table 1).

Further analysis of participants’ sociodemographic and personal characteristics revealed no significant difference in positive perceptions in attitude toward aging among older adult men across demographic variables (Table 2). However, significant differences were observed in negative perceptions based on Internet usage ($F = 6.254, p < 0.001, \eta^2 = 0.110$), self-assessed health status ($F = 5.403, p = 0.001, \eta^2 = 0.096$), and self-assessed economic status ($F = 3.534, p = 0.016, \eta^2 = 0.065$) (Table 2). *Post-hoc* test results indicated that older men who did not use the Internet had significantly higher negative perceptions compared to those who used computers and smartphones to access the Internet. Moreover, participants who assessed their health status to be poor had significantly higher negative perception in the attitude toward aging compared to those who rated their health status to be very good. Those who rated their economic status as average had significantly higher negative perceptions than those who rated their economic status as highly satisfactory.

3.2 Health literacy among older men

The average total score from the HLQ-OA was 47.841 (SD = 6.592, SE = 0.526). The competencies were ranked based on their mean scores as follows: appraising (M = 12.121, SD = 1.733, SE = 0.138), understanding (M = 12.025, SD = 1.911, SE = 0.152), accessing (M = 11.898, SD = 1.840, SE = 0.146), and applying (M = 11.796, SD = 2.040, SE = 0.162) (Table 1).

TABLE 1. Descriptive statistics of demographics, health literacy questionnaire for older adults, and Taiwan attitude toward aging questionnaire (n = 157).

Variables	n (%)	Mean \pm Standard Deviation
Demographics		
Age (yr)		
65–69	40 (25.5)	75.57 \pm 7.10
70–74	33 (21.0)	
75–79	32 (20.4)	
80–84	36 (22.9)	
85–89	11 (7.0)	
>90	5 (3.2)	
Marital status		
Unmarried	5 (3.2)	
Married (including cohabitation)	125 (80.1)	
Divorce or separation	5 (3.2)	
Widowed	21 (13.5)	
Level of education		
Never went to school	4 (2.5)	
Elementary school	47 (29.9)	
Junior high school	28 (17.8)	
Senior high school (vocational school)	38 (24.2)	
>College/university	40 (25.5)	
Residence status		
Live alone	22 (14.1)	
Live with spouse only	39 (25.0)	
Live with children or grandchildren	86 (55.1)	
Live with other people	4 (2.9)	
Others	5 (3.2)	
Self-perceived health status		
Low	3 (1.9)	
Middle	33 (21.0)	
Good	54 (34.4)	
Excellent	67 (42.7)	
Self-perceived financial status		
Very dissatisfied	16 (10.2)	
Fair	10 (6.4)	
Satisfied	65 (41.4)	
Very satisfied	66 (42.0)	
Internet usage		
Did not use or did not know how to use the Internet	47 (30.1)	
Only used computers	7 (4.5)	
Only used mobile phones	71 (45.5)	
Both used mobile phones and computers	31 (19.9)	
Health Literacy Questionnaire for Older Adults (HLQ-OA)		
Access		11.898 \pm 1.840
Understand		12.025 \pm 1.911
Appraise		11.796 \pm 2.040
Apply		12.121 \pm 1.733
Total Score		47.841 \pm 6.592
Taiwan Attitude toward Aging Questionnaire (TAAQ)		
Positive Self-Perception of Aging		11.898 \pm 1.840
Negative Self-Perception of Aging		12.025 \pm 1.911

TABLE 2. Factors associated with older men's attitude toward aging (n = 157).

