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Associations Between Health Literacy and Acute Mood Responses to Recreational Exercise in Older Women

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Abstract

The aim of this study was to examine the association between health literacy (HL) and mood state before, and after recreational physical exercise in older women. The study included 44 community-dwelling women aged 60–80 years (70.5±4.0 years) from Split, Croatia. Mood states were assessed using the Brunel Mood Scale (BRUMS) immediately before and after an organized recreational exercise session conducted in a public park environment. HL was evaluated using the Croatian version of the European Health Literacy Survey Questionnaire. The dependent samples t-test indicated significant ($p<0.05$) changes in mood state following exercise participation, with favorable changes identified for four of six of the BRUMS subscales and the BRUMS total score. Canonical correlation analysis revealed significant associations between HL-subdomains and BRUMS-subscores both before and after exercise participation, with stronger correlations after the exercise session (Can R =0.74 and 0.85, for pre- and post-measurement, respectively). In both measurements, the HL canonical root was primarily defined by understanding-, appraising-, and applying-healthcare-related information, while the BRUMS root was mainly characterized by tension, depression, and confusion. Significant negative correlations were also observed between HL-total and BRUMS-total before ($r=0.39$, $p<0.05$) and after exercise ($r=0.43$, $p<0.05$). In conclusion, HL may represent an important factor influencing acute post-exercise mood states, with potential implications for exercise adherence and healthy aging.

Keywords: *public space, mood, aged, women, physical activity, exercise response*

Introduction

Regular physical exercise has been consistently associated with numerous physical and psychological benefits in older persons, including improved cardiovascular health, functional capacity, balance, muscular strength, and overall quality of life (Vogel et al., 2009). In addition to physiological adaptations, exercise has been shown to reduce symptoms of anxiety and depression, enhance emotional well-being, and promote more positive mood states. Previous studies have demonstrated that even a single bout of exercise may induce acute improvements in affect and psychological well-being among older adults (Pierce & Pate, 1994).

The most substantial health benefits are generally observed when exercise is performed regularly and maintained over a longer period of timeand therefore, the long term adherence to exercise programs is considered essential for achieving sustainable physical and mental health outcomes. The research suggests that positive acute mood responses following exercise may play an important role in motivating individuals to continue participating in physical activity and maintaining exercise adherence (Arent, Landers, & Etnier, 2000; Pierce & Pate, 1994). Consequently, experiencing favorable acute mood state changes after exercise may represent a key psychological mechanism supporting long-term participation in recreational exercise programs among older persons. These effects may be particularly important in older women, who are at increased risk of age-related declines in physical function, reduced independence, and psychological distress.

Studies consistently demonstrate that acute recreational

physical exercise produces significant psychological benefits, particularly in older women, including improved mood, reduced anxiety, and enhanced cognitive function (Peiffer, Darby, Fullenkamp, & Morgan, 2015; Slaven & Lee, 1994). For example, in a Japanese study, the authors found that 36 older women (mean age 68.5 years) showed significant improvements in positive mood and reduced trait anxiety following strength training (Tsutsumi et al., 1998). Another study reported that 16 trained older women (mean age 64.5 years) experienced significant decreases in tension, depression, fatigue, and anger, with increased vigor immediately after a 75-minute aerobic session (Pierce & Pate, 1994). These findings were supported in a more recent investigation that demonstrated that 54 older women aged 60+ showed significantly increased positive mood following acute exercise (Christofoletti et al., 2019). Finally, Barnett examined self-efficacy and affective responses to an acute exercise bout in sedentary older and younger women to determine whether aging has an effect on affective states and found that an acute bout of moderate-intensity exercise produced more positive and fewer negative affective states in both groups, with no significant age effect (Barnett, 2013). Considering the variations of the achieved effects (i.e.., some participants experienced more favorable effects of physical exercising than others) it would be important to evaluate the factors which could be potentially related to changes in mood state as a result of physical exercising. One of the potential factors of influence is health literacy.

Health literacy (HL) refers to an individual's ability to access, understand, evaluate, and use health-related information in ways that promote and maintain good health (Jukic, Pehar, Kvesić, Kontić, & Zenić, 2026; Kesic, Savicevic, Peric, Gilic, & Zenic, 2022). In older adults, HL is particularly important because aging is often associated with increased healthcare needs, chronic disease management, and more frequent interactions with health systems. Higher levels of HL have been linked to healthier lifestyles, better self-management behaviors, improved adherence to medical and exercise recommendations, and overall better health outcomes in older populations. Not surprisingly, HL is considered an important factor influencing participation in physical activity, particularly among older adults (Buja et al., 2020). Individuals with higher levels of HL are more likely to understand the benefits of regular exercise, interpret health-related information correctly, and adopt healthier lifestyle behaviors.

Previous research has shown that older adults with adequate HL participate more frequently in recreational and health-oriented exercise programs than those with limited HL (Flegar, 2025). Supportively, a systematic review and meta-analysis demonstrated that older individuals with lower HL were significantly less likely to engage in regular physical activity (Lim, van Schooten, Radford, & Delbaere, 2021). In older women specifically, HL may play an even more important role due to age-related physiological changes, chronic health conditions, and the need to maintain functional independence.

Given the established association between HL and participation in physical activity, it is reasonable to assume that HL may also influence acute mood state changes following exercise through mechanisms such as better understanding of exercise benefits, higher self-efficacy, and more positive expectations toward physical activity. However, despite these theoretical assumptions, there is an evident lack of research examining the relationship between HL and acute psychological or mood responses to exercise, particularly among older women.

Therefore, the aim of this study was to examine the association between HL and mood state before and immediately after a recreational exercise program in older women. A better understanding of the potential link between HL and acute mood responses could contribute to the development of more effective and psychologically supportive exercise programs for older women. Initially, we hypothesized that better HL will be associated with more favorable mood states both before and after exercise session.

Methods

Participants

The participants in this study were community-dwelling older women aged 60 to 80 years from the city of Split, Croatia (n=44; mean age 70.5±4.0 years). To reduce the potential influence of sociocultural variability, all participants were recruited from the same geographical area. The sample included women with diverse health profiles, ranging from those without diagnosed medical conditions to those with chronic diseases such as cardiovascular disorders, diabetes, and arthritis. Despite these differences, all participants were functionally independent and capable of participating in the organized recreational exercise program. Prior to enrollment, participants were informed about the study aims, procedures, potential benefits, and possible risks, after which written informed consent was obtained from all participants. Inclusion criteria were female sex, age over 60 years, residence in the city of Split, and sufficient functional mobility and independence for participation in recreational physical activity (please see later for details on exercise program). Exclusion criteria included severe cognitive impairment, inability to complete the assessment procedures independently, and inadequate motor functioning preventing safe participation in the exercise program. The study protocol was approved by the Ethics Committee of the Faculty of Kinesiology, University of Split.

Variables and study protocol

Variables in this study included participants' age (in years), mood state before and after the recreational exercise session, and HL.

Mood state was assessed using the Brunel Mood Scale (BRUMS), a widely used instrument developed to evaluate transient affective states in both athletic and nonathletic populations. Previous studies have demonstrated satisfactory reliability, factorial validity, and sensitivity of the BRUMS for detecting exercise-related mood fluctuations across different populations and cultural settings (Gibson, 1997; Lan, Lane, Roy, & Hanin, 2012; Terry et al., 2022). Due to its sensitivity to short-term psychological fluctuations, the BRUMS is considered particularly suitable for studies investigating acute mood responses to physical exercise (Randfield & Phillips, 2025; Znazen et al., 2021).

The instrument consists of 24 items grouped into six mood dimensions: tension, depression, anger, vigor, fatigue, and confusion, with each subscale containing four items. Participants were instructed to indicate how they felt "right now" using a 5-point Likert scale ranging from 0 ("not at all") to 4 ("extremely"). Scores for each subscale were calculated by summing the corresponding items, resulting in subscale scores ranging from 0 to 16, while a total mood disturbance score was additionally calculated (BRUMS total). In the present study, the BRUMS questionnaire was administered immediately before (pre) and immediately after (post) the recreational exercise session. This repeated-measures approach enabled the examination of both baseline affective states and immediate psychological responses following physical activity participation.

HL was assessed using the validated Croatian version of the European Health Literacy Survey Questionnaire (HLS-EU-Q), which has previously been applied in studies involving Croatian adult and older populations. The questionnaire evaluates individuals' perceived abilities to access, understand, appraise, and apply health-related information necessary for making informed health decisions and maintaining health-promoting behaviors. In the present study, twelve HL subdomains were analyzed, encompassing competencies related to healthcare, disease prevention, and health promotion. Specifically, the analyzed dimensions included accessing healthcare information, understanding healthcare information, appraising healthcare information, applying healthcare information, accessing disease prevention information, understanding disease prevention information, appraising disease prevention information, applying disease prevention information, accessing health promotion information, understanding health promotion information, appraising health promotion information, and applying health promotion information. Responses were recorded using a 4-point Likert scale ranging from 1 ("very difficult") to 4 ("very easy"), with higher scores indicating higher perceived HL. In addition to the subdomain scores, an overall HL index (HL-total) was calculated and used in univariate analyses.

The study was conducted during organized recreational exercise sessions performed in a public park environment in the city of Split, Croatia during the spring period. Participants completed the BRUMS immediately before the exercise session to assess baseline mood states prior to physical activity participation. Following completion of the recreational exercise program, the BRUMS was administered again to evaluate acute post-exercise mood state changes induced by the activity session. HL was assessed independently from the exercise sessions under controlled laboratory conditions using an online version of the HLS-EU-Q. This study design enabled the examination of the associations between HL and both pre-exercise and post-exercise mood states in older women.

Statistics

Statistical analyses were conducted in four consecutive phases. In the first phase, descriptive statistics were calculated for all study variables, including means and standard deviations for the HL and mood state measures. In the second phase, paired-samples t tests were performed to examine differences between preexercise and postexercise BRUMS scores, including both individual mood state subscales and the overall BRUMS total score.

In the third phase, canonical correlation analysis was applied to examine the multivariate relationships between HL subdomains and BRUMS mood state dimensions. Two separate canonical correlation analyses were conducted: the first using BRUMS scores obtained immediately before the recreational exercise session (preexercise) and the second using BRUMS scores obtained immediately after exercise participation (postexercise). In these analyses, only the HL and BRUMS subdomain scores were included, while the total scores of HL and BRUMS were intentionally excluded to avoid multicollinearity effects.

Finally, in the fourth phase, Pearson's linear correlation coefficients were calculated to examine the associations between the overall HL index (HL-total) and the overall BRUMS total score separately for the preexercise and postexercise assessments.

Statistical significance was set at $p<0.05$ for all analyses, and Statistica version 14.5 (Tibco Inc. Palo Alto, CA, USA) was used for all analyses.

Results

Descriptive statistics for the HL subdomains and total HL are presented in Table 1.

Table 1. Descriptive statistics for the health literacy subdomains and total score

	Mean	Minimum	Maximum	SD
HC-assessing	36.48	16.67	50.00	10.10
HC-understanding	38.06	16.67	50.00	10.38
HC-appraising	32.22	12.50	50.00	9.79
HC-applying	37.96	20.83	50.00	8.30
DP-assessing	39.20	12.50	50.00	9.19
DP-understanding	39.94	25.00	50.00	9.24
DP-appraising	35.19	20.00	50.00	9.31

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Table 1. Descriptive statistics for the health literacy subdomains and total score

	Mean	Minimum	Maximum	SD
DP-applying	30.00	16.67	50.00	11.14
HP-assessing	35.19	13.33	50.00	9.47
HP-understanding	34.47	8.33	50.00	12.03
HP-appraising	40.40	22.22	50.00	8.75
HP-applying	34.56	16.67	50.00	10.46
HL total	35.99	21.97	49.65	7.90

Legend. HL – health literacy; HC – healthcare-related information; DP – information related to disease prevention; HP – information related to health promotion information related to health promotion.

Figure 1 presents the descriptive statistics and t test differences between pre- and posttesting of the mood state. As evident, pre- to post differences were significant for four of six BRUMS subscores (Figure 1A) and the BRUMEL total score (Figure 1B). In general, favorable changes in mood state are evidenced.

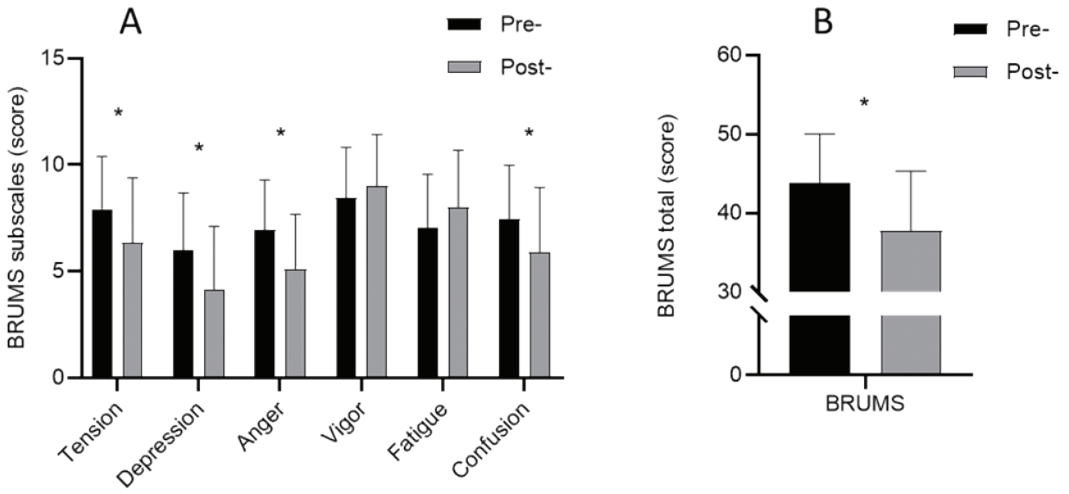

Figure 1. Descriptive statistics (results presented as means ± SDs) and differences between pre- and post-measurement for the BRUMS subscales (1A), and BRUMS total score (1B).

The results of the canonical correlation analyses calculated between HL subscores and BRUMS subscores are presented in Table 2. Analysis revealed significant associations between the first pair of canonical roots at pretesting, with 55% of the variance explained ($p < 0.05$). The first canonical root of the HL is saturated with high projections of three HL-subscores, namely, HC-understanding, HC-appraising, and HC-applying. Meanwhile, the first root of the mood state before exercising is saturated with tension, depression and confusion subscores. The numerical value of the coefficients (e.g., positive in the HL-set and negative in the BRUMS-set of the variables) actually indicates an association of better HL with a better mood state (i.e., lower scores on the BRUMS subscales indicate a better mood state, while higher scores on the HL measurement scale indicate better HL). When canonical correlation was calculated between HL and postexercise BRUMS variables, the correlation coefficient slightly increased, and the first pair of canonical roots explained 67% of the variance of two sets of variables, with similar root structures as for the preexercise variables.

Table 2. Canonical correlations between health literacy subdomains, and BRUMS scale subscores before (pre-test), and immediately after the exercise session (post-test)

		Pre-test	Post-test
		Root 1	Root 1
Health literacy subdomains	HC-assessing	-0.12	0.08
	HC-understanding	0.48	0.58
	HC-appraising	0.53	0.75
	HC-applying	0.57	0.52
	DP-assessing	0.04	0.11
	DP-understanding	0.22	-0.01
	DP-appraising	0.10	-0.18
	DP-applying	-0.30	0.45
	HP-assessing	0.14	-0.19
	HP-understanding	0.28	-0.26
	HP-appraising	0.24	-0.05
	HP-applying	-0.10	0.09
BRUMS subscores	Tension	-0.43	-0.44
	Depression	-0.48	-0.89
	Anger	0.03	0.27
	Vigor	0.25	0.33
	Fatigue	0.10	-0.08
	Confusion	-0.59	-0.49
Can R		0.74	0.85
Can R2		0.55	0.67
Chi square		63.89	90.64
p-level		0.03	0.01

Legend. HC – healthcare-related information; DP – information related to disease prevention; HP – information related to health promotion information related to health promotion.

The linear correlation between total HL and total BRUMS score is presented in Figure 2. The correlations were significant in the pre- and posttests, indicating 16% of the common variance when the HL total score was correlated with the BRUMS total obtained immediately before recreational exercise (Figure 2A). The correlation slightly increased for the posttest, with <19% of the common variance (Figure 2B).

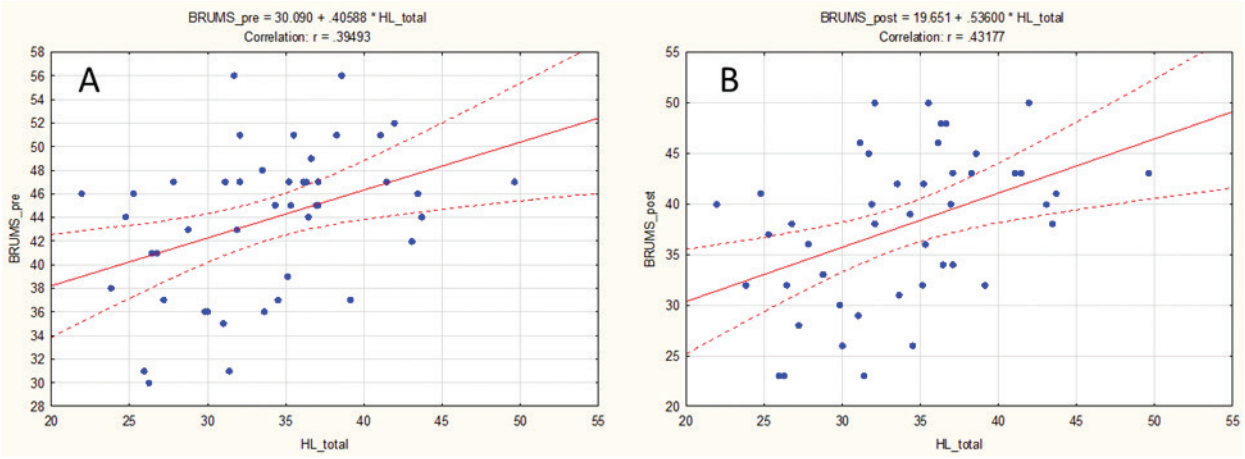

Figure 2. Linear correlations between health literacy total score (HL_total) and BRUMS total score before (2A) and immediately after the exercise session (2B).

Discussion

There are two most important findings of this investigation. First, the results point to significant associations between HL and mood states in older women, both before and after participation in a recreational exercise session. Therefore, we can accept our initial study hypothesis. Second, the strength of the association slightly increased when correlations were calculated after the exercise session.

Preexercise correlations

As stated previously, higher HL was associated with a better mood state before the exercise session. The first explanation may lie in a better understanding of the health benefits of physical activity among women with higher levels of HL. In other words, individuals who better understand and interpret health-related information are likely to perceive physical exercise as a beneficial health behavior rather than as a potentially threatening or exhausting activity. Consequently, women with higher levels of HL may experience lower anticipatory stress and reduced psychological discomfort before exercise participation. Specifically, for the sample of participants observed here (e.g., older women), a better understanding of the positive effects of physical activity on healthy aging, functional independence, and disease prevention may contribute to more positive emotional states prior to exercise engagement.

To the best of our knowledge, no previous study has directly examined the relationship between HL and acute mood states before exercise participation. However, the present findings may be indirectly supported by findings of studies that reported an association between HL and (more) positive perceptions of physical activity, greater exercise self-efficacy, and lower perceived barriers to exercise participation (Dominick, Dunsiger, Pekmezi, & Marcus, 2013). Additionally, previous research has shown that individuals with higher HL tend to report greater confidence in engaging in physical activity and more adaptive health-related beliefs, which may contribute to lower anticipatory stress and more favorable emotional states prior to exercise (Friis, Vind, Simmons, & Maindal, 2016). Therefore, it is possible that the lower levels of tension and depression observed in women with higher HL reflect, at least partially, these broader psychosocial mechanisms linking HL and physical activity as health behavior.

Another possible explanation for the observed findings may be related to greater self-efficacy and perceived control among women with higher levels of HL. Namely, it is relatively well known that individuals who are better able to understand and use health-related information often report greater confidence in managing their health and engaging in health-promoting behaviors, including physical activity (Ünlü & Altındiş, 2025). Additionally, previous research has demonstrated that higher HL is associated with greater exercise self-efficacy, lower perceived barriers to physical activity, and more positive health-related beliefs (Osborn, Paasche-Orlow, Bailey, & Wolf, 2011). Such psychological characteristics may reduce uncertainty and anticipatory stress before exercise participation, which could partially explain the lower levels of tension, depression and confusion observed in women with higher HL.

These findings may also be interpreted within the framework of social cognitive theory, which emphasizes the role of self-efficacy and perceived control in shaping emotional and behavioral responses (Bandura, 1997). According to this perspective, individuals who feel more capable of understanding and managing health-related behaviors are likely to experience lower stress and anxiety in situations involving physical activity. Similarly, the Health Belief Model suggests that individuals with higher HL may perceive greater benefits and fewer barriers related to exercise participation, potentially contributing to more favorable preexercise mood states.

Another possible explanation may be related to previous positive experiences with physical activity among women with higher levels of HL. Individuals with greater HL are generally more likely to participate regularly in health-promoting behaviors, including recreational exercise (Buja et al., 2020). Therefore, they may have accumulated more positive emotional and experiential associations with physical activity over time. Although no studies have directly examined the relationship between HL and preexercise mood states, previous research has consistently shown that higher HL is associated with greater

participation in physical activity and exercise programs (Buja et al., 2020; Dominick et al., 2013; Friis et al., 2016). Consequently, women with higher HL may approach exercise sessions with more positive expectations and lower anticipatory discomfort, which could partially explain the lower levels of tension and fatigue observed before exercise participation.

This explanation may be particularly important in the context of the preexercise assessment, since the exercise session had not yet occurred and the observed mood states therefore likely reflected anticipatory emotional responses rather than the direct effects of exercise itself. Therefore, lower levels of tension and depression among women with higher HL may indicate more positive expectations regarding the upcoming exercise session and its potential psychological or health-related benefits. Such expectations are likely to be more pronounced among individuals with previous positive exercise experiences. Namely, it is logical that repeated positive affective responses to physical activity may shape more favorable emotional anticipation before future exercise participation (Magnan, Kwan, & Bryan, 2013)

Postexercise associations

The postexercise findings revealed a pattern of associations that was highly similar to the preexercise results, although the strength of the relationship between HL and mood states became more pronounced following participation in the recreational exercise session. Specifically, women with higher levels of HL continued to report lower levels of tension, depression and confusion after exercise, while the HL total score was associated with a lower BRUMS total score. This suggests that HL may influence acute psychological responses to physical activity. Apart from those mechanisms discussed previously in relation to preexercise mood state, some additional explanations may help explain this stronger postexercise association.

As already stated, the positive correlation between HL and knowledge of the beneficial effects of physical exercise is well documented and already discussed (Buja et al., 2020). In the context of postexercise status, it is important to highlight that women with higher HL could interpret exercise-induced sensations more positively and with less uncertainty. In addition, greater self-efficacy and perceived control may contribute to more adaptive emotional responses during and after physical activity (McAuley, Talbot, & Martinez, 1999). It could reduce the likelihood that exercise-related exertion is experienced as threatening or excessively exhausting, resulting in an association between HL and a favorable postexercise mood state in our study.

Additionally, the stronger postexercise association may indicate that women with higher HL are not only psychologically better prepared for exercise participation but may also derive greater acute emotional benefits from the exercise session itself. This interpretation is particularly relevant because acute positive affective responses to exercise are considered important predictors of future exercise adherence and long-term participation in physical activity programs. In other words, humans tend to repeat behaviors that feel good and avoid behaviors that feel bad, so affective experience during and after exercise functions as a reinforcement signal (Ekkekakis & Dafermos, 2012). Consequently, the present findings suggest that HL may represent an important psychosocial factor influencing both anticipatory and immediate postexercise emotional states in older women. Apart from being plausible in the interpretation of our results, this finding may have practical implications for the design of recreational exercise interventions. In brief, this indicates that strategies aimed at improving HL could enhance both psychological experiences during exercise and long-term exercise engagement.

An additional explanation for the stronger postexercise association may be related to the generally higher levels of physical activity and better physical fitness common among individuals with higher HL (Keith, Clark, Stump, & Callahan, 2015). However, the association between higher HL and better fitness must not be simplified in the interpretation. Previous research has shown that people with greater HL are more likely to engage regularly in physical activity and maintain healthier lifestyles, which over time may contribute to better functional capacity and exercise tolerance (Jayakumar, Methre, & Patil, 2023). Therefore, it seems that HL had no direct effect on fitness, but it works entirely through "higher physical activity" as behavior (Hnidková et al., 2024). However, irrespective of the mechanism of influence, it can be expected that women with higher HL may experience the exercise session as less physically demanding and recover more efficiently from exercise-induced exertion. In contrast, women with lower HL and potentially lower fitness levels may perceive the exercise session as more physically demanding, resulting in less favorable postexercise mood states.

Study limitations and strengths

Some important limitations of this study should be acknowledged. First, due to the cross-sectional design, causal relationships between HL and acute mood responses to exercise cannot be established. Second, the study included only older women from urban areas, which limits the generalizability of the findings to older male populations and older adults in general. However, this is one of the first studies to examine the association between HL and mood states before and after recreational exercise. Additionally, the fact that all participants were tested during the equal exercise session organized in "real-life" circumstances could contribute to the ecological validity of the results.

Conclusion

In conclusion, the findings suggest that HL is associated with more favorable mood states before and after recreational exercise participation in older women. Women with higher HL reported lower levels of tension, confusion, and depression, while these associations became stronger after exercise participation. Therefore, it seems that a better understanding of health-related information, greater self-efficacy, and more positive perceptions of physical activity may contribute to better emotional responses to physical exercise.

Accordingly, individuals with lower levels of HL should be provided with additional support to overcome barriers to-

ward physical exercise. In other words, it should not be expected that such individuals will independently decide to engage in physical activity but rather that they should be specifically approached, motivated, and provided with clear explanations about the benefits of regular exercise and its importance for health and healthy aging.

Future research should further examine the relationship between HL and exercise-related mood responses using longitudinal and repeated-measurement designs across multiple exercise sessions. Such approaches would help determine whether the observed associations remain stable over time and whether improvements in HL lead to more favorable psychological responses and greater exercise adherence.

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Conflict of interest

The authors declare no conflicts of interest.

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