

# Does Physical Literacy Moderate Acute Mood Responses to Recreational Exercise in Older Females?

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## Abstract

Physical literacy (PL), encompassing motivation, confidence, physical competence, and knowledge related to physical activity, is recognized as an important determinant of lifelong engagement in physical activity. However, limited evidence exists regarding whether higher levels of PL influence acute mood responses to recreational physical activity in older women. Therefore, the aim of this study was to examine the association between physical literacy and mood state assessed before and after outdoor recreational exercise. The sample consisted of 42 women (70.4±4.1 years) involved in a community-based recreational exercise program conducted in a public park. Physical literacy was assessed at baseline, while mood state was measured immediately before (pretest) and after (posttest) the exercise session using the Brunel Mood Scale (BRUMS). Participants demonstrated significant improvements in overall mood state following the exercise session (43.6±5.5 vs. 37.2±7.1 at pre- and posttest, respectively;  $t=5.11$ ,  $p<0.05$ ). No significant correlations between the PL and BRUMS subscores and the total score were observed in the pretest. However, at posttest, PL was significantly associated with tension ( $r=-0.32$ ,  $p<0.05$ ), depression ( $r=-0.33$ ,  $p<0.05$ ), and total BRUMS score ( $r=-0.35$ ,  $p<0.05$ ), indicating more favorable mood responses among participants with higher PL. When the correlation between PL and posttest BRUMS total score was partialized while controlling for exercise experience, the correlation coefficient slightly decreased but remained statistically significant ( $r=-0.32$ ,  $p<0.05$ ). The findings suggest that PL may enhance the psychological benefits of exercise later in life and should be considered in the design of recreational physical activity programs for older women.

**Keywords:** *psychological well-being, aged, physical activity, healthy aging, community-based exercise*

## Introduction

Aging is commonly associated with declines in muscular strength, cardiovascular capacity, balance, mobility, and cognitive functioning, all of which can negatively affect quality of life and everyday functioning (Weinstein, van Aert, Donovan, Muskens, & Kop, 2024). However, it is relatively well known that regular physical exercise plays a crucial role in maintaining health and functional independence in older adulthood (Liu et al., 2017). Numerous studies have demonstrated that regular participation in recreational physical activity can reduce many age-related physiological and psychological changes. Specifically, physical exercise has been linked to improved cardiovascular health, enhanced muscular endurance, better postural stability, and reduced risk of chronic diseases such as

osteoporosis, diabetes, and hypertension (Taylor & Johnson, 2008). In addition to physical benefits, engagement in exercise contributes to greater social participation, higher self-efficacy, and improved overall well-being among older adults (Taylor et al., 2004). Physical activity has also been recognized as an important nonpharmacological strategy for preserving cognitive health and promoting healthy aging. What is particularly important, there is a growing body of evidence suggesting that even a single bout of physical exercise can produce immediate positive changes in mood states and affective responses in older individuals (Weinstein et al., 2024; Yeung, 1996).

Mood state represents a transient psychological condition characterized by fluctuations in positive and negative emotional experiences, including feelings such as tension,

vigor, fatigue, depression, and happiness (Clark, 2005). In the field of exercise psychology, mood state has become an important construct for understanding the immediate psychological effects of physical activity, particularly among older adults. Numerous studies have shown that acute bouts of exercise are associated with reductions in negative affective states, including anxiety, tension, and depressive symptoms, while simultaneously enhancing positive affect and subjective well-being (Weinstein et al., 2024). Research has demonstrated that even moderate-intensity recreational exercise can produce measurable improvements in mood immediately after activity, with some effects persisting for several hours post-exercise (Christofoletti et al., 2019; Pierce & Pate, 1994). These affective responses appear to be influenced by exercise intensity, duration, environmental conditions, and individual characteristics such as fitness level and exercise self-efficacy (Chan et al., 2019). In older populations, positive mood responses to exercise are particularly important because they may contribute not only to psychological health but also to long-term adherence to physical activity programs (Arent, Landers, & Etnier, 2000). Previous findings further suggest that older women may experience especially pronounced emotional benefits from recreational physical exercise, including increased vigor and reduced emotional distress following acute exercise sessions (Arent et al., 2000; Windle, Hughes, Linck, Russell, & Woods, 2010).