Attitude toward aging among older adult males															
Variables	SoV	Positive perception						Negative perception						Post-hoc	
		SS	df	MS	F	p-value	η^2	SoV	SS	df	MS	F	p-value		η^2
Age															
	BCs	1.152	5	0.230				BCs	2.351	5	0.470				
	BRs	41.393	151	0.274	0.841	0.523	0.027	BRs	45.989	151	0.305	1.544	0.180	0.049	Non-significant
	Total	42.545	156					Total	48.340	156					
Marital status															
	BCs	2.154	3	0.718				BCs	2.287	3	0.762				
	BRs	40.388	152	0.266	2.702	0.061	0.051	BRs	44.551	152	0.293	2.601	0.054	0.049	Non-significant
	Total	42.542	155					Total	46.839	155					
Residence status															
	BCs	1.235	4	0.309				BCs	0.358	4	0.090				
	BRs	41.305	151	0.274	1.129	0.345	0.029	BRs	47.700	151	0.316	0.283	0.888	0.007	Non-significant
	Total	42.540	155					Total	48.058	155					
Internet usage															
	BCs	1.572	3	0.524				BCs	5.280	3	1.760				
	BRs	40.968	152	0.270	1.945	0.125	0.037	BRs	42.778	152	0.281	6.254	<0.001***	0.110	Do not use the Internet, only used mobile phones > Both used mobile phones and computers
	Total	42.540	155					Total	48.058	155					
Education level															
	BCs	0.253	4	0.063				BCs	1.856	4	0.464				
	BRs	42.292	152	0.278	0.227	0.923	0.006	BRs	46.484	152	0.306	1.517	0.200	0.038	Non-significant
	Total	42.545	156					Total	48.340	156					
Self-perceived health status															
	BCs	1.023	3	0.341				BCs	4.630	3	1.543				
	BRs	41.522	153	0.271	1.257	0.291	0.024	BRs	43.709	153	0.286	5.403	0.001***	0.096	Low > Good, Excellent
	Total	42.545	156					Total	48.340	156					
Self-perceived financial status															
	BCs	2.102	3	0.701				BCs	3.133	3	1.044				
	BRs	40.443	153	0.264	2.651	0.051	0.049	BRs	45.207	153	0.295	3.534	0.016*	0.065	Fair > Very satisfied
	Total	42.545	156					Total	48.340	156					

* $p < 0.05$; *** $p < 0.001$; SoV: sources of variation; SS: sum of squares; df: degrees of freedom; MS: mean square; BC: between classes; BR: between replicates.

Analysis of the participants' sociodemographic and personal characteristics revealed significant differences in health literacy among older men across different age groups ($F = 2.924$, $p = 0.015$, $\eta^2 = 0.088$), marital status ($F = 4.123$, $p = 0.008$, $\eta^2 = 0.075$), living arrangements ($F = 5.269$, $p = 0.001$, $\eta^2 = 0.122$), Internet usage patterns ($F = 6.184$, $p = 0.001$, $\eta^2 = 0.109$), education levels ($F = 5.137$, $p = 0.001$, $\eta^2 = 0.119$), and economic status ($F = 4.309$, $p = 0.006$, $\eta^2 = 0.078$) (Table 3).

Post-hoc test results showed that older men aged 65 to 74 demonstrated significantly better health literacy compared to those aged 90 and above. Married older men exhibited significantly better health literacy than widowers. Additionally, older men living with their spouses had significantly better health literacy than those living alone, or with their children or grandchildren. Those who used cell phones, or both cell phones and computers to access the Internet had showed significantly better health literacy compared to those who did not access the Internet. Older men with no formal education had significantly lower health literacy than those with some level of education. Finally, older men who were very satisfied or satisfied with their economic status had significantly better health literacy than those who rated their economic status as average (Table 3). These findings suggest that health literacy among older men, especially those living alone, are widowers, those with no formal education, or do not use the Internet requires to be improved. These groups should be the targeted by community-based health literacy promotion programs tailored specifically older men.

3.3 Attitudes toward aging and health literacy among older men

Hierarchical multiple regression analysis was employed to examine the impact of various factors on health literacy. In the first stage, demographic variables previously identified as significant predictors of health literacy, including age, marital status, residence status, Internet usage, education level and economic status, were used as independent variables. The overall health literacy and individual competency scores were used as dependent variables to examine the impact of different demographic variables on overall health literacy and its various dimensions. In the second stage, positive and negative perceptions of aging were added as independent variables to the regression models. This stage aimed to evaluate the influence of attitudes toward aging on overall health literacy and individual competency scores, while controlling for the effects of the demographic variables identified in the first stage.

The results of the Kolmogorov-Smirnov test for the overall and individual competency scores ranged from 0.058 to 0.070, with p -values less than 0.05. This indicates that the data conform to a normal distribution. Additionally, collinearity diagnostics revealed variance inflation factor values of each independent variable ranging from 1.053 to 1.486, indicating no significant collinearity issues.

According to the regression analysis results (Table 4), demographic variables such as individual age, marital status, living arrangement, Internet usage patterns, educational level and self-rated economic status explained 14.9% of the variance in

overall health literacy ($F(6, 148) = 4.318$, $p < 0.001$). In particular, Internet usage ($\beta = 0.206$, $p = 0.022$) and educational level ($\beta = 0.163$, $p = 0.049$) had significant positive effects on health literacy. This indicates that individuals who used cell phones or computers to access the Internet and those with higher educational levels tended to have better health literacy. After controlling for demographic variables, the inclusion of positive and negative perceptions of the attitude toward aging increased the explanatory power by 11.1% ($F(2, 146) = 10.905$, $p < 0.001$). The overall model adjusted explanatory power was 21.9% ($F(8, 146) = 6.398$, $p < 0.001$). Controlling for other variables, a positive perception in the attitude toward aging was positively associated with overall health literacy ($\beta = 0.197$, $p = 0.013$), while a negative perception in the attitude toward aging decreased it ($\beta = -0.227$, $p = 0.005$).

Further analysis of the dimensions of individual competencies revealed that the influence of demographic characteristics accounted for between 6.8% to 16.4% of the variance in each dimension, all reaching statistically significant levels. Internet usage and educational level positively affected all dimensions, consistent with the regression results for overall health literacy. However, the influence of education on the "applying" and "appraising" dimensions of health literacy was not significant, which differed from the overall results. In addition, while marital status did not significantly impact the overall analysis, it had a significant effect on the "applying" dimension ($\beta = -0.189$, $p = 0.032$). This suggests that older men who are either divorced or widowers may exhibit lower competencies in health literacy.

After controlling for demographic variables, positive and negative perceptions in the attitude toward aging increased the explanatory power of each dimension by 6.7% to 10.9%. The adjusted overall explanatory power of the regression models for the four competency dimensions ranged from 13.2% to 18.8%, all of which were statistically significant. Specifically, a positive perception in the attitude toward aging significantly enhanced competencies of accessing ($\beta = 0.171$, $p = 0.033$), applying ($\beta = 0.176$, $p = 0.031$), and appraising ($\beta = 0.192$, $p = 0.021$) health information, but not significantly affect the understanding dimension ($\beta = 0.149$, $p = 0.063$). Conversely, a negative perception in attitude toward aging significantly negatively impacted the competencies of understanding ($\beta = -0.246$, $p = 0.003$), applying ($\beta = -0.164$, $p = 0.049$), and appraising ($\beta = -0.228$, $p = 0.007$). This indicates that higher levels of negative attitude toward aging are associated with lower understanding, applying and appraising competencies in health literacy. Meanwhile, a negative perception did not significantly affect the competency of accessing ($\beta = -0.158$, $p = 0.053$).

4. Discussion

We find that the overall average score of older men's health literacy was 47.841. Individual competency scores ranging between 11.796 and 12.121, indicating a sufficient level of competency. This suggests that the majority of older men possess a certain degree of understanding and application of health knowledge, skills and attitudes. However, among the competencies, application was ranked the lowest. Clearly,

TABLE 3. Factors associated with health literacy questionnaire for older men (HLQ-OA) (n = 157).

