

How Different Health Literacy Dimensions Influences Health Status and Well-being among Men and Women: The Mediating Role of Health Behaviors

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Research article

Keywords: gender, health literacy dimensions, health behavior, physical condition, well-being

Posted Date: May 3rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-23168/v1>

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Abstract

Background. Health literacy, the ability to access, understand, evaluate, and apply health information, was found to contribute to positive health outcomes, possibly via promoting healthy behaviors. However, the specific pathways linking different health literacy skills to health and well-being has remained unclear.

Methods. A cross-sectional survey with structural questionnaires was administered among 2236 community-based adults in Hong Kong (mean age = 46.10 ± 19.05). Health literacy was measured by HLS-Asian-47. Participants' health behavior, physical conditions, and well-being were reported.

Results. With structural modeling path analysis, health literacy in finding and understanding information showed a direct effect on enhancing physical health. While applying information capacity had an indirect positive effect via promoting health behaviors, which was moderated by gender. Only among women this indirect effect in predicting fewer physical symptoms and greater well-being was significant.

Conclusions. Although similar patterns were found in physical condition and well-being, distinct direct and indirect pathways were found of different health literacy dimensions for men and women. Based on the findings, by targeting specific health literacy skills, education programs should be developed to enhance women's health knowledge, and men's application of the knowledge in healthy lifestyle.

Background

Health literacy, a concept referring to a set of abilities to access, comprehend, appraise, and apply information to function effectively to promote and maintain health in different contexts (Sørensen et al. 2012), is found to play a key role in individual's health behaviors and health status (Baker et al. 2007; Von Wagner et al. 2009). However, inadequate health literacy was found to have a high prevalence across different countries. For example, research supported by the Agency for Healthcare Research and Quality (AHRQ) has found that approximately one third of Americans only have limited health literacy, and this rate went up to 70% among the individuals aged above 75 (Koenig 2019). A recent systematic review on the prevalence of limited health literacy in Southeast Asia has reported that with a large variation across five countries (i.e., Laos, Malaysia, Myanmar, Singapore, and Thailand), on average, over 50% of the population showed limited health literacy (Rajah et al. 2019), and the rate was even higher in the healthcare settings (67.5%). Similar rate was reported by a recent study conducted in Hong Kong sample (Zhang et al. 2020), with higher prevalence of limited health literacy being found in mainland China. In a study of 1360 participants (aged 15–69) in Shanghai, the prevalence of low health literacy was approximately 85%. In consistent, when looking at the health literacy regarding specific types of disease, it was found that over 70% of people only have limited health literacy about chronic disease (Qian et al. 2019), while about 80% of people do not have adequate health literacy for infectious disease in mainland China (Gao et al. 2018).

Why the prevalence of limited health literacy could be so high in Chinese society? It is possible that the general public has remained unaware about the significance and mechanism of health literacy. In fact, previous literature showed that greater health literacy was consistently associated with various benefits for individual's health outcomes, including more healthcare actions (Von Wagner et al. 2009), better health status (Baker et al. 2007), and well-being (Angner et al. 2010). A systematic review reported that limited health literacy was associated with poorer physical health and higher all-cause mortality rate even after controlling for cognitive functioning (Berkman et al. 2011). People with low health literacy were also more likely to have depressive symptoms (Coffman and Norton 2010; Lincoln et al. 2006) or mental disorders. In addition, inadequate health literacy could lead to low medical adherence among patients with cardiovascular disease (Murray et al. 2004), poor glycemic control in type-2 diabetes (Schillinger et al. 2002), and high hospital admission (Baker et al. 2002).

Besides the effect on physical health, health literacy was also found to affect individual's well-being, although the existing evidence has been relatively thin. In the review by Berkman et al., (2011) only one study showed low health literacy was related to more depressive symptoms after controlling for the possible confounders (Lincoln et al. 2006). By investigating the relationship between health literacy and happiness (Angner et al. 2010). Angner et al., (2010) found inadequate health literacy, in addition to poverty and poor health, was associated with lower level of happiness. However, despite this finding being widely cited, the single-item measurement for health literacy (i.e., "how confident are you in filling out medical forms by yourself") may not be adequate to capture individual's ability to process health-related information, raising potential challenges to the conclusion. Also, the underlying mechanism of how health literacy influences well-being remained unclear. Therefore, future studies addressing the effects of health literacy on well-being are in need.

To explain the positive effect on health, a possible underlying mechanism was that health literacy could promote people's healthy lifestyle and behaviors. Unhealthy lifestyle behaviors, such as smoking, alcohol consumption, or being physically inactive, are found to lead to poorer health and higher mortality rate, that they are direct linked to the top five causes of death (i.e., heart disease, cancer, cerebrovascular disease, respiratory disease, and diabetes) (Mokdad et al. 2004). Fortunately, these risk behaviors were modifiable by certain psychosocial factors such as health literacy. With higher level of health literacy, people are more likely to engage in healthy lifestyle behaviors, including having physical exercise (Suka et al. 2015), reducing the usage of alcohol, as well as getting regular physical examination, etc (Blow et al. 2000; Södergren et al. 2012). However, regarding the relationship between health literacy and dietary habits (Geboers et al. 2014) or smoking behavior (Geboers et al. 2016; Reisi et al. 2014), the finding was rather inconclusive. For example, Geboers et al., (2016) has analyzed the data of 3,241 older adults from the LifeLines Cohort Study, and found inadequate health literacy was associated with poorer health habits such as limited physical activities, insufficient intake of fruit and vegetables, and low alcohol use, but not smoking. It is possible that due to the inconsistency in defining and assessing health literacy, different types of health literacy skills were discussed across studies. Also, due to the multifaceted nature of health literacy, the effects of different dimension on health behaviors could vary. For example, it was found that the capacities of accessing to, comprehending, and applying health-related information were more important for smoking cessation among college students (Panahi et al. 2017), Therefore, instead of general health literacy, the current study would examine the relationships between different health literacy dimensions and health outcomes.

In addition, we would also address the potential gender difference in the effects of health literacy. Past research has found gender difference in various aspects of health. For example, women's life expectancy is usually 4–5 years longer than men, although they are less healthy than men at any age (Bird and Rieker 1999). This could be an outcome of complex biological and social processes. Schünemann et al., (2017) included gender-specific preferences in health

behaviors (e.g., consumptions of tobacco, alcohol, or drug) into the economic model of health deficit accumulation, and found 89% of the gender gap in life expectancy was explained additionally. This behavioral difference, could be mainly driven by the gender difference in health literacy (Sudore et al. 2006; Von Wagner et al. 2009). In particular, the level of health literacy was usually lower among men than women (for a review, see Davey et al. 2015), despite their tendency to over-report the abilities when answering health literacy questions (Lee et al. 2013a). Older women were more likely to watch health-related television programs and have social engagement, which could result in higher health literacy and better health outcomes (Duong et al. 2018). However, how gender would moderate the health behavior pathways between health literacy and outcomes has been relatively unstudied in the existing literature.

To fill the abovementioned research gap, we have collected the data of 2236 adults in Hong Kong to test our hypotheses that health behaviors would at least partially mediate the effects of health literacy on physical health and well-being, and this mediation effect might vary across different genders. By assessing four health literacy skills (HLS-Asia-47), the current study has a three-fold research purpose: 1) to explore how the effects of different health literacy skills were mediated by health behaviors; 2) to test whether the mediation pathway of health behavior differ when predicting physical conditions and well-being; 3) to clarify whether the indirect effects of health literacy are moderated by gender. In addition to providing an updated profile of health literacy level in Hong Kong, the current study also aimed to provide valuable insights for tailoring educational programs to promote general public health.

Methods

Design

A cross-sectional study was conducted with structured questionnaires among individuals living in different districts of Hong Kong. For younger and mid-age adults, the questionnaires were self-administered. For those aged 65 or above, the questionnaires were administered by a trained research assistant, in case they may have difficulties in understanding the questions due to the relatively low level of education. Written consent was obtained at the beginning of the study.

