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Analyzing Associations Between Health Literacy, Physical Literacy, and Physical Activity: A Structural Comparison of Exercising and Non-Exercising Older Women

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Abstract

Health literacy (HL) and physical literacy (PL) are hypothesized to be important determinants of physical activity (PA) in older individuals. The aim of the study was to evidence possible associations between PL, HL, and PA, evidencing structural comparison of exercising and nonexercising postmenopausal women. The sample included 62 females (+60 years of age) divided into exercising (E; n=37) and nonexercising groups (NE; n=25). Participants were tested on HL (via the European Health Literacy Survey Questionnaire), PL (via the Perceived Physical Literacy Questionnaire), and PA (via the Nordic Physical Activity Questionnaire – short) in controlled settings. Group-specific Pearson's correlation matrices were calculated to examine associations among PL, HL, and PA. Between-group differences in correlations were tested using Fisher's z-transformation with false discovery rate correction, and structural patterns were further explored using correlation network analysis. Fisher's z tests identified significant between-group differences in selected associations, with E women showing a stronger bridging role of PL and weaker cognitive constraints on PA. Network analyses further demonstrated greater connectivity and cognitive dominance in NE women, whereas E women exhibited more differentiated and functionally organized relational structures. The results suggest that PA-related interventions targeting older women should move beyond information provision and explicitly promote PL development.

Keywords: *aged women, motor skills, exercise, qualitative differences*

Introduction

Maintaining functional independence is a crucial goal of healthy aging, and regular physical activity (PA) is one of its most important determinants. Specifically, regular PA has been shown to reduce the risk of cardiovascular disease in older adults and is associated with improved glycemic control and a lower incidence of type 2 diabetes (Bull et al., 2020; Colberg et al., 2016; Lear et al., 2017). Furthermore, PA has been shown to improve and preserve bone mineral density and reduce osteoporotic fracture risk in older women, and higher levels of PA are linked with a reduced risk of sarcopenia and age-related loss of muscle function (Howe et al., 2011; Peterson, Sen, & Gordon, 2011). Last but not least, there is evidence that PA is associated with reductions in depressive symptoms in older adults (Mura & Carta, 2013). Despite all the benefits, PA levels decline with age, particularly among older women, and many do not meet recommendations of at least 150–300 minutes of moderate intensity aerobic PA per week or 75–150 minutes of vigorous intensity PA combined with resistance training two or more days per week (Sun, Norman, & While, 2013). It is generally accepted that there is a clear gap between the known health benefits of PA and actual PA-related behavior across different age groups, which suggests that there are deeper psychosocial factors influencing engagement in PA in older age.

One determinant that could be associated with PA levels in older age is physical literacy (PL). The PL can be described as the motivation, confidence, physical competence, knowledge, and understanding to take value and responsibility for engagement in PA (Whitehead, 2010). In older adults, PL has been linked to functional movement capacity and perceived ability to perform daily physical tasks, while higher PL may also support confidence in participation in structured exercise and community-based activity programmes (Edwards, Bryant, Keegan, Morgan, & Jones, 2017). However, findings suggest that PL alone may not always be strongly correlated with PA levels in older women (Flegar et al., 2025). This implies that other factors may also be of importance.

Another possible determinant of PA in older adults is health literacy (HL). HL refers to the ability to access, understand, appraise, and apply health-related information in ways that support positive health decisions (Geets-Kesić, Maras, & Gilić, 2023; Sorensen et al., 2012). Among adults, better HL has been associated with greater participation in PA and other positive health behaviors (Van Der Heide et al., 2013). Additionally, systematic reviews indicate that inadequate HL is linked with a lower chance of engaging in PA in older populations, suggesting that individuals with higher HL are more likely to meet activity recommendations than those with limited literacy (Lim, van Schooten, Radford, & Delbaere, 2021). In studies investigating older women, higher levels of HL, including comprehension and decision making, influence engagement in PA (Babak, Majid, Rashid, Leili, & Shahryar, 2022). However, it is important to note that HL alone is not the only guarantee for consistent PA behavior in older adults. It has been shown that environmental factors, social support and health system levels all influence behavior and that HL should not be considered an isolated term (McCormack, Thomas, Lewis, & Rudd, 2017). Collectively, the current findings suggest that HL and PL can support PA engagement, but in contexts that allow individuals to use that knowledge and their abilities.