Variables	Sources of variation	SS	df	MS	F	p-value	η^2	Post-hoc
Age								
	BCs	2.337	5	0.467				
	BRs	24.143	151	0.160	2.924	0.015	0.088	65–69, 70–74 > Above 90
	Total	26.481	156					
Marital status								
	BCs	1.909	3	0.636				
	BRs	23.457	152	0.154	4.123	0.008	0.075	Married (including cohabitation) > Widowed
	Total	25.366	155					
Residence status								
	BCs	3.243	4	0.811				
	BRs	23.232	151	0.154	5.269	0.001	0.122	Live with spouse only > Live alone, Live with children or grandchildren
	Total	26.475	155					
Internet usage								
	BCs	2.880	3	0.960				
	BRs	23.595	152	0.155	6.184	0.001	0.109	Only used mobile phones, both used mobile phones and computers > Did not use the Internet or did not know how to use the Internet
	Total	26.475	155					
Education level								
	BCs	3.153	4	0.788				
	BRs	23.327	152	0.153	5.137	0.001	0.119	Elementary school, Junior high school, Senior high school, College/University > never went to school
	Total	26.481	156					
Self-perceived health status								
	BCs	0.337	3	0.112				
	BRs	26.144	153	0.171	0.657	0.580	0.013	Non-significant
	Total	26.481	156					
Self-perceived financial status								
	BCs	2.063	3	0.688				
	BRs	24.418	153	0.160	4.309	0.006	0.078	Very satisfied, Satisfied > Fair
	Total	26.481	156					

SS: sum of squares; df: degrees of freedom; MS: mean square; BC: between classes; BR: between replicates.

this area could be further strengthened in future health literacy education programs.

We further explored the factors influencing older men's health literacy and found that age had a significant negative impact on individual health literacy. As age increased, the proportion of individuals with poor health literacy also rose, which aligns with existing research [25]. This suggests that age may affect an individual's health literacy level due to its correlation with cognitive abilities such as memory, processing speed and reasoning [26]. Consequently, older adults tend to have lower health literacy level. This decline in health literacy can negatively affect their health status, increase family medical expenses, and contribute to higher social costs, underscoring the need for targeted interventions for this group.

Furthermore, married individuals exhibited better health literacy, while widowers had poorer health literacy. This finding is consistent with Liu *et al.*'s [27] survey of 1396 older adult individuals aged 65 and above in Xinjiang, China, which strongly suggests that marital status leads to significant differences in health literacy levels. Older men living with their spouses had better health literacy than those living alone, or with children or grandchildren. This underscores the critical role spouses play in helping older people access, understand,

appraise and apply health information [28]. Next, individuals who used cell phones and computers to access the Internet had significantly better health literacy than non-users. Specifically, the ability to use cell phones to access relevant health information is a decisive factor in enhancing health literacy. Technological advancements, use of cell phones, and online information transmission are essential channels for older individuals to access health-related information [29]. Interventions aimed at improving interactive health literacy could effectively enhance older adults' health and well-being [30]. Studies also show that the digital gap and low health literacy make it challenging for individuals to access and use health information. Adults who lack Internet equipment or skills face a severe digital gap and greater challenge in collecting, understanding, appraising and applying the vast volumes of health information available online [31]. Therefore, older men who live alone and lack digital capabilities become a doubly disadvantaged due to low digital access and health literacy. Men are often classified as a "hard-to-reach" group for preventative health measures and harm reduction [32]. While targeting high-risk populations is necessary, it is insufficient to address inequities in power, resources and opportunities. Health literacy interventions should be accessible and understandable for all, with

TABLE 4. Regression analysis of older men's attitude toward aging and health literacy (n = 157).

Method	Variables	Total Score		Access		Understand		Appraise		Apply	
		ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1											
	Age		0.005		-0.012		0.039		-0.047		0.045
	Marital status		-0.154		-0.147		-0.132		-0.180*		-0.068
	Residence status	0.149***	0.021	0.164***	0.023	0.127**	0.045	0.131**	0.024	0.068*	-0.021
	Internet usage		0.206*		0.161*		0.201*		0.188*		0.168*
	Education level		0.163*		0.227**		0.171*		0.087		0.084
	Self-perceived financial status		-0.043		-0.033		-0.007		-0.009		-0.110
Step 2											
	Age		0.005		-0.014		0.041		-0.049		0.045
	Marital status		-0.167		-0.159		-0.141		-0.193*		-0.081
	Residence status		-0.005		0.002		0.020		0.003		-0.047
	Internet usage	0.111***	0.095	0.067**	0.076	0.098***	0.096	0.072**	0.100	0.109***	0.058
	Education level		0.164*		0.229**		0.169		0.089		0.084
	Self-perceived financial status		-0.074		-0.058		-0.033*		-0.036		-0.140
	Positive perception M		0.197*		0.171*		0.149		0.176*		0.192*
	Negative perception M		-0.227**		-0.158		-0.246**		-0.164*		-0.228**
<i>F</i>		6.398 (8, 146)		5.469 (8, 146)		5.293 (8, 146)		4.623 (8, 146)		3.929 (8, 146)	
Total <i>R</i> ²		0.260***		0.231***		0.225***		0.202***		0.177***	
Adjust <i>R</i> ²		0.219***		0.188***		0.182***		0.158***		0.132***	
<i>N</i>		157									

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

a particular focus on those disproportionately affected by low health literacy [33].

The difference and regression analyses demonstrate that older men's educational level is a major factor influencing health literacy. Since health literacy skills are closely related to general literacy and numeracy, a lack of basic functional health literacy skills can prevent individuals from accurately obtaining relevant health information (such as understanding health risks and navigating the health system) and applying this knowledge to several prescribed activities [33]. Those with low educational attainment may have experienced negative early learning, leading to self-deprecation and reluctance to participate in learning activities. Alternatively, they might find health literacy course content extensively theoretical and difficult to understand. These potential adverse factors may contribute to poor health literacy [34]. Therefore, developing methods to help older adults with low educational attainment access, understand, appraise and apply health-related information is crucial for maintaining their health and promoting healthy aging.

The results also indicate that older men had mean scores of 31.452 for positive perceptions of aging and 18.229 for nega-

tive perceptions. Stereotype Embodiment Theory suggests that early stereotypes about aging may be continually reinforced by the social environment experienced during upbringing, forming established views on aging [35]. Previous studies have shown older men are more likely to benefit from positive aging stereotypes, such as the belief that older people possess wisdom and hold authoritative positions in the family, helping them shape positive aging attitudes [36]. Nevertheless, men can also be influenced by adverse factors, such as declining health, loss of resources, and reduced social support, which can lead to negative perspectives on aging [37]. Additionally, men are also more likely than women to delay seeking help for mental health problems, such as therapy or counselling, amid concerns of scrutiny about their masculinity [38].

We found no significant differences in positive attitude toward aging across demographic variables. However, older men who live alone, do not use the Internet, have poorer self-rated health, and worse economic conditions tend to exhibit a higher negative attitude toward aging, which is consistent with previous research [39]. Jang *et al.* [22] also found that as individuals age, they may face retirement, illness or declining physical functions. The loss of work often comes

with the loss of colleagues, networks, social support and autonomy [40]. These circumstances may lead to a reduction or loss of resources, including financial, social and health ones. When individuals perceive these losses, they may experience negative emotions and cognitions, such as decreased self-worth, helplessness and insecurity. These negative feelings can influence their views on aging, making them more prone to developing negative attitudes and expectations about aging.

Masculine norms are social rules and expected behaviors associated with men and manhood within a given culture [41]. During the aging process, older men are influenced by personal health and economic factors, which may lead to the conflict of role reversal as older men transition from being a resource provider to a dependent. This shift can intensify feelings of worthlessness and further impact their attitude toward aging. Today's society also emphasizes individual capability and autonomy, which can potentially increase negative feelings associated with dependency [23, 39, 42]. For men, this effect may be more pronounced due to masculine norms that expect them to play roles of dominance and power [43]. Nonetheless, as they age and experience role reversal via the transition from providers to dependents, they may feel that they have lost their role and dominance. This can negatively affect their attitude toward aging and make it challenging to adapt to a life without the roles they once held.

Even after controlling for demographic variables, the attitude toward aging significantly affects health literacy. A more positive attitude toward aging is associated with improved overall health literacy and enhanced abilities to access, apply and appraise health information. Conversely, a more negative attitude toward aging tends to correlate with poorer overall health literacy and diminished abilities to understand, apply and appraise health information. Studies have also shown that older individuals with a positive attitude toward aging are more likely to engage in preventive health behaviors and exhibit better health outcomes. In contrast, those with a negative attitude toward aging may perceive the decline associated with aging to be inevitable, leading to pessimism and reluctance to seek treatment and adopt coping strategies [11, 44].