Sample

A random sampling method was used to recruit two thousand and two hundred thirty-six adults from universities, community centers, social and health centers for the elderly all over Hong Kong. Participants were invited via invitation letters and emails, and those who met the following inclusion criteria were recruited: 1) aged 18 or above; 2) native Chinese speaker (including both Cantonese and mandarin, with the majority of the participants being Cantonese speakers); 3) no history of cognitive impairment (according to the record provided by the community center which helped with the recruitment). The ethical approval for the study was obtained from the Human Research Ethics Committee of XXX University (blinded for review).

Measures

Participants' demographic information, including sex (0 = male, 1 = female), age, education (0 = "Primary school or lower", 1 = "secondary school or above"), marital status (0 = single/divorced/widowed; 1 = married), were collected. Participants also reported their health literacy, health behavior, physical symptoms, and well-being.

Health literacy (HL) was measured by the Chinese version of HLS-EU (HLS-Asian-Q Duong et al. 2018). HLS-Asian-Q includes 47 items assessing the information-processing abilities across three domains of health, i.e., health care, disease prevention, and health promotion. Four types of information-processing abilities were evaluated: a) the ability to seek and obtain health information (13 items), b) the ability to understand or comprehend health information (11 items), c) the ability to appraise, interpret, or filter health information (12 items), and d) the ability to communicate or apply the information to maintain and improve health (11 items). Participants were asked to choose from "1" (very difficult) to "4" (very easy) when responding to the items, and the response of "5" (do not know) was coded as missing. The average score of each subscale was generated to indicate the level of HL in different dimensions (van der Heide et al. 2013). For general HL, the mean score of all the items was transformed into an HL index ranging from 0 to 50 according to the formula suggested by the European Health Literacy Project [$I = (\text{Mean} - 1) * 50/3$] (Berens et al. 2016), with an higher score indicating greater HL. Participant were grouped into four levels based on the cutoff value suggested by prior study (HLS-Eu Consortium 2012): an HL index of 0 to 25 indicates the health literacy is "inadequate", and 26 to 33 indicates "problematic"; an index from 34 to 42 indicates "sufficient", and above 42 indicates "excellent" HL. HLS-Asian-Q has been validated in 6 Asian countries including Taiwan, Indonesia, Kazakhstan, Malaysia, Myanmar, and Vietnam (Duong et al. 2018). The Cronbach Alpha in our sample was 0.98, suggesting good internal consistency.

Health behavior was measured by three items asking about individual's smoking, drinking, and physical exercise. Since different Likert scale was used for each behavior, the responses were recoded into dichotomous variables indicating whether the participant is a current user of tobacco (0 = "non-smoker", 1 = "smoker"), alcohol (0 = "non-user of alcohol", 1 = "alcohol user"), or a frequent exerciser (0 = "frequent exerciser, i.e., doing exercise for 30 minutes over 2 times per week"; 1 = "infrequent exerciser"). Three items were combined to generate a total score of health behavior, with higher score indicating more presences of unhealth behaviors, and the total score was used in the pathway analysis.

Individual's well-being was measured by the 5-item World Health Organization well-being index (WHO well-being index, (Heun et al. 2001). It asked participants in the past two weeks, how often they have "felt cheerful and in good spirits", "felt calm and relaxed", "felt active and vigorous", "woken up feeling fresh and rested", and "felt daily life has been filled with interesting things". A 6-point response set was used ("0" = "at no time", and "5" = "all of the time"). Total score was the sum of all five items, and a higher score indicating better well-being. Good reliability was indicated by a Cronbach alpha of 0.89.

The presences of physical symptoms were used to evaluate participants' self-reported physical health (Wong et al. 2006). The presence of 28 physical symptoms and chronic disease were measured, namely hypertension, high blood cholesterol, high blood lipid, diabetes, cardiovascular disease, heart failure, respiratory disease, asthma, thyroid disease, liver disease, rheumatism, arthritis, osteoporosis, other musculoskeletal disease, cancer, depression, anxiety

disorder, mood disorder, other mental health problem, eating disorder, alcoholism, drug abuse, reproductive disease, hearing impairment, visual impairment, limb loss, and other. The total number of "yes" to the health symptoms was obtained to indicate health condition.

Statistical analyses

The Lavaan package in R was used to conduct the structural equation modeling (Rosseel 2012), to test the hypotheses regarding how different dimensions of health literacy influence physical health and well-being, as well as whether health behavior would mediate the associations if there is any. Age, marital status, and education level were controlled as covariates. Pair-wise deletion was used to deal with the missing values in the dataset. The scores of four HL capacities were entered as predictors, with the presence of physical symptoms and well-being index as outcome variables. Gender was also included in the pathway between health literacy capacities to health behavior, to test this moderated mediation effect. The hypothesized model was displayed in Fig. 1.

Results

Two thousand and two hundred thirty-six adults (aged from 18 to 93, mean = 45.07 ± 19.05) participated in the survey. Approximately half of the participants were female (53.8%) and married (55.1%), with the majority having secondary education or above (79.7%, for details, see Table 1). The average number of reported physical symptoms was 1.20 (SD = 1.56), and the total score of well-being was 14.84 (SD = 4.85). The average number of unhealthy behaviors are 0.91 (SD = 0.90). By adopting the formula to transform the HL rating, the average HL score was 31.24 (SD = 8.61). Based on this score, participants were categorized into four groups of HL, 20.7% were in the inadequate HL group, 35.2% in problematic HL group, 34.5% in sufficient HL group, and 9.6% reported an excellent level of HL (see Table 1). Since gender was proposed as a moderator, we have tested the gender difference in having limited HL (inadequate and problematic) and adequate HL (sufficient and excellent), and the results showed that there were more women being in the limited HL group compared with men ($\chi^2 = 4.23, p = 0.04$). Across four domains of HL, evaluating information was perceived as the most difficult (mean per item was 2.76, SD = 0.59), while applying information was perceived as the easiest (mean per item was 2.95, SD = 0.52).

Table 1
The descriptive results of demographic information, health literacy, health behaviors, and health status

	Mean (SD)	Range	No. of Missing
Age	46.10 (19.5)	[18–93]	0
Gender (% of women)	53.8%		1
Education (% of having secondary education or above)	79.7%		0
Marital status (% of married)	55.1%		0
Total number of unhealthy behaviors	0.91 (0.9)		
% of smokers	23.0%		5
% of alcohol users	33.7%		21
% of non-frequent exercisers	48.3%		7
No. of health conditions	1.13 (1.56)	[0–15]	2
Well-being	14.84 (4.85)	[0–25]	3
Health literacy	31.25 (8.61)	[0–50]	7
Insufficient HL (%)	20.7%		
Problematic HL (%)	35.2%		
Sufficient HL (%)	34.5%		
Excellent HL (%)	9.6%		
	Mean per item (SD)		
Finding information	2.88 (0.57)		11
Understanding information	2.92 (0.55)		8
Evaluating information	2.76 (0.59)		14
Applying information	2.95 (0.52)		8

The correlations among predictors, mediator, moderator, and health outcomes were displayed in Table 2. Path analysis using structural equation modeling approach was performed to examine the goodness-of-fit of the hypothesized path model predicting individual's health outcomes, including total number of physical symptoms and sum score of well-being. The two outcome variables were regressed on individual's age, education, marital status, gender, and HL capacities (i.e., finding information, understanding information, evaluating information, and applying information). By using the Lavaan package in R, the goodness-of-fit of the hypothesized model was considered good (chi-square value $\chi^2 = 28.163$, degree-of-freedom $df = 9$, $p = 0.001$, RMSEA = 0.03, SRMR =

0.005, CFI = 0.988, NNFI = 0.952). The structural relationships with standardized path coefficients among the variables are presented in Fig. 2 (only significant paths were included).

Table 2
The correlation matrix among Health literacy, health behavior, and health outcomes

	Education	Marital status	Gender	HL total	HL_finding info	HL_understanding info	HL_evaluating info	HL_applying info	Health behavior	Physical symptom	Well-being
Age	-0.614**	0.390**	0.049*	-0.304**	-0.348**	-0.315**	-0.248**	-0.213**	-0.146**	0.553**	0.080**
Education	1										
Marital Status	-0.111**	1									
Gender	-0.106**	-0.047*	1								
HL total	0.366**	-0.045*	-0.023	1							
HL_finding info	0.384**	-0.052*	-0.020	0.936**	1						
HL_understanding Info	0.364**	-0.066*	-0.020	0.947**	0.859**	1					
HL_evaluating Info	0.343**	0.016	-0.040	0.927**	0.823**	0.837**	1				
HL_applying info	0.269**	-0.076**	-0.002	0.909**	0.790**	0.836**	0.782**	1			
Health behavior	0.128**	-0.009	-0.235**	-0.142**	-0.120**	-0.135**	-0.098**	-0.188**	1		
Physical symptoms	-0.456**	0.148**	0.143	-0.370**	-0.406**	-0.374**	-0.313**	-0.281**	0.028	1	
Well-being	-0.023	0.076**	0.059**	0.253**	0.218**	0.218**	0.225**	0.285**	-0.203**	-0.057**	1

Note: Edu = education (0= "Primary school or lower", 1= "secondary school or above"), marital status (0 = single/divorced/widowed; 1 = married), gender (0 = male,1 = female), HL = health literacy, HL_finding info = Health literacy in finding information, HL_understanding info = health literacy in understanding information, HL_evaluating info = health literacy in evaluating information, HL_applying info = health literacy in applying information; higher score of "health behaviors" indicated more presence of unhealthy behaviors.

"*": $p < 0.05$; "**": $p < 0.01$; "***": $p < 0.001$

Table 3
The moderated mediation model of health literacy in predicting physical symptoms

	B (95% CI)	p-value
Association between HL dimensions and Physical symptoms (DV: <i>Physical symptoms</i> #; IV: HL dimensions)		
HL_finding information	-0.569***	< 0.001
HL_understanding information	-0.385**	0.001
HL_evaluating information	0.113	0.220
HL_applying information	0.196	0.193
Association between HL dimensions and health behaviors (DV: <i>health behaviors</i> #; IV: HL dimensions; moderator: gender)		
HL_finding information	-0.180	0.070
HL_understanding information	-0.083	0.478
HL_evaluating information	0.144	0.125
HL_applying information	-0.198*	0.047
HL_finding information × gender	0.160	0.237
HL_understanding information × gender	-0.003	0.984
HL_evaluating information × gender	0.059	0.631
HL_applying information × gender	-0.333**	0.010
Association between health behaviors and physical symptoms (DV: <i>physical symptoms</i> #; IV: <i>health behaviors</i>)		
Health behavior	0.118***	< 0.001
Indirect effects of HL dimensions via health behaviors in men and women (DV: <i>physical symptoms</i> #; mediator: health behaviors)		
Men: HL_finding information	-0.021	0.108
HL_understanding information	-0.010	0.485
HL_evaluating information	0.017	0.155
HL_applying information	-0.023	0.088
Total effect	-0.583***	< 0.001
Women: HL_finding information	-0.002	0.829
HL_understanding information	-0.010	0.415
HL_evaluating information	0.024*	0.035
HL_applying information	-0.063**	0.001
Total effect	-0.597***	< 0.001
# Physical symptom was adjusted for age, education, and marital status.		
DV: dependent variable of the underlying regression model		
IV: independent variable of the underlying regression model		
B: regression coefficient		
CI: confidence interval		
HL: Health literacy		

Table 4
The moderated mediation model of health literacy in predicting well-being

	B (95% CI)	p-value
Association between HL dimensions and well-being (DV: well-being #; IV: HL dimensions)		
HL_finding information	0.399	0.280
HL_understanding information	-0.632	0.133
HL_evaluating information	0.283	0.395
HL_applying information	2.564***	< 0.001
Association between HL dimensions and health behaviors (DV: <i>health behaviors</i> #; IV: HL dimensions; moderator: gender)		
HL_finding information	-0.180	0.070
HL_understanding information	-0.083	0.478
HL_evaluating information	0.144	0.125
HL_applying information	-0.198*	0.047
HL_finding information × gender	0.160	0.237
HL_understanding information × gender	-0.003	0.984
HL_evaluating information × gender	0.059	0.631
HL_applying information × gender	-0.333**	0.010
Association between health behaviors and well-being (DV: <i>well-being</i> #; IV: <i>health behaviors</i>)		
Health behavior	-0.729***	< 0.001
Indirect effects of HL dimensions via health behaviors in men and women (DV: <i>well-being</i> #; mediator: <i>health behaviors</i>)		
Men: HL_finding information	0.131	0.088
HL_understanding information	0.061	0.480
HL_evaluating information	-0.105	0.136
HL_applying information	0.144	0.067
Total effect	2.845***	< 0.001
Women: HL_finding information	0.014	0.828
HL_understanding information	0.063	0.408
HL_evaluating information	-0.149*	0.018
HL_applying information	0.387***	< 0.001
Total effect	2.931***	< 0.001
# Well-being was adjusted for age, education, and marital status.		
DV: dependent variable of the underlying regression model		
IV: independent variable of the underlying regression model		
B: regression coefficient		
CI: confidence interval		
HL: Health literacy		

In consistent with previous literature, health literacy capacities have direct effects on health outcomes. After adjusting for education, age, and marital status, higher level of HL in finding and understanding information was associated with fewer physical symptoms (HL_finding information: $\beta = -0.569, p < .001$; HL_understanding information: $\beta = -0.385, p = .001$); and higher level of health literacy in applying information was associated with greater subjective well-

being ($\beta = 2.564, p < .001$). In addition, health behaviors (i.e., the number of unhealthy lifestyle behaviors) was also found to mediate the effect of health literacy on physical health and well-being. In particular, the capacities of finding and applying health-related information was associated with fewer unhealthy behaviors (HL_finding information: $\beta = -0.180, p = 0.07$; HL_applying information: $\beta = -0.198, p = 0.05$), with the effect of HL_applying information being moderated by gender ($\beta = -0.333, p = 0.01$). Meanwhile, more unhealthy behaviors were related with more physical symptoms ($\beta = 0.118, p < .001$) and lower subjective well-being ($\beta = -0.729, p < .001$).

To probe the moderating effect of gender, the indirect effects of health literacy in applying information were compared among men and women. The results showed that among men, the capacity of applying information has marginally significant indirect effects on physical health and well-being (physical health: $\beta = -0.023, p = 0.088$; well-being: $\beta = 0.144, p = 0.067$). However, among women, the indirect effects on physical symptoms and well-being are both significant, such that via reducing unhealth behaviors, the capacity of applying information was associated with fewer physical symptoms ($\beta = -0.063, p = 0.001$) and greater well-being ($\beta = 0.387, p < 0.001$).

Discussion

Health literacy was found to be a key contributor to individual's health. Although the related changes in health behaviors were proposed to be an underlying mechanism of the health literacy, limited evidence has been found regarding the mediating role of health behavior. By conducting a large-scale survey in Hong Kong, the current study has tested a moderated mediation model of health literacy predicting physical health and well-being through influencing health behaviors. Furthermore, we have looked at the effects of specific health literacy skills, i.e., finding, understanding, evaluating, and applying health-related information.

With a sample of 2236 adults, we found the prevalence of limited HL was 55%, which was close to the average levels in Malaysia and Singapore (Rajah et al. 2019). The prevalence of limited HL was higher among women than men, which was inconsistent with the previous findings that men actually have lower level of HL (Kaneko and Motohashi 2007; Sudore et al. 2006). It might be because that men's education level was higher in our sample ($\chi^2 = 24.99, p < 0.001$), which was associated with better health literacy. It is also possible that as mentioned by Lee et al., (2013b) men may use over-reporting style when answering health literacy questions, thus leading to a higher HL score. The structural modeling analysis showed similar patterns of health literacy were found in predicting physical health and well-being. While different health literacy capacities had different direct and indirect effects on health behaviors and outcomes. The health literacy in finding and understanding information showed a direct effect in predicting fewer physical symptoms, and health literacy in applying information was directly associated with greater well-being. As for the indirect effect via health behavior, only health literacy in applying information showed a significant result, which was moderated by gender. Despite similar patterns were found, the indirect effect of the applying information capacity on promoting health and well-being was significant among women.

This is the first study to test how the direct and indirect effects of health literacy vary across the four dimensions. As aforementioned, previous literature among college students showed that understanding and applying health information had stronger effect in promoting people's smoking cessation behaviors (Panahi et al. 2018). In line with this, our findings suggested that finding and understanding information were associated with fewer self-report physical symptoms, while applying information had a moderated mediation effect, that only among women the indirect positive effect reached significant level. The results suggested that the capacities of finding and understanding information may influence our health in a more direct and general way, while the applying ability of health information may function via modifying our behavior, particularly for women. It is probably because applying information (e.g., "make decisions to improve your health", "Join a sport club or exercise class") is usually the last step when making health decision, and it is more closely related to taking-action. Therefore, this is the only domain that had an indirect effect on health outcomes via health behaviors.

The mediating role of health behaviors is consistent with the previous pathway model linking health literacy to health outcome in the patient population, which suggested that health literacy functions mainly in three domains, including the access to and use of health care, patient-provider interaction, and patient's self-care (Osborn et al. 2011; Paasche-Orlow and Wolf 2007). The health behaviors that we have focused on fell into the domain of self-care. In line with previous studies showing that health literacy is associated with being physically active, taking balanced diet, and lower usage of tobacco and alcohol (Geboers et al. 2016; Liu et al. 2018), our study also showed that across different age groups, the health literacy, especially better ability in applying health information, would reduce unhealth behaviors thus benefiting physical health and well-being via promoting self-care agency. Furthermore, this indirect effect of health literacy only reached significance level among women, potentially suggesting that with sufficient health information, women could more readily apply them to modify their behaviors toward a healthier lifestyle. Men, on the other hand, may need to be motivated to transform the health information they have into actions.

Though our findings provided evidence for how health literacy influences health status and well-being through behaviors, there are several limitations to be acknowledged. First, the health status was measured by self-reported physical symptoms, which could be influenced by individual's personal reporting styles, and may not accurately capture the health condition of the individual. Future studies should adopt more objective measures, such as medical record or physiological measures to see if the influences of health literacy will still be found. Second, we have only collected cross-sectional data in the current study, which may not be sufficient to support the causal relationship between health literacy and health outcomes, in other words, there might be a reciprocal association between the two. For example, a previous study has found that people with chronic disease may have higher level of health literacy, which would prevent them from developing more chronic symptoms (Qian et al. 2019). Therefore, longitudinal data is needed to further clarify the interplay between health literacy and health outcomes.

Conclusion

To conclude, the current study provided supportive evidence that promotions for health literacy is still urgent for Hong Kong population, such that over 50% of the lay public showed a limited level of health literacy, and this prevalence is a little higher among women. In addition, by addressing specific direct and

indirect effects of four dimensions of health literacy on physical health and well-being, the findings showed that better perceived capacities in finding and understanding health information could lead to better physical health, while better capacity in applying health information is associated with healthier lifestyle. Based on the findings, more educational programs to advocate health knowledge and increase awareness of healthy lifestyle should be developed for the lay public. In particular, effort should be paid to enhance women's general health literacy, and to motivate men to apply their health knowledge in behavior modifications.

Abbreviations

Agency for Healthcare Research and Quality (AHRQ)

Health literacy (HL)

HL_finding info: Health literacy in finding information

HL_understanding info= health literacy in understanding information

HL_evaluating info= health literacy in evaluating information

HL_applying info= health literacy in applying information

Declarations

Ethics approval and consent to participate

The ethical approval for the study was obtained from the Human Research Ethics Committee of The Education University of Hong Kong, and participants have provided written consent before taking part in the study.

Consent to publish

Not applicable

Availability of data and materials

Derived data supporting the findings of the study is available from the corresponding author on request.

Competing interests

There was no competing interest that need to be declared.

Funding

This study was funded through Dean's Strategies Research Area (grant number 04187). The funder has no role in study design, data collection and analysis, or preparation of manuscript

Authors' Contributions

ZF has analyzed and interpreted the data, as well as written and edited the manuscript. PO was a major contributor in generating the research idea, collecting data, and editing the manuscript. JC was also a contributor in generating the research idea and data collection.

All authors have read and approved the final version of the manuscript.

Acknowledgements

The author would like to thank Prof. Cheng Sheung-Tak for his constructive suggestions and help for the manuscript.

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Figures

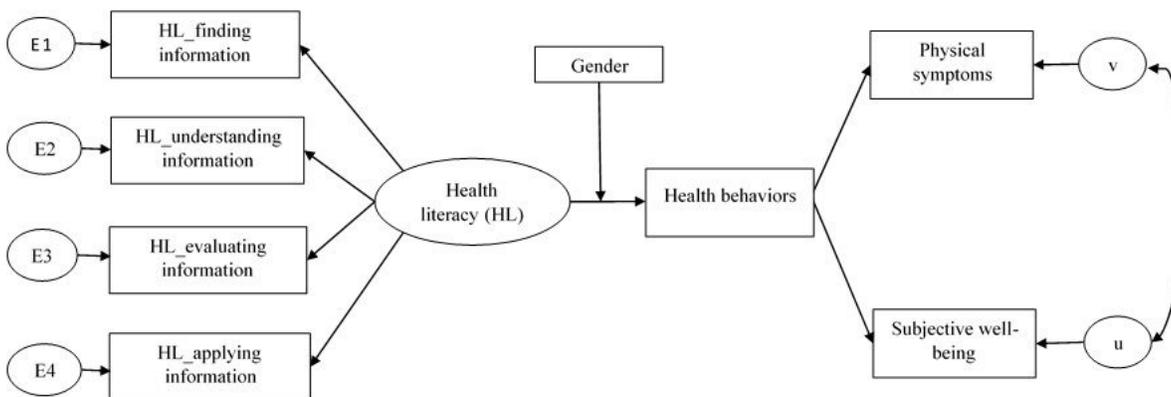


Figure 1

The hypothesized model of health literacy, health behaviors, and health outcomes

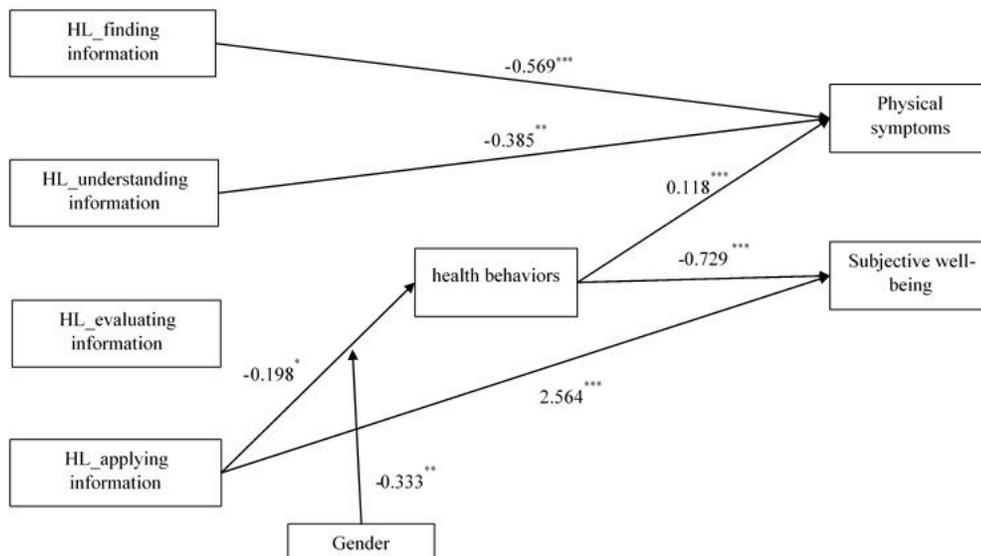


Figure 2

The structural model of health literacy predicting physical health and well-being (Note: health behavior, physical symptom and well-being were adjusted for individual's age, educational level, and marital status)

Supplementary Files

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