The association between HL and PL with PA is a problem worth studying, particularly in postmenopausal women. Namely, postmenopausal women experience an increased risk of cardiometabolic diseases, osteoporosis, sarcopenia, falls, and functional and cognitive decline, all of which contribute to reduced independence (Chavez, Scales, & Kling, 2021). Meanwhile, regular PA has been shown to improve bone mineral density and reduce fracture risk in postmenopausal women, particularly with resistance training (Linhares et al., 2022). In addition, exercise interventions targeting strength, balance, and coordination significantly reduce fall risk and improve neuromuscular function in older women (Bull et al., 2020). Furthermore, evidence indicates that regular PA is associated with improved mood and cognitive functioning in older women (Mura & Carta, 2013; Wang, Lii, Hsu, Ho, & Yeh, 2025). Finally, continuous engagement in PA is linked with better quality of life and prolonged independence, even among women with preexisting chronic conditions (Chavez et al., 2021). These findings highlight the importance of identifying determinants of PA behavior, such as PL and HL, to develop effective strategies to promote active and healthy aging among older women.

From the previous literature overview, it is clear that the association between PL, HL and PA in postmenopausal women is a problem worth studying, but to the best of our knowledge, studies have rarely investigated PL and HL as simultaneous correlates of PA in postmenopausal women. In one of the rare studies, the authors recently investigated the correlations between HL and PL as predictors of PA in 60+ females and reported a significant correlation between facets of HL and PA, with no significant association between PL and PA (Flegar et al., 2025). However, this study observed a mixed sample of women and included those who were involved in recreational PA programs and those who were not included in such programs. Naturally, this specific clustering could influence the observed associations, resulting in a covariate effect of "involvement in physical exercising" (i.e., those women involved in recreational exercising logically have higher PA, irrespective of the eventual influence of HL and PL). Therefore, the aim of this study was to evaluate and compare the associations between HL, PL, and PA among postmenopausal women, emphasizing the differences in their current PA status. Specifically, we observed two subsamples: one consisted of women actively involved in recreational PA, and the age-matched subsample consisted of women who were not involved in any form of PA. To extend current knowledge, this study will not only assess correlations between PL, HL, and PA but also examine whether the structure of these relationships differs based on participation in a recreational PA program. By comparing correlation patterns across two distinct subsamples, we aim to uncover potential structural differences that may be masked in aggregated analyses. We hypothesized that the correlations would significantly differ between subsamples.

Methods

Participants

The study sample consisted of 62 women aged 60 to 80 years (71.3±4.5 years) from the city of Split, located in southern Croatia. Considering the substantial influence of sociocultural factors on HL, PL, and PA, participants were recruited from a single geographical region to minimize sociocultural variability within the sample. The participants varied in health status and included individuals without major health conditions as well as those with chronic illnesses, such as diabetes, cardiovascular disease, and arthritis. All participants were physically capable of independently visiting the testing center, indicating adequate functional mobility and independence. The total sample was divided into two groups according to participants' exercise status. The first group comprised exercising participants (E; n=37, those who participated in regular organized physical exercise programs for more than 2 months). The second group consisted of age-matched nonexercising females (NE; n=25).

Participants were personally invited to take part in the study as part of a research project conducted at the Faculty of Kinesiology, University of Split. Prior to data collection, they were informed that participation was voluntary and that they could withdraw at any time without consequence. The potential benefits and risks of participation were explained, and written informed consent was obtained from all participants.

The inclusion criteria were female sex, age 60 years or older, residence in the city of Split, sufficient functional independence to attend the testing sessions independently, and adequate cognitive capacity to understand and complete the health literacy and physical literacy questionnaires. Exclusion criteria included age below 60 years, cognitive impairment preventing questionnaire completion, and insufficient motor function or independence to attend the testing center. The study protocol was approved by the Ethics Committee of the University of Split, Faculty of Kinesiology.

Variables

Apart from age, variables in this study included PL and HL indices and PA. The PL was assessed using the Perceived Physical Literacy Questionnaire for South Eastern Europe (PPLQ-SEE) (Gilic, Sekulic, Munoz, Jaunig, & Carl, 2025). The questionnaire consists of 24 items organized into six domains: (i) physical competence, (ii) understanding, (iii) motivation, (iv) confidence, (v) knowledge, and (vi) physical activity behavior. Items within the first four domains are rated on a six-point Likert scale ranging from strongly agree to strongly disagree (5–0), whereas the PL-knowledge domain includes items with dichotomous response options (true–false). In the present study, five subdomains (PL-competence, PL-understanding, PL-motivation, PL-confidence, and PL-knowledge) along with the overall score (PL-total) were used as indicators of participants' physical literacy.

HL was measured using the validated Croatian version of the European Health Literacy Survey Questionnaire (HLS-EU-Q) (Blažević, Blazevic, & Sekulic, 2024; Geets-Kesić et al., 2023; Sestan, Zovko, & Sekulic, 2025). This instrument evaluates individuals' ability to access, understand, appraise, and apply health-related information, as well as to navigate health services and make informed health decisions. The following subscales were included in the analyses: (i) accessing healthcare-related information (HC-AC), (ii) understanding healthcare-related information (HC-U), (iii) appraising healthcare-related information (HC-AP), (iv) applying healthcare-related information (HC-APPL), (v) accessing disease prevention–related information (DP-AC), (vi) understanding disease prevention–related information (DP-U), (vii) appraising disease prevention–related information (DP-AP), (viii) applying disease prevention–related information (DP-APPL), (ix) accessing health promotion–related information (HP-AC), (x) understanding health promotion–related information (HP-U), (xi) appraising health promotion–related information (HP-AP), and (xii) applying health promotion–related information (HP-APPL). A composite health literacy index (HL-total) was calculated using a 4-point Likert scale with response options ranging from very difficult (1) to very easy (4). Index scores were computed using the formula: index=(mean−1)×(50/3), resulting in a standardized scale from 0 (lowest HL) to 50 (highest HL) (Sorensen et al., 2012).

PA levels were measured with the short version of the Nordic Physical Activity Questionnaire (NPAQ-short), which estimates engagement in moderate-to-vigorous (MVPA) and vigorous PA (VPA) (Danquah, Petersen, Skov, & Tolstrup, 2018). Participants reported the total time spent in PA during leisure and transportation time. Weekly minutes of MVPA and VPA were calculated.

Statistics

Participants were categorized into exercising (E) and nonexercising (NE) groups based on their current participation in organized recreational physical activity. Separate Pearson correlation matrices were computed for each group to examine bivariate associations among physical literacy (PL), health literacy (HL), and physical activity (PA) indicators.

Between-group differences in corresponding correlation coefficients were tested using Fisher's z-transformation. A total of 231 correlations were compared. To control for inflation of Type I error due to multiple testing, false discovery rate (FDR) correction was applied. Correlations remaining significant after FDR adjustment were interpreted as robust between-group differences, whereas uncorrected findings were treated as exploratory.

To further examine structural differences between groups, correlation network analyses were conducted separately for the E and NE samples. Networks were constructed using a threshold of $|r|\geq 0.30$ to retain moderate-to-strong associations. Network characteristics, including the number of edges, density, and average degree, were calculated and compared descriptively. Visual representations were generated using force-directed layouts.

All statistical analyses were performed using Statistica version 14.5 (Tibco Inc. Palo Alto, CA, USA) and Python-based analytical tools. The level of statistical significance was set at $p<0.05$.

Results

Bivariate correlations among PL, HL, and PA indicators for the NE and E groups are presented in Tables 1 and 2, respectively.

Table 1. Pearson's correlation between study variables for the nonexercising group (coefficients > 0.38 are significant at $p < 0.05$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PL-competence (1)	-																			
PL-understanding (2)	-0.07	-																		
PL-motivation (3)	-0.08	-0.03	-																	
PL-confidence (4)	0.09	0.05	0.10	-																
PL-knowledge (5)	-0.30	0.17	0.05	0.48	-															
PL-total (6)	0.26	0.16	0.55	0.80	0.52	-														
HC-AC (7)	0.13	0.38	0.06	-0.15	0.11	0.07	-													
HC-U (8)	0.01	0.51	0.04	-0.05	0.25	0.14	0.88	-												
HC-AP (9)	-0.04	0.62	-0.20	-0.04	0.08	-0.04	0.74	0.77	-											
HC-APPL (10)	0.26	0.55	0.00	0.06	-0.06	0.17	0.80	0.82	0.78	-										
DP-AC (11)	-0.05	0.43	-0.23	-0.22	0.03	-0.20	0.80	0.72	0.80	0.76	-									
DP-U (12)	0.11	0.63	-0.24	0.13	0.22	0.13	0.76	0.83	0.73	0.86	0.78	-								
DP-AP (13)	-0.07	0.71	-0.02	0.17	0.19	0.20	0.71	0.70	0.78	0.79	0.79	0.86	-							
DP-APPL (14)	-0.37	0.39	-0.36	-0.09	0.09	-0.29	0.50	0.39	0.70	0.43	0.76	0.53	0.67	-						
HP-AC (15)	-0.13	0.65	-0.10	-0.14	0.06	-0.08	0.61	0.57	0.67	0.68	0.71	0.72	0.76	0.58	-					
HP-U (16)	-0.23	0.37	-0.35	-0.32	-0.06	-0.41	0.63	0.50	0.70	0.52	0.76	0.56	0.59	0.82	0.81	-				
HP-AP (17)	0.09	0.51	-0.06	-0.19	0.06	-0.03	0.82	0.83	0.66	0.78	0.79	0.84	0.71	0.48	0.80	0.73	-			
HP-APPL (18)	0.24	0.45	-0.04	-0.46	-0.42	-0.27	0.43	0.27	0.53	0.42	0.52	0.33	0.41	0.33	0.45	0.38	0.38	-		
HL-total (19)	-0.03	0.62	-0.16	-0.15	0.05	-0.08	0.87	0.82	0.89	0.85	0.93	0.87	0.88	0.74	0.85	0.82	0.88	0.55	-	
MOD-VIG PA (20)	0.10	-0.15	0.39	0.49	0.17	0.54	-0.17	-0.19	-0.37	-0.20	-0.46	-0.18	-0.14	-0.54	-0.38	-0.62	-0.40	-0.17	-0.40	-
VIG PA (21)	-0.04	-0.35	-0.08	-0.32	-0.27	-0.36	0.09	0.00	-0.25	-0.12	-0.04	-0.11	-0.17	0.07	-0.18	0.08	0.05	-0.31	-0.09	-0.32

PL – physical literacy, HC-AC – accessing healthcare-related information, HC-U – understanding healthcare-related information, HC-AP – appraising healthcare-related information, HC-APPL – applying healthcare-related information, DP-AC – accessing information related to disease prevention, DP-U – understanding information related to disease prevention, DP-AP – appraising information related to disease prevention, HP-APPL – applying information related to disease prevention, HP-AC – accessing information related to health promotion, HP-AP – appraising information related to health promotion, HP-U – understanding information related to health promotion, HP-APPL – applying information related to health promotion, MOD-VIG PA – moderate to vigorous physical activity, VIG PA – vigorous physical activity.

Table 2. Pearson's correlation between study variables for the exercising group (coefficients >0.33 are significant at $p < 0.05$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PL-competence (1)	-																			
PL-understanding (2)	-0.09	-																		
PL-motivation (3)	0.10	0.26	-																	
PL-confidence (4)	-0.14	0.18	0.01	-																
PL-knowledge (5)	-0.20	0.14	-0.21	0.31	-															
PL-total (6)	0.56	0.32	0.30	0.57	0.42	-														
HC-AC (7)	-0.06	0.41	0.19	0.23	0.01	0.19	-													
HC-U (8)	0.14	0.11	0.22	0.20	-0.30	0.14	0.35	-												
HC-AP (9)	0.13	0.25	0.14	0.35	-0.06	0.32	0.45	0.56	-											
HC-APPL (10)	-0.04	0.05	0.22	0.21	-0.11	0.10	0.44	0.72	0.63	-										
DP-AC (11)	0.15	0.32	0.22	0.24	0.03	0.35	0.64	0.40	0.74	0.55	-									
DP-U (12)	-0.05	0.27	0.24	0.25	0.12	0.25	0.23	0.49	0.51	0.69	0.50	-								
DP-AP (13)	0.03	0.32	0.06	0.33	-0.04	0.23	0.38	0.46	0.70	0.50	0.56	0.54	-							
DP-APPL (14)	-0.05	0.17	0.20	0.29	-0.11	0.14	0.04	0.38	0.31	0.30	0.20	0.26	0.49	-						
HP-AC (15)	0.08	0.21	0.03	0.29	-0.04	0.22	0.51	0.32	0.64	0.42	0.64	0.33	0.71	0.34	-					
HP-U (16)	0.04	0.26	0.04	0.08	-0.07	0.09	0.32	0.45	0.59	0.54	0.58	0.53	0.69	0.43	0.66	-				
HP-AP (17)	0.06	0.24	0.22	0.24	-0.18	0.18	0.48	0.35	0.54	0.51	0.62	0.58	0.53	0.25	0.44	0.53	-			
HP-APPL (18)	-0.07	0.15	0.14	0.45	-0.08	0.21	0.22	0.46	0.54	0.56	0.38	0.71	0.72	0.43	0.48	0.44	0.56	-		
HL-total (19)	0.05	0.32	0.20	0.36	-0.09	0.28	0.60	0.67	0.83	0.76	0.79	0.69	0.85	0.50	0.79	0.79	0.71	0.72	-	
MOD-VIG PA (20)	0.13	-0.06	-0.06	-0.04	-0.06	0.02	-0.04	-0.18	-0.16	-0.28	-0.09	-0.25	-0.16	-0.12	-0.04	-0.20	-0.09	-0.28	-0.21	-
VIG PA (21)	0.25	0.10	0.07	0.21	-0.09	0.27	0.13	0.16	0.36	0.16	0.30	0.23	0.49	0.37	0.40	0.38	0.35	0.37	0.43	-0.11

PL – physical literacy, HC-AC – accessing healthcare-related information, HC-U – understanding healthcare-related information, HC-AP – appraising healthcare-related information, HC-APPL – applying healthcare-related information, DP-AC – accessing information related to disease prevention, DP-U – understanding information related to disease prevention, DP-AP – appraising information related to disease prevention, HP-APPL – applying information related to disease prevention, HP-AC – accessing information related to health promotion, HP-AP – appraising information related to health promotion, HP-U – understanding information related to health promotion, HP-APPL – applying information related to health promotion, MOD-VIG PA – moderate to vigorous physical activity, VIG PA – vigorous physical activity.

In the NE group, correlations were generally stronger and more homogeneous, particularly among HL subscales, which demonstrated high intercorrelations. Several PL domains also exhibited moderate-to-strong associations with PA indicators. In contrast, the E group displayed a more differentiated correlation pattern. Intercorrelations among HL subscales were generally weaker, and relationships between PL domains and PA indicators were less uniform. Visual inspection of the matrices suggested greater functional specialization among constructs in physically active women compared with their inactive counterparts.

To formally examine differences between corresponding correlation coefficients in the NE and E groups, Fisher's z tests were applied, and the results are briefly reported in Table 3.

Table 3. Significant between-group differences in correlation coefficients between control and experimental groups based on Fisher's z-tests with FDR correction

Variable 1	Variable 2	Pearson's r (Non-Exercising)	Pearson's r (Exercising)	Z	p	FDR p
HC-AC	HC-U	0.88	0.35	3.72	<0.001	0.041
PL-confidence	HP-APPL	−0.46	0.45	−3.63	<0.001	0.03

In general, a total of 231 correlations were compared. To control for multiple testing, false discovery rate (FDR) correction was applied. After FDR adjustment, two correlations differed significantly between groups. The association between the HC-AC and HC-U subscales was significantly stronger in the NE group than in the E group ($Z=3.72$, $p<0.001$, FDR $p=0.041$). Conversely, the relationship between the PL-confidence and the HP-APPL was significantly stronger in the E group ($Z=-3.63$, $p<0.001$, FDR $p=0.030$). In addition to these robust effects, several further correlations demonstrated notable between-group differences prior to correction, particularly those involving HL and PA indicators, as well as PL domains and moderate-to-vigorous PA.

To explore higher-order structural properties of the relationships among PL, HL, and PA, correlation networks were constructed separately for each group using a threshold of $|r|\geq0.30$. The resulting networks are presented in Figure 1.

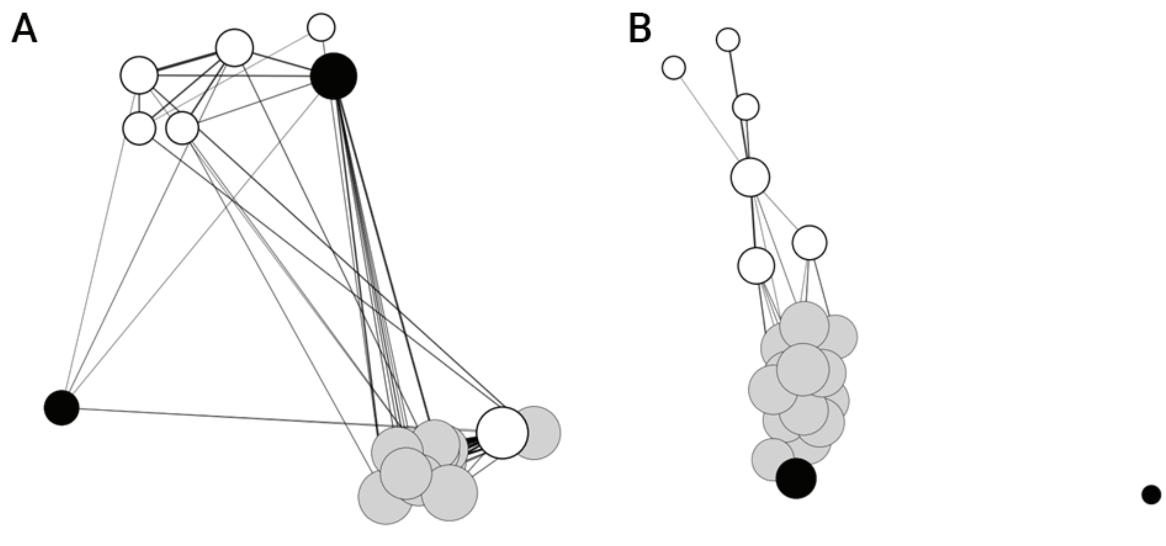

Figure 1. Network graphs of variable associations in nonexercising (1A) and exercising (1B) group (grey circles - physical literacy variables, white circles – health literacy variables, black circles – physical activity variables)

The NE group network (Figure 1A) consisted of 21 nodes and 117 edges, with a network density of 0.56 and an average degree of 11.14. This network was characterized by high connectivity and strong clustering among HL subscales, indicating substantial interdependence between health-related competencies. Several PL domains and PA indicators were embedded within this dense structure. The E group network (Figure 1B) comprised 21 nodes and 96 edges, with a density of 0.46 and an average degree of 9.14. Compared with the NE group, this network exhibited lower connectivity and greater modularity. HL subscales formed a coherent core cluster, while the PL-total score occupied a more central bridging position between (both) literacy-related domains and PA. Moderate-to-vigorous physical activity showed weaker integration within the network structure. Overall, these network characteristics suggest that participation in recreational physical activity is associated with a more differentiated and less saturated relational structure among the PL, HL, and PA constructs.

Discussion

There are several important findings of this study. First, in the NE group, HL-facets formed a highly interconnected and homogeneous system, characterized by (i) strong coupling among HL variables and (ii) substantial dependence of PA on HL-competencies. On the other hand, the E group demonstrated greater functional differentiation in HL dimensions (evident as weaker interdependence among HL components) and a more prominent integrative role of PL. Therefore, our initial study hypothesis can be accepted.

Interconnection between health literacy facets in nonexercising and exercising groups

One of the most important findings of this study is the evidently stronger interconnection among HL subscales in the NE group, particularly between the HL-assessing and HL-understanding dimensions. This pattern suggests that, in inactive women, health-related skills tend to function as a tightly integrated cognitive system. Interestingly, although investigations consistently reported strong correlations between HL-facets and health outcomes, studies rarely examined the correlations between HL-facets in older populations (Fry et al., 2024). However, it is reasonable to suggest that the integration in HL subdomains we have found herein in nonexercising women may reflect a high level of health awareness. On the other hand, it may also indicate limited flexibility in applying health knowledge to everyday behavior, including participation in PA.

More specifically, inactive women may rely predominantly on careful deliberation and risk evaluation when making health-related decisions. As a matter of fact, such a mechanism is not known, and studies repeatedly emphasize that thorough risk evaluation is essential for sound health-related decision-making, being a component of effective health decision-making (Desmond, Brubaker, & Ellner, 2013). However, it is not hard to suppose that such cognitive (over)dominance may lead to cautious or avoidant attitudes toward PA. While such caution may appear reasonable, frequent focus on potential risks, physical limitations, or negative health outcomes may narrow the perspective on positive outcomes of regular PA. In other words, individuals may overlook the positive effects of physical exercise, even when those benefits are well known and clearly understood. As a result, women may delay initiating exercise, participate less frequently, or discontinue activity altogether, despite having sufficient health-related knowledge and understanding of the benefits of PA.

In contrast, the E group demonstrated weaker interconnections among HL subdomains, indicating greater differentiation of health-related skills. Quite opposite to nonactive participants, this pattern may suggest a more adaptive and context-sensitive use of health information. In other words, in this group of participants, specific HL competencies are likely to be applied according to situational demands. For example, when "understanding" is needed, individuals will adequately comprehend health-related information. Additionally, when "action" is needed, they will be more likely to act in ways that promote health (including regular exercising). In other words, we may suppose that participation in structured PA programs may contribute to the development of more functional and flexible HL profiles.

Health literacy as a correlate of physical activity in inactive women

In the NE group, HL facets were not only strongly interconnected but were also closely linked to PA indicators. In general, the positive association between HL and PA is a known issue, and similar results have already been reported in the literature (Buja et al., 2020; Lim, van Schooten, Radford, & Delbaere, 2021). This structure suggests that behavioral engagement in inactive women may be strongly regulated by cognitive evaluations, health concerns, and perceived risks. Such reliance on cognitive regulation may foster conservative or avoidant behavioral patterns. This is particularly possible among older women with chronic health conditions and those who fear injury or are uncertain regarding exercise safety. Specifically, when health-related thinking is not supported by positive practical experience, it may discourage regular PA. For example, a woman with joint pain may carefully analyze the potential risks of exercise and decide to avoid walking or group exercise classes, even though moderate physical activity could be beneficial for her health (Law, Markland, Jones, Maddison, & Thom, 2013). In this context, HL (rather than facilitating action) may unintentionally reinforce inactivity through heightened risk sensitivity.

In contrast, in the E group, associations between HL facets and PA indicators were weaker, suggesting that PA engagement in this group was less directly constrained by cognitive evaluation alone. This weaker link may indicate that careful health-related thinking plays a smaller role in guiding PA behavior among physically active women. The background mechanism of such (lack) of association in this particular group of participants is logical and understandable. For example, women who regularly participate in exercise programs may decide to attend training sessions or go for walks based on habit, enjoyment, or social interaction rather than continuous evaluation of potential health risks and benefits. Similarly, instead of repeatedly considering whether exercise is safe or appropriate, physically active women may rely on their previous positive experiences, established routines, and confidence in their abilities when deciding to remain active. The presented mechanism has already been confirmed, particularly in older adults, and studies repeatedly reported that enjoyment and social interaction (rather than health risk-benefit evaluation) drive exercise participation at later ages (Franco et al., 2015). On the other hand, such "chain reactions" are hardly expectable in women who do not regularly exercise.

Physical literacy as a bridge between health literacy and physical activity in the exercising group

Our results highlight the central role of PL in physically active women. Specifically, network and correlation analyses identified PL (particularly the PL total score) as a key "bridge" between HL and PA in the E group. Moreover, the positive association between PL confidence and HL application was significantly stronger among active participants, whereas this relationship was weaker in the NE group. These findings suggest that PL may serve as a critical mechanism facilitating the translation of cognitive resources derived from HL facets into sustained PA behavior among women who are already physically active. Simply theoretically, this interpretation is in line with Whitehead's conceptualization of PL, which emphasizes "the integration of motivation, confidence, physical competence, knowledge, and understanding in supporting lifelong engagement in physical activity" (Whitehead, 2010). Within this framework, physically literate individuals are better equipped to apply health-related knowledge in meaningful and context-appropriate ways.

In other words, we may suppose that active participation in recreational programs may reduce cognitive constraints by providing repeated positive experiences that reinforce perceived competence and confidence. Women who regularly attend supervised exercise may experience reduced pain, improved mobility, and enhanced mood. It altogether can gradually replace risk-focused evaluations with embodied confidence. Over time, physical activity may become less influenced by careful health-related concerns. Instead, it may be guided more by perceived competence, enjoyment, and established routines, which support sustained engagement. Supportively, studies highlighted that repeated mastery experiences and positive affective responses (achieved by participation in physical activity) may strengthen motivational processes linked to long-term PA in older adults (McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Although the precise mechanisms underlying these effects cannot be definitively established within the present study, this pattern of findings may help explain the observed differences in correlations between active and inactive participants.

Meanwhile, in inactive women, PA appeared to depend more strongly on individual competencies. In this group, PL confidence most likely did not translate effectively into PA as a health-promoting action. This pattern may reflect already mentioned motivational barriers such as low exercise self-efficacy, fear of injury, perceived physical limitations, or insufficient behavioral opportunities in the absence of organized programs. Indeed, even when individuals perceive themselves as capable, concerns about pain, fatigue, social evaluation, or previous negative exercise experiences may reduce their willingness to initiate or maintain regular PA (Bandura, 1997).

Limitations and strengths

Before reaching conclusions, several limitations should be acknowledged. First, the cross-sectional design precludes causal inference regarding the direction of the observed relationships. Therefore, longitudinal and experimental studies are needed to determine whether participation in physical activity leads to structural reorganization among physical literacy, health literacy, and physical activity or whether preexisting relational patterns influence program adherence. Second, the relatively small sample size limits statistical power and the generalizability of the findings. In addition, participants were recruited from a single geographical region characterized by a Mediterranean climate and specific sociocultural and environmental conditions that may facilitate or constrain physical activity engagement. Therefore, the present results may not be fully generalizable to older women living in different climatic, cultural, or infrastructural contexts. Third, the reliance on self-report measures may have introduced response and recall biases. Future research should incorporate objective assessments of physical activity and performance-based measures of physical and health literacy to enhance measurement precision.

On the other hand, this study is among the first to examine structural differences in the associations between HL, PL, and PA separately in exercising and nonexercising participants. Furthermore, the focus on postmenopausal women, a population with specific health needs and well-documented benefits from regular PA, represents a significant strength of the present study.

Conclusion

The presented results highlight PL as a key mechanism through which health-related knowledge and understanding are translated into sustained PA in older women. In physically active women, confidence, competence, and embodied experience (as evidenced by higher levels of PL) appear to facilitate the practical application of health information, thereby supporting more autonomous and self-regulated behavior.

From an applied perspective, these results suggest that interventions targeting older women should move beyond information provision and explicitly promote PL development. Programs that emphasize skill acquisition, confidence building, and positive movement experiences may be particularly effective in fostering long-term engagement in physical exercise programs.

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Conflict of interest
The authors declare no conflicts of interest.

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