Although the positive effects of acute physical exercise on mood state are supported by a substantial body of evidence (Arent et al., 2000; Windle et al., 2010), considerably less is known about the factors that may influence the magnitude and direction of these affective responses. As stated previously, research has repeatedly demonstrated improvements in positive affect and reductions in negative mood states following exercise; however, considerable interindividual variability in these responses has also been observed. In other words, some individuals experience pronounced emotional benefits after exercise, whereas others demonstrate only minor or inconsistent changes in mood state. This variability suggests that affective responses to exercise may be moderated by a range of psychological, physiological, and contextual factors. The literature has discussed several potential moderators, including exercise intensity, fitness level, self-efficacy, motivational orientation, exercise preferences, social environment, and prior physical activity experience (Chan et al., 2019). Nevertheless, the mechanisms underlying these individual differences remain insufficiently understood. Consequently, there is a growing need to identify personal characteristics and psychosocial constructs that may help explain why some older individuals experience greater mood-enhancing effects of exercise than others.

One construct that may help explain individual differences in affective responses to exercise is physical literacy. Physical literacy is commonly defined as a multidimensional concept encompassing motivation, confidence, physical competence, knowledge, and understanding that enables individuals to value and engage in physical activity throughout life (Blažević, Blazevic, & Sekulic, 2024; Gilic, Sekulic, Munoz, Jaunig, & Carl, 2025; Jukic, Pehar, Kvesić, Kontić, &

Zenić, 2026). Although traditionally examined in children and younger populations, recent research has increasingly emphasized the importance of physical literacy in older adulthood, particularly in relation to healthy aging and sustained participation in physical activity (Jones et al., 2018; Petrusevski, Morgan, MacDermid, Wilson, & Richardson, 2022). It is generally accepted that individuals with higher levels of physical literacy may experience exercise in a more competent, autonomous, and enjoyable manner, potentially leading to more positive emotional and psychological responses during and after physical activity. In particular, motivational and affective domains of physical literacy are naturally related to exercise enjoyment, which could be naturally associated with more favorable changes in mood as a result of physical exercising.

Despite the evident increase in interest in physical literacy as a potential factor influencing the effectiveness of physical exercise in older adults, limited research has directly examined whether physical literacy may predict the magnitude of acute changes in mood state following recreational exercise, especially among older women. Therefore, the aim of this study was to evaluate the association between physical literacy and mood state assessed before and after outdoor recreational physical exercise. Initially, we hypothesized that physical literacy would be positively associated with the mood state of the participants before and after recreational physical exercise.

## Methods

### Participants

The participants in this study were older adult women aged between 60 and 80 years from the city of Split, located in southern Croatia ( $n=42$ ,  $70.4\pm 4.1$  years of age). To minimize the potential influence of sociocultural differences, the study intentionally focused on participants from a single geographical region. The sample included women with varying health statuses, ranging from those without diagnosed health conditions to those with chronic diseases such as diabetes, cardiovascular disorders, and arthritis. Nevertheless, all participants were functionally independent and capable of attending organized recreational physical activity (please see later for details). Before participation, all participants were informed about the aims, procedures, potential benefits, and possible risks of the study, and they provided informed consent. The inclusion criteria were female sex, age above 60 years, residence in the city of Split, and an adequate level of functional independence and mobility. Exclusion criteria included severe cognitive impairment, inability to complete the assessment procedures independently, and insufficient motor functionality for participation in the recreational exercise program. The study protocol was approved by the Ethical Committee of the Faculty of Kