



Original Article

Health Literacy and Health-Related Lifestyle Behaviors Among Older Adults: A Multivariable Analysis

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Abstract

Introduction: Health literacy (HL) is increasingly recognized as an important determinant of healthy aging because it influences individuals' ability to access, understand, evaluate, and apply health information. However, evidence regarding the relationship between HL and health-related lifestyle behaviors (HLBs) among older adults in Thailand remains limited. This study aimed to examine HL and HLBs among older adults and identify socio-demographic and health-related factors associated with both outcomes.

Methods: A cross-sectional study was conducted among 440 elderly individuals aged ≥ 60 years in Pathum Thani, Thailand, recruited from community centers and primary healthcare facilities. Data were collected using structured questionnaires assessing socio-demographic characteristics, HL, health perception, and HLBs. Descriptive statistics, independent t-tests, one-way ANOVA, Pearson's correlation analysis, and ordinary least squares regression were used for data analysis.

Results: The overall mean health literacy score and the mean HLB score were 2.60 (SD=0.56) and 43.49 (SD=22.22), respectively. HL significantly differed based on marital status, education level, occupation, family income, income sufficiency, healthcare rights, and living arrangement ($P < 0.05$). HL was positively correlated with health perception of illness ($r = 0.284$, $P < 0.001$) and HLB ($r = 0.141$, $P = 0.003$). In the regression model, education ($\beta = 0.226$, $P < 0.001$), family income ($\beta = 0.071$, $P < 0.001$), income sufficiency ($\beta = 0.182$, $P < 0.001$), marital status ($\beta = 0.118$, $P = 0.001$), and health perception of illness ($\beta = 0.134$, $P < 0.001$) were significant HL predictors. In the model predicting HLB, HL ($\beta = 0.169$, $P = 0.005$), health perception of illness ($\beta = 0.111$, $P < 0.001$), family income ($\beta = 0.085$, $P = 0.006$), income sufficiency ($\beta = 0.213$, $P = 0.021$), and marital status ($\beta = 0.195$, $P = 0.004$) were significantly associated with healthier lifestyle behaviors.

Conclusion: HL was linked with HLBs among older adults and remained an essential predictor after adjustment for socio-demographic and health-related factors. Educational attainment, socioeconomic conditions, and health perception were related to HL and lifestyle behaviors. Interventions aimed at strengthening HL may support healthier lifestyles, thereby contributing to healthy aging among older adults.

Keywords: Health Literacy, Health-Related Lifestyle Behaviors, Older Adults, Healthy Aging, Health Perception, Thailand



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Introduction

The global demographic shift toward an aging population presents significant public health challenges and opportunities. Individuals become more susceptible to chronic diseases, functional decline, and reduced quality of life as they age (1). Similar to many other nations, the proportion of older adults is steadily increasing in Thailand, highlighting an urgent need for effective health promotion strategies (2). Promoting healthy lifestyle behaviors among the elderly is paramount to maintaining their independence,

reducing healthcare burdens, and enhancing overall well-being (3). These behaviors encompass a range of practices, including regular physical activity, balanced nutrition, adequate sleep, and avoidance of harmful substances, such as tobacco and excessive alcohol consumption (4).

Health literacy (HL), defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (5), has emerged as an important determinant of health outcomes across



the lifespan. Among older adults, adequate HL facilitates access to healthcare services, comprehension of health information, adherence to treatment recommendations, and engagement in health-promoting behaviors. In contrast, limited HL has been associated with poorer health status, increased healthcare utilization, lower medication adherence, and reduced participation in preventive health practices (6). Consequently, inadequate HL may contribute to widening health disparities and diminished quality of life among aging populations (7).

As Thailand continues its transition toward an aging society, promoting healthy lifestyle behaviors among older adults has become an essential public health priority. Health-related lifestyle behaviors (HLBs), including physical activity, dietary practices, stress management, and self-care, play a critical role in maintaining health and functional independence in later life. Although previous studies have examined HL among various Thai populations (8-9), evidence regarding factors associated with HL and its relationship with HLBs among community-dwelling older adults remains limited, particularly at the provincial level. Due to its rapidly growing elderly population and diverse mix of urban and peri-urban communities, Pathum Thani Province represents an appropriate setting for examining these issues. Understanding how socio-demographic characteristics, health perception, and HL are related to lifestyle behaviors may provide valuable evidence for developing targeted interventions that support healthy aging.

Therefore, this study aims to evaluate HL and HLBs among older adults residing in Pathum Thani Province, Thailand. Specifically, the study investigates socio-demographic and health-related factors associated with HL and examines the extent to which HL is related to HLBs after controlling for relevant background characteristics. The findings contribute to the growing body of evidence on healthy aging and may inform the development of community-based health promotion programs aimed at improving HL and promoting healthier lifestyles among older adults.

Study Objectives

1. This study seeks to examine the levels of HL and HLBs among older adults in Pathum Thani Province, Thailand.
2. It also investigates the associations between socio-demographic and health-related factors and HL among older adults.
3. Finally, the study evaluates the relationship between HL and HLBs after controlling for socio-demographic and health-related factors.

Conceptual Framework and Literature Review

HL has become an increasingly important concept in public health and healthy aging research. It is commonly defined as the ability to access, understand, appraise, and apply health information in ways that support appropriate health decisions and actions (10-13). Moreover, contemporary HL frameworks emphasize that HL extends beyond basic

reading and writing skills and includes individuals' capacity to navigate healthcare systems, evaluate health information, communicate with healthcare professionals, and engage in self-management activities (14-17). As populations age and chronic conditions become more prevalent, HL has gained recognition as a critical factor influencing health outcomes among older adults. Likewise, previous research has consistently demonstrated that HL is associated with a wide range of health outcomes. Individuals with higher HL tend to report better health status, greater adherence to treatment recommendations, improved disease management, and higher engagement in preventive health practices (10-13). Conversely, limited HL has been linked to poorer health outcomes, increased healthcare utilization, medication errors, and reduced participation in health-promoting behaviors (6, 10, 11). These findings suggest that HL may function as a crucial mechanism through which individuals acquire and use health-related knowledge in daily life.

Among older adults, HL may be particularly essential because aging is frequently accompanied by increased healthcare needs, multiple chronic conditions, and more frequent interactions with healthcare systems (18-21). Some previous studies have reported that older adults with higher levels of HL are more likely to engage in behaviors that support healthy aging, including physical activity, healthy dietary practices, medication adherence, and disease prevention activities (13, 17). HL may, therefore, contribute to maintaining functional independence and improving overall well-being in later life. Nutbeam's HL model (21) provides an important theoretical foundation for understanding these relationships. The model proposes that HL serves as a critical pathway through which individuals acquire knowledge, develop decision-making skills, and engage in health-promoting actions. According to this perspective, HL is influenced by broader social and environmental conditions, thereby affecting health behaviors and health outcomes. Consequently, HL can be viewed both as an outcome of social determinants and as a factor that influences behavioral practices.

Consistent with this perspective, socio-demographic factors have frequently been identified as important determinants of HL (22-25). In addition, educational attainment is among the most consistently reported predictors, as formal education contributes to cognitive skills, information processing abilities, and communication competencies that facilitate health-related decision-making (26-30). Higher educational attainment has generally been associated with higher HL levels across diverse populations. Similarly, socioeconomic conditions, including income and financial resources, influence opportunities to access healthcare services, health information, and lifelong learning experiences (16, 30-32). Furthermore, individuals with greater economic resources often demonstrate higher levels of HL because they face fewer structural barriers to obtaining and utilizing health information (33-35).

Additionally, marital status and social circumstances may contribute to HL. Older adults who receive support from

spouses, family members, or social networks may have greater opportunities to discuss health concerns, access health information, and receive assistance in managing health conditions (36, 37). Social support has been identified as an essential contextual factor that can facilitate both HL and health-related behaviors among aging populations (38). Moreover, health perception is another factor that has received increasing attention. It refers to an individual's subjective assessment and understanding of his or her health condition (18). According to previous research, individuals who possess greater awareness of their health status are more likely to seek health information, engage with healthcare providers, and participate in preventive health activities (19). Health perception may, therefore, be related to both HL and HLBs.

HLBs represent a significant outcome within Nutbeam's framework. These behaviors include activities such as regular exercise, healthy eating, stress management, and other practices that contribute to maintaining health and preventing disease. Prior studies have reported positive associations between HL and health-promoting behaviors, suggesting that individuals with higher literacy levels are better able to translate health information into practical actions (13, 17, 29). Nevertheless, lifestyle behaviors are influenced by multiple factors, including socioeconomic conditions, perceived health status, demographic characteristics, and access to healthcare resources (29, 32).

Based on the literature and the underlying theoretical perspectives, the present study conceptualizes HL as both a dependent and explanatory variable. Socio-demographic characteristics (gender, age, marital status, education, family income, and income sufficiency), anthropometric characteristics (weight, height, and body mass index [BMI]), and health perception of illness are expected to be associated with HL. Subsequently, HL, together with these socio-demographic and health-related factors, is expected to be linked with HLBs among older adults.

Although previous studies have documented associations among HL, health status, and health behaviors, evidence from community-dwelling older adults in Thailand remains limited. Existing Thai studies have largely focused on specific populations or individual health outcomes, and few studies have simultaneously examined factors related to HL and HLBs within the same analytical framework (8, 9). Furthermore, little evidence is available from Pathum Thani Province, an area characterized by rapid population aging and diverse socioeconomic conditions. Therefore, the present study has been conducted to examine factors associated with HL and HLBs among older adults in Pathum Thani Province, Thailand, thereby contributing evidence to support healthy aging and community-based health promotion strategies.

The conceptual framework in [Figure 1](#) of this study was developed based on Nutbeam's HL model (21) and the social determinants of health perspective (29, 37). This model proposes that HL is a key determinant of health-related decision-making and behavioral outcomes because it influences individuals' ability to access, understand,

evaluate, and apply health information. Simultaneously, social determinant perspectives indicate that demographic, socioeconomic, and health-related characteristics shape opportunities to acquire health knowledge and engage in health-promoting behaviors throughout the life course. . Subsequently, HL is hypothesized to be related to HLBs while controlling for socio-demographic and health-related characteristics. Accordingly, the framework proposes two interrelated pathways. First, socio-demographic and health-related factors influence HL. Second, HL, coupled with socio-demographic and health-related factors, affects HLBs among older adults. This framework guided the selection of study variables and the development of the regression models used in the analysis.

Materials and Methods

Study Design

This study employed a cross-sectional survey design to assess the relationship of HL on HLBs among elderly individuals in Pathum Thani, Thailand. Data were collected through structured questionnaires to extract information on HL levels and HLBs.

Sample and Setting

This cross-sectional study was performed among older adults aged 60 years and above residing in Pathum Thani Province, Thailand. In addition, data were collected from multiple community-based settings, including community centers, primary healthcare facilities, elderly clubs, and organized elderly care programs located across urban and peri-urban districts of the province. Further, a multi-site community-based approach was employed to capture variation in socio-demographic characteristics, educational backgrounds, economic conditions, and health status among older adults. Furthermore, study sites were selected using purposive sampling based on predefined criteria, including accessibility to older adult populations, their role as primary service access points for elderly residents, and their ability to represent diverse community contexts within Pathum Thani Province.

Within each selected site, participants were recruited using consecutive sampling. All older adults who attended the selected facilities during the data collection period and met the eligibility criteria were invited to participate in this study. Recruitment continued consecutively until the required sample size was achieved. Given that neither study sites nor participants were selected using probability sampling techniques, the findings should be interpreted within the context of non-probability sampling and may be most applicable to older adults utilizing similar community-based services. Required data were collected between May and July 2025. This period was considered appropriate for the assessment of HL and HLBs, as these constructs are generally stable over short periods and are unlikely to be substantially influenced by seasonal variation. Eligibility criteria included individuals aged 60 years and older who were residing in Pathum Thani Province, able to communicate in Thai, and willing to

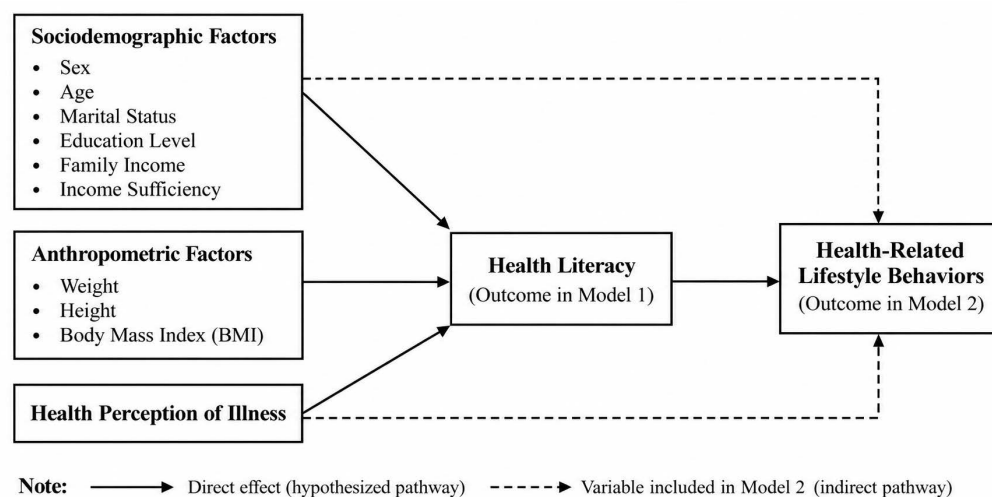


Figure 1. Conceptual Framework of the Study

provide informed consent. To ensure data quality and response validity, individuals with clinically diagnosed cognitive impairments, severe hearing or communication difficulties, or serious medical conditions that could interfere with questionnaire completion were excluded from the study.

Sample Size

The required sample size was determined using Yamane's formula for finite populations based on the registered elderly population of Pathum Thani Province ($N = 56,763$). Using a 95% confidence level and a margin of error of 5%, the minimum required sample size was calculated to be 398 participants. Likewise, recruitment continued beyond the minimum requirement to increase the precision of the estimates while minimizing the potential impact of incomplete questionnaires or missing data. A total of 440 older adults were enrolled in the study. The final sample exceeded the calculated minimum sample size and was considered sufficient for the planned analyses, including descriptive statistics, group comparisons, Pearson's correlation analysis, and ordinary least squares (OLS) regression models examining factors associated with HL and HLBs.

Research Instruments

The study utilized four primary research instruments: (1) a socio-demographic questionnaire, (2) the Elder HL Questionnaire (EHLQ), (3) the Health Perception of Illness Questionnaire, and (4) the Health-Related Behavior Questionnaire. The socio-demographic questionnaire was utilized to collect background information, including age, occupation, education level, marital status, income sufficiency, weight, height, BMI, chronic disease status, and sources of health information. These variables were treated as independent variables in the analysis. Moreover, the EHLQ was adapted from the conceptual framework of the HL Questionnaire (HLQ), originally developed and validated by Osborne et al (20), which has been widely used

to measure multidimensional aspects of HL across diverse populations, including older adults. The HLQ is grounded in contemporary HL theory that conceptualizes HL as a multidimensional construct encompassing the ability to access, understand, appraise, and apply health information in healthcare and disease prevention contexts (21, 22).

In addition, the structure of the EHLQ aligns with established health promotion and behavioral change theories, including the Health Belief Model (23), Social Cognitive Theory (33), and the Social Ecological Model (24), which emphasize individuals' cognitive processing of health information, self-efficacy, and interaction with social environments as determinants of health behavior.

To ensure linguistic equivalence and cultural appropriateness, the translation process followed a forward-backward translation procedure. The translated version was reviewed by two experts in public health and gerontology prior to data collection.

The EHLQ consists of 29 items covering four domains: accessing health information, understanding health information, appraising health information, and applying health information in decision-making. Each item is rated on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Further, total scores ranged from 29 to 145 and were categorized into four levels: inadequate (29–58), limited (59–87), sufficient (88–116), and excellent (117–145). Furthermore, subscale scores were calculated by summing the items within each domain and dividing by the number of items to obtain mean domain scores. In the present study, the overall Cronbach's alpha coefficient was 0.91, with subscale reliability coefficients ranging from 0.82 to 0.88, indicating good internal consistency.

The Health Perception of Illness Questionnaire was designed to assess participants' perceived understanding of their health conditions and their ability to manage illness. The instrument comprises eight items, each rated on a 0–10 numeric scale, where 0 and 10 represent no understanding and complete understanding, respectively. Moreover, total

scores range from 0 to 80, with higher scores reflecting better perceived health understanding. The Cronbach's alpha coefficient for this instrument in the current study was 0.84, demonstrating acceptable reliability. Likewise, the Health-Related Behavior Questionnaire was newly developed based on established health promotion and behavioral change theories relevant to elderly populations. The instrument includes 32 items across three domains: exercise (12 items), behavioral change (12 items), and stress management (8 items). All items are rated on a 5-point Likert-type scale ranging from 1 (never) to 5 (always), with total scores ranging from 32 to 160. Higher scores display better engagement in health-related behaviors. Construct validity was examined using exploratory factor analysis. The Kaiser–Meyer–Olkin measure was 0.89, and Bartlett's test of sphericity was statistically significant ($P < 0.001$), confirming the suitability of the data for factor analysis. Three factors with eigenvalues greater than 1 were extracted, explaining 58.72% of the total variance, and all factor loadings exceeded 0.50. Content validity was also evaluated by four experts in health promotion and elderly care using the content validity index, yielding an average content validity index of 0.85. Additionally, reliability testing was conducted in two phases. A pilot test with 30 participants demonstrated good internal consistency (Cronbach's alpha = 0.89), and in the main study, the Cronbach's alpha coefficient was 0.90, with domain-specific reliability coefficients ranging from 0.83 to 0.88. These findings support the validity and reliability of the instrument for assessing health-related behaviors among elderly individuals.

Data Collection

As mentioned earlier, data were collected between May and July 2025 following approval from the Institutional Review Board of Kanchanaphisek College of Medical Technology and Public Health (approval No. KMPHT-68010002). Prior to data collection, the research team coordinated with community centers, primary healthcare facilities, and elderly care programs participating in the study. Furthermore, participants were recruited by registered nurses working at the selected study sites. To ensure consistency across locations, all recruiting personnel participated in a standardized training session organized by the research team. Moreover, the training covered the study objectives, eligibility criteria, participant screening procedures, ethical considerations, and informed consent requirements. Further, written recruitment and data collection guidelines were provided to support standardized implementation throughout the study period.

Potential participants were also screened according to the predefined inclusion and exclusion criteria. Eligible individuals received an explanation of the study purpose, procedures, potential benefits and risks, confidentiality safeguards, and their right to withdraw from the study at any time without consequence. Ultimately, written informed consent was obtained from all participants prior to enrollment.

Data Analysis

Data were analyzed using Jamovi software (version 2.6.44). Descriptive statistics, including frequencies, percentages, means, and standard deviations, as well as minimum and maximum values, were used to summarize participants' socio-demographic characteristics, HL scores, HLBs, and health perception of illness. Independent-samples t-tests and one-way analysis of variance were conducted to examine differences in HL and HLBs across socio-demographic groups. Pearson's correlation coefficient was employed to assess the relationships among continuous variables, including age, weight, height, BMI, health perception of illness, HL, and HLBs. Two OLS regression models were estimated to identify factors associated with HL and HLB. In model 1, HL was specified as the dependent variable, whereas gender, age, weight, height, BMI, marital status, education level, family income, income sufficiency, and health perception of illness were included as independent variables. In model 2, HLBs served as the dependent variable, with the same set of socio-demographic and health-related variables included, together with HL as an explanatory variable. The regression results were reported as unstandardized coefficients (B), standard errors (SE), t-values, and P-values. Finally, model fit was evaluated using the coefficient of determination (R^2), adjusted R^2 , and the overall F-statistic. Statistical significance was established at $P < 0.05$.

Results

Table 1 presents the distribution of HL and HLBs across socio-demographic characteristics among older adults.

The overall mean HL score was 2.60 (SD = 0.56). In addition, HL differed significantly according to marital status ($F = 4.812$, $P = 0.009$), education level ($F = 8.142$, $P < 0.001$), occupation ($F = 3.567$, $P = 0.004$), monthly family income ($F = 5.212$, $P < 0.001$), income sufficiency ($t = 3.428$, $P = 0.001$), healthcare rights ($F = 6.941$, $P < 0.001$), and living arrangement ($F = 3.115$, $P = 0.026$). Based on the results, no significant differences were observed in terms of gender ($t = 1.284$, $P = 0.200$) or religion ($F = 0.621$, $P = 0.538$).

Participants with postgraduate education reported the highest HL score (mean = 3.18, SD = 0.41), whereas those in the "other" education category reported the lowest score (mean = 2.12, SD = 0.48). Further, HL scores tended to increase across higher income categories, ranging from 2.41 (SD = 0.58) among participants with no income to 3.05 (SD = 0.44) among those reporting a monthly family income of 52,501–67,500 Baht.

The overall mean HLB score was 43.49 (SD = 22.22). Significant differences in HLB were found with regard to marital status ($F = 19.500$, $P < 0.001$), education level ($F = 2.727$, $P = 0.029$), occupation ($F = 2.856$, $P = 0.015$), healthcare rights ($F = 13.797$, $P < 0.001$), and living arrangement ($F = 5.885$, $P = 0.001$). Conversely, there were no significant differences in terms of gender ($t = -3.840$, $P = 0.438$), religion ($F = 0.314$, $P = 0.730$), monthly family income ($F = 1.386$, $P = 0.228$), or income sufficiency ($t = 0.003$, $P = 0.959$). Among the marital status groups,

Table 1. Descriptive Statistics and Statistical Analysis of Health Literacy and Health-Related Lifestyle Behaviors by Socio-Demographic Factors

Factors	Frequency	(%)	Mean	Health Literacy			Health-Related Lifestyle Behaviors			
				SD	T-Test/F-Test	Sig.	Mean	SD	T-Test/F-Test	Sig.
Gender										
Female	344	78.2	2.58	0.55	1.284	0.200	38.62	21.79	-3.840	0.438
Male	96	21.8	2.67	0.58			48.35	22.66		
Total	440	100	2.6	0.56			43.49	22.22		
Marital status										
Single	26	5.9	2.72	0.51	4.812	0.009	48.96	16.45	19.500	0.000
Married	306	69.5	2.54	0.56			36.51	21.15		
Widowed/divorced/separated	108	24.5	2.74	0.54			50.69	23.26		
Total	440	100	2.6	0.56			45.39	20.29		
Religion										
Buddhism	368	83.6	2.61	0.56	0.621	0.538	40.48	22.85	0.314	0.730
Christianity	40	9.1	2.57	0.52			43.42	19.90		
Islam	32	7.3	2.55	0.61			40.48	19.04		
Total	440	100	2.6	0.56			41.46	20.60		
Education level										
	93	21.1	2.35	0.54	8.142	<0.001	40.67	22.69	2.727	0.029
Primary school	196	44.5	2.55	0.52			45.70	22.78		
Secondary school	142	32.3	2.84	0.55			47.63	21.47		
Bachelor's degree or equivalent	4	0.9	3.18	0.41			55.04	0.00		
Postgraduate	5	1.1	2.12	0.48			27.52	0.00		
Others										
Total	440	100	2.6	0.56			41.31	13.39		
Occupation										
	74	16.8	2.68	0.55	3.567	0.004	46.37	21.25	2.856	0.015
Not employed	94	21.4	2.48	0.58			34.56	23.04		
Employed	37	8.4	2.83	0.49			37.12	15.17		
Government/state enterprise	34	7.7	2.44	0.53			42.82	18.30		
Farmer	89	20.2	2.59	0.57			40.93	24.16		
Self-employed	112	25.5	2.63	0.55			42.62	23.01		
Others										
Total	440	100	2.6	0.56			40.74	20.82		
Monthly family income										
	70	15.9	2.41	0.58	5.212	<0.001	42.59	22.05	1.386	0.228
No income	69	15.7	2.46	0.57			42.05	21.63		
7,500–15,000 Baht	121	27.5	2.58	0.53			42.75	20.38		
15,001–25,500 Baht	120	27.3	2.72	0.55			38.14	23.17		
25,501–37,500 Baht	52	11.8	2.88	0.49			36.29	26.24		
37,501–52,500 Baht	8	1.8	3.05	0.44			50.40	13.50		
52,501–67,500 Baht										
Total	440	100	2.6	0.56			42.04	21.16		
Sufficiency of income										
Sufficient	335	76.1	2.68	0.54	3.428	0.001	40.77	23.36	0.003	0.959
Insufficient	105	23.9	2.39	0.57			40.64	18.75		
Total	440	100	2.6	0.56			40.70	21.06		
Healthcare rights										
	28	6.4	2.49	0.61	6.941	<0.001	38.85	26.91	13.797	0.000
Self-pay	135	30.7	2.81	0.51			45.15	21.18		
Reimbursable	64	14.5	2.28	0.59			25.28	24.00		
Social insurance	213	48.4	2.57	0.54			42.82	19.90		
Government Welfare gold card										
Total	440	100	2.6	0.56			38.02	23.00		
People living with										
	9	2	2.49	0.47	3.115	0.026	39.01	1.18	5.885	0.001
Living alone	413	93.9	2.61	0.56			41.06	22.34		
Living with Family	14	3.2	2.32	0.51			23.23	19.58		
Living with Siblings/relatives	4	0.9	3.08	0.38			72.96	0.00		
Others										
Total	440	100	2.6	0.56			44.06	10.78		

Note. SD: Standard deviation; Sig.: Level of significance.

widowed, divorced, or separated participants reported the highest HLB score (mean = 50.69, SD = 23.26), whereas married participants mentioned the lowest score (mean = 36.51, SD = 21.15). Eventually, participants with postgraduate education demonstrated the highest HLB score (mean = 55.04), while those classified in the “other” education category reported the lowest score (mean = 27.52).

Table 2 provides the descriptive statistics and correlations between socio-demographic and health-related variables, HL, and HLBs.

Among the examined variables, HL was significantly associated with height ($r = -0.115$, $P = 0.016$) and health perception of illness ($r = 0.284$, $P < 0.001$). Older adults who reported better understanding and perception of their health condition tended to have higher HI scores. Contrarily, age, weight, and BMI were not substantially correlated with HL ($P > 0.05$). For HLBs, significant relationships were observed with weight ($r = -0.097$, $P = 0.041$), height ($r = -0.191$, $P < 0.001$), health perception of illness ($r = -0.193$, $P < 0.001$), and HL ($r = 0.141$, $P = 0.003$). Although the correlation coefficients were

relatively small, the results indicated that HLBs varied according to both health-related characteristics and HL levels. Additionally, a positive correlation was found between HL and HLB ($r = 0.141$, $P = 0.003$), suggesting that participants with higher levels of HL tended to report more favorable HLBs. Finally, there were no significant associations between HLB and age or BMI ($P > 0.05$).

Table 3 summarizes the results of two OLS regression models. Models 1 and 2 examined factors associated with HL and HLBs, respectively. In model 1, several socio-demographic and health-related variables were significantly related to HL. Marital status was positively associated with HL ($\beta = 0.118$, $P = 0.001$), while higher educational attainment showed the strongest positive relationship ($\beta = 0.226$, $P < 0.001$). In addition, family income ($\beta = 0.071$, $P < 0.001$), income sufficiency ($\beta = 0.182$, $P < 0.001$), and health perception of illness ($\beta = 0.134$, $P < 0.001$) were positively linked with HL. Height represented a small negative association with HL ($\beta = -0.006$, $P = 0.016$). In contrast, age, weight, and BMI were not markedly related to HL. The model explained 23.1% of the variance in HL ($R^2 = 0.231$; adjusted $R^2 = 0.213$) and was statistically

Table 2. Descriptive Statistics and Correlations of Health Literacy and Health-Related Lifestyle Behaviors With Socio-Demographic and Health Variables

Factors	Minimum	Maximum	Mean	SD	Health Literacy (r)	P-Value	HLB (r)	P-Value
Age	60	78	68.04	4.356	0.086	0.071	0.019	0.693
Weight	41	93	66.21	9.750	-0.082	0.087	-0.097*	0.041
Height	143	185	167.19	8.151	-0.115*	0.016	-0.191**	<0.001
Body mass index	17.93	30.00	23.69	2.619	-0.028	0.553	0.010	0.837
Health perception of illness	2.88	8.13	4.99	1.188	0.284**	<0.001	-0.193**	<0.001
Health literacy	1.17	4.31	2.60	0.556	-	-	0.141**	0.003
Health-related lifestyle behaviors	1.00	96.00	43.49	22.22	0.141**	0.003	-	-

Note. SD: Standard deviation; HLB: Health-related lifestyle behaviors.

Table 3. OLS Regression Models Predicting Health Literacy and Health-Related Lifestyle Behaviors

Variable	Model 1: Health Literacy				Model 2: HLB			
	Coef.	SE	t	P-value	Coef.	SE	t	P-value
Intercept (Constant)	1.245	0.487	2.556	0.011*	9.986	2.607	3.830	<0.001**
Gender (male: Ref.)	0.062	0.028	2.214	0.027*	0.053	0.107	0.491	0.623
Age	0.003	0.002	1.587	0.113	0.004	0.008	0.528	0.598
Weight	-0.002	0.004	-0.500	0.617	0.046	0.017	2.684	0.006*
Height	-0.006	0.003	-2.412	0.016*	-0.048	0.015	-3.247	0.001**
BMI	-0.008	0.012	-0.664	0.507	-0.123	0.049	-2.537	0.012*
Marital status (single: Ref.)	0.118	0.034	3.471	0.001**	0.195	0.067	2.908	0.004*
Education (no education: Ref.)	0.226	0.024	9.417	<0.001**	-0.025	0.046	-0.529	0.597
Family income	0.071	0.016	4.438	<0.001**	0.085	0.031	2.758	0.006*
sufficiency (no enough: Ref.)	0.182	0.047	3.872	<0.001**	0.213	0.092	2.326	0.021*
Health Perception of illness	0.134	0.014	9.571	<0.001**	0.111	0.027	4.138	<0.001**
Health literacy	-	-	-	-	0.169	0.059	2.855	0.005*
R ²	0.231				0.141			
Adjusted R ²	0.213				0.119			
F-statistic	12.840**				6.394**			

Note: OLS: Ordinary least squares; HLB: Health-related lifestyle behaviors; Coef.: Coefficient; SE: Standard error. * $P < 0.05$; ** $P < 0.01$.

significant overall ($F = 12.840$, $P < 0.01$).

Model 2 assessed predictors of HLBs. Further, weight ($\beta = 0.046$, $P = 0.006$), family income ($\beta = 0.085$, $P = 0.006$), income sufficiency ($\beta = 0.213$, $P = 0.021$), health perception of illness ($\beta = 0.111$, $P < 0.001$), and HL ($\beta = 0.169$, $P = 0.005$) were positively associated with HLB. Conversely, height ($\beta = -0.048$, $P = 0.001$) and BMI ($\beta = -0.123$, $P = 0.012$) were negatively linked with HLB. Based on the results, marital status remained significant after adjustment for other variables ($\beta = 0.195$, $P = 0.004$). No significant associations were observed for gender, age, or education level. The model accounted for 14.1% of the variance in HLB ($R^2 = 0.141$; adjusted $R^2 = 0.119$), and the overall model was statistically significant ($F = 6.394$, $P < 0.01$). Comparing the two models, education, income, income sufficiency, and health perception of illness were related to HL, whereas HL itself remained remarkably associated with HLB after controlling for socio-demographic and health-related variables. Among the predictors included in model 2, health perception of illness ($\beta = 0.111$) and HL ($\beta = 0.169$) displayed the strongest positive associations with HLB.

Discussion

This study was guided by Nutbeam's HL model and selected elements of the theory of planned behavior, which emphasize the role of HL in supporting individuals' capacity to access, understand, evaluate, and use health information in ways that influence health-related decisions and behaviors. By examining both HL and HLBs within the same analytical framework, the present study provided a broader understanding of how socio-demographic and health-related factors are associated with health outcomes among older adults.

The findings indicated that HL was related to several socio-demographic and health-related characteristics. Moreover, education emerged as one of the strongest correlates of HL, with higher educational attainment linked with higher literacy scores. This finding is consistent with the results of previous studies, suggesting that education provides individuals with foundational cognitive skills that facilitate the acquisition, interpretation, and application of health information (30-33). Likewise, education may enhance communication with healthcare providers and improve the ability to navigate increasingly complex healthcare systems. Although educational attainment cannot completely capture functional HL, the present findings suggest that formal education remains an important structural factor related to literacy levels among older adults.

Additionally, economic factors were associated with HL. Further both family income and income sufficiency showed positive relationships with HL, indicating that older adults with greater financial resources tended to report higher literacy levels. Similar findings have been reported in previous research, demonstrating that socioeconomic resources may facilitate access to health information, healthcare services, and learning opportunities throughout the life course (34-36). Furthermore, income sufficiency

may be particularly important because it reflects individuals' perceived ability to meet daily needs, which may influence opportunities to engage with health information and health services (37).

Health perception of illness demonstrated a positive association with HL. In addition, older adults who reported greater understanding of their health conditions tended to have higher literacy scores, which is in conformity with conceptual models suggesting that HL and health awareness are closely interconnected (38). Individuals with stronger HL skills may be better able to understand symptoms, interpret medical advice, and evaluate health-related information, resulting in greater confidence in managing their health (21, 31).

The second model focused on HLB-related factors. HL remained significantly associated with HLB after adjustment for socio-demographic and health-related variables, which corroborates previous evidence indicating that HL is related to engagement in health-promoting behaviors, including lifestyle modification, disease prevention, and self-management activities (13, 26, 29). Older adults with higher literacy levels may be better equipped to understand health recommendations and translate health information into daily behavioral practices.

Moreover, health perception of illness was positively linked with HLB. Older adults who reported greater awareness and understanding of their health status tended to report healthier lifestyle behaviors. This finding conforms to health behavior theories that emphasize the importance of personal perceptions and health awareness in motivating behavioral engagement. It is noteworthy that individuals who recognize the importance of maintaining their health may be more likely to adopt behaviors that support long-term well-being (39-41).

Among the socioeconomic variables, family income and income sufficiency remained significant predictors of HLB. These findings are in line with the broader literature on the social determinants of health, which suggests that economic resources influence opportunities to engage in healthy behaviors. Financial security may facilitate access to nutritious food, recreational activities, preventive healthcare services, and other resources that support healthy living (32, 33).

It should be noted that the relationships observed for anthropometric variables require cautious interpretation. Weight showed a positive association with HLB, whereas BMI demonstrated a negative association. These findings may reflect the complex relationship between body composition, aging, and health behavior. In older populations, moderate body weight may be linked with better physical functioning and greater participation in health-promoting activities, while higher BMI may reflect underlying health conditions or functional limitations that restrict behavioral engagement. Due to the cross-sectional nature of the study, the direction of these relationships cannot be established.

Interestingly, age was not significantly related to either HL or HLB in the multivariable models, implying that

differences in literacy and lifestyle behaviors among older adults may be more strongly related to educational, economic, and perceptual factors than to chronological age itself. Similar findings have been reported in studies indicating that age-related differences frequently diminish after accounting for socioeconomic and health-related characteristics (34-38).

Although both regression models were statistically significant, the amount of explained variance was modest. Model 1 explained 23.1% of the variance in HL, whereas model 2 explained 14.1% of the variance in HLB. Based on these findings, additional factors not included in the present study may contribute to literacy and behavioral outcomes among older adults. Social support, self-efficacy, community participation, access to health information technologies, environmental resources, and psychological well-being may provide additional explanatory value and should be considered in future studies accordingly (14, 29).

Overall, the findings highlight the interconnected roles of education, socioeconomic conditions, health perception, and HL in shaping HLBs among older adults. The results support the view that HL functions as an important intermediary factor linking individual and contextual characteristics with behavioral outcomes. Future longitudinal studies should clarify the temporal relationships among these factors and examine potential pathways through which HL contributes to healthy aging (39-41).

The regression model was statistically significant; however, it explained approximately 14% of the variance in health-related behavior ($R^2 \approx 0.14$). Although modest, this level of explanatory power is consistent with behavioral research in aging populations, where health behaviors are shaped by complex and interacting determinants beyond those measured in the present study (22-25). Health behaviors are influenced by a broad range of determinants, including psychological characteristics, social support systems, environmental conditions, cultural norms, access to healthcare services, and broader structural factors. Many of these influences were beyond the scope of the present study (38). Importantly, rather than constructing a fully predictive model, this study examined the explanatory contribution of theoretically grounded variables, particularly HL and selected socio-demographic factors, within a community-based elderly population. The observed R^2 , therefore, reflects the specific contribution of these variables rather than the totality of determinants influencing behavior. Additionally, the relatively modest explanatory power suggests that additional variables such as self-efficacy, social support, environmental facilitators, community engagement, and psychosocial factors should be incorporated in future research in order to provide a more comprehensive understanding of health-related behaviors in older adults. It should be noted that expanding the model to include multi-level or ecological determinants may further enhance predictive accuracy.

HL emerged as a statistically significant correlate of HLB, consistent with Nutbeam's conceptualization of HL as a

functional capacity that enables health-promoting action. Individuals with higher HL may be better equipped to evaluate information, navigate healthcare systems, and implement recommended behaviors (26-29). However, the cross-sectional design precludes causal inference. It is equally plausible that individuals already engaged in healthier behaviors actively seek health information and thus demonstrate higher measured literacy, suggesting potential bidirectionality.

Education presented an interesting discrepancy. While significant in univariate analysis, it was not retained as a significant predictor in the multivariable model. This shift represents that the apparent effect of education may be mediated or shared with HL and socioeconomic factors (13). In older populations, formal educational attainment does not necessarily translate into functional HL, particularly in contexts where access to digital health information and health system navigation skills vary widely (34). The findings reinforce the conceptual distinction between education as a structural resource and HL as an applied capacity.

Anthropometric indicators represented mixed associations. BMI and weight were inversely associated with HLB, aligning with literature linking higher body mass to reduced engagement in certain health-promoting activities (11). However, these associations should not be interpreted as directional effects. They may reflect underlying health constraints, mobility limitations, or chronic disease burdens that simultaneously influence body composition and behavioral engagement. Accordingly, the inverse association between height and HLB warrants careful interpretation. Height is unlikely to exert a direct behavioral influence. Instead, it may function as a proxy for early-life nutritional status or socioeconomic conditions, which have long-term health implications across the life course (29, 34). Alternatively, statistical suppression effects or intercorrelations among anthropometric variables (height, weight, and BMI) may contribute to this pattern when simultaneously included in the regression model. This unexpected finding highlights the importance of cautious interpretation, suggesting the need for future studies to explore life-course and contextual explanations more explicitly.

Economic indicators revealed that income sufficiency, rather than absolute income level alone, was positively associated with HLB, which conforms prior evidence indicating that financial stability is linked with improved access to health resources and behavioral opportunities (32). Subjective financial adequacy may influence behavioral engagement through reduced stress, increased perceived control, or improved access to health-related resources, consistent with broader social determinant frameworks (13, 37). Additionally, marital status was related to HLB, supporting literature emphasizing the role of social integration and structured daily routines in shaping behavioral patterns (33). Social roles may provide accountability, emotional support, and normative expectations that facilitate health-promoting activities.

However, direct measures of social support were not included and should be incorporated in future research.

Age showed a positive association with HLB in this sample, which contradicts some literature linking advanced age to reduced behavioral engagement. Previous studies have reported both positive and negative associations between age and health behavior, depending on contextual and cohort characteristics (34-38). The association observed here may reflect cohort-specific norms, selective survival effects, or generational differences in health awareness rather than age itself as a causal determinant. Given the cross-sectional design, age should be interpreted as statistically associated with HLB rather than predictive of behavioral change.

Overall, the findings emphasize a pattern of statistically significant associations among structural (socio-demographic), perceptual (health perception), and functional (HL) factors and health-related behavior among older adults. Furthermore, the modest explanatory power of the model reinforces the complexity of health behavior in aging populations, indicating that additional psychological, environmental, and social variables should be incorporated in future studies. It is noteworthy that longitudinal designs or structural equation modeling approaches would enable more rigorous examination of potential mediating and reciprocal pathways among education, HL, socioeconomic context, and behavioral engagement.

Limitations of the Study

The study's cross-sectional design limited the ability to infer causality between HL and HLBs. As data were collected at a single point in time, it was difficult to determine whether HL influences lifestyle behaviors or if lifestyle behaviors has any relationship with HL. Furthermore, the use of self-reported data introduced the potential for bias, as participants may provide responses that reflect social desirability or may misremember certain details, leading to recall inaccuracies (39-41). Additionally, the convenience sampling method, while practical, may not perfectly represent the diversity of the elderly population in Pathum Thani, thus limiting the generalizability of the findings to a broader population. Another limitation was the potential for unmeasured confounding variables, such as socio-economic status, mental health conditions, or access to healthcare, which could influence both HL and lifestyle behaviors but were not directly addressed in the study. These factors could have implications for the validity of the study's conclusions and should be considered when interpreting the results. Finally, future studies employing longitudinal designs, objective measurements, and more diverse sampling methods may help overcome these limitations and provide deeper insights into the relationship between HL and lifestyle behaviors (40-41).

Conclusion

This study examined the relationships between socio-demographic factors, HL, and HLBs among older adults in Pathum Thani Province, Thailand. The findings revealed

that HL was associated with educational attainment, family income, income sufficiency, marital status, health perception of illness, and selected anthropometric characteristics. In addition, HL was positively related to HLBs, even after controlling for socio-demographic and health-related factors. Overall, the results indicated that older adults with higher levels of HL tend to report more favorable lifestyle behaviors. Likewise, health perception of illness and socioeconomic factors, particularly family income and income sufficiency, were linked with both HL and HLBs. These findings underscore the importance of considering both individual capabilities and social circumstances when developing health promotion programs for older adults. Given the growing aging population in Thailand, interventions aimed at improving HL may contribute to healthier lifestyle behaviors and support healthy aging. Moreover, community-based health education programs, accessible health communication strategies, and initiatives designed to strengthen older adults' ability to access, understand, and use health information may help improve health outcomes and quality of life. Future research should employ longitudinal designs to further evaluate the pathways linking socioeconomic factors, HL, and HLBs over time.

Implications for Nursing and Midwifery Practice

The findings of this study have significant implications for nursing and midwifery practice. Nurses and midwives are essential in improving HL by delivering clear, culturally appropriate health information in a manner that is easily understood by patients. Moreover, by incorporating effective educational strategies, healthcare professionals can empower elderly individuals to make informed decisions regarding their health and lifestyle. Thus, nurses and midwives should focus on providing health education materials that use simple language and visual aids, encouraging elderly patients to actively participate in managing their health. Given that HL levels vary among individuals, healthcare providers must tailor interventions to meet the specific needs of each patient, incorporating personalized communication strategies such as one-on-one counseling, group discussions, and hands-on activities (26).

Midwives and nurses in community settings can further enhance HL by organizing workshops or educational programs that raise awareness about healthy lifestyles and chronic disease prevention, thus fostering a culture of health promotion. Furthermore, continuous support for self-management is crucial, as HL is related to the ability to manage chronic conditions. Nurses and midwives should provide resources, guidance, and follow-up care to build patients' confidence in making health decisions. Additionally, advocating for policies that prioritize HL in healthcare delivery ensures that educational resources are accessible to vulnerable groups, such as the elderly (27). By integrating HL into public health campaigns, nurses and midwives can significantly improve the well-being of aging populations. In conclusion, enhancing HL among the elderly is vital for improving their health outcomes,

and nurses and midwives are in a key position to foster this improvement, promoting healthier behaviors while reducing the risk of chronic diseases (26).

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Competing Interests

The authors declare that they have no competing interests.

Ethical Approval

This study was approved by the Institutional Review Board of Kanchanaphisek College of Medical Technology and Public Health (approval No. KMPHT-68010002, issued on 22 April 2024). The approval period for this study was set for one year. Moreover, participants were informed that participation was voluntary and anonymous, and that their privacy was protected and their data would be kept secure. Finally, informed consent was obtained from all participants before data collection.

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