From a psychological perspective, older individuals with a positive attitude toward aging typically exhibit a higher sense of self-efficacy. They believe that they have sufficient competencies and strategies to cope with life's difficulties [23, 45]. This belief motivates them to engage in more proactive health behaviors to maintain or improve their health. In a study examining attitudes toward aging and learning behaviors among older adults in Canada and Japan, Hori and Cusack [46] found that those with a positive attitude toward aging were more active in learning activities and had a greater willingness to participate. As a result, older individuals with a positive attitude toward aging are more inclined to seek and learn health-related information. Their confidence in their ability to understand and apply this health information boost their motivation and behavior toward learning, thereby improving their health literacy.

Conversely, individuals with a negative attitude toward aging may lack confidence in their abilities and often attribute problems encountered in daily life to aging [47]. Older men may struggle to acquire health knowledge, and believe they

cannot understand or apply it, nor make changes or solve problems in their lives. This belief reduces their willingness to engage in health-promoting behaviors, thereby affecting their health literacy. Moreover, older men who are not technologically inclined face challenges in both physical and mental health, making them doubly disadvantaged due to low digital access and health literacy.

From a social participation perspective, older individuals with a positive attitude toward aging are more likely to maintain ongoing social contact. This continuous interaction allows them to acquire new health-related knowledge through social engagement, thereby enhancing their health literacy [21]. However, a negative attitude toward aging may affect an individual's motivation to participate in social activities, leading to reduced social interactions and even social isolation [45]. This isolation impedes their ability to access and acquire health-related knowledge and skills, adversely affecting their health literacy.

From a gender role perspective, society often expects men to present a strong, proactive and challenge-embracing image [43]. These expectations may lead men to adopt a positive view of aging and actively engage in health literacy activities, such as health education and regular check-ups, to align with societal standards and maintain their social roles. However, when older men encounter adverse effects on their health and economic status, they may experience role reversal, leading to feelings of diminished competence and value [43]. This sense of role reversal can result in frustration and helplessness, which may decrease their focus on and participation in health literacy activities. Additionally, a negative attitude toward aging might increase resistance to addressing health issues and reduce their willingness to seek help or make necessary changes.

This study has certain limitations. First, the sampling method is not representative of the entire Taiwanese population, as it focuses solely on community-dwelling older men in Hsinchu. This may introduce selection bias, potentially limiting the generalizability of the findings to older men across Taiwan. Second, due to the COVID-19 pandemic, some community-based long-term care facilities were closed, and older adult activities remained suspended during the questionnaire distribution and collection. As a result, the number of completed questionnaires was relatively low, necessitating caution when interpreting the results.

5. Conclusions

First, this study highlights the significant impact of attitudes toward aging on health literacy in older men. Specifically, older men with low levels of education, those living alone, those who are divorced or widowed, or those who do not use the Internet tend to have poorer health literacy. Furthermore, negative attitudes toward aging exacerbate these challenges, impairing health literacy even further.

Second, from a practical standpoint, community workers should focus on eliminating ageism and promoting positive attitudes toward aging when organizing health literacy activities for older men. These activities should be tailored to the daily lives and health needs of older adults, taking into account their individual health conditions and capabilities. Providing real-

time feedback during the activities will help older men track their learning progress and identify areas for improvement, ultimately empowering them.

Finally, future research should investigate how other psychological factors affect health literacy. For example, by using experimental designs or longitudinal studies could help establish and confirm these cause-and-effect relationships. Additionally, efforts should be made to enhance the quality and accessibility of health information, improve skills and support frontline professional in gerontology and health literacy, and create a supportive health communication environment to ensure that resources and cultural support are readily available.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

SHK—designed the study and carried them out; prepared the manuscript for publication and reviewed the draft of the manuscript. MHL—supervised the data collection, analyzed the data, interpreted the data. Both of authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Human Research Ethics Committee, Yuanpei University of Medical Technology (YPU-IRB-1110728). All subjects provided their consent to participate and signed written informed consent forms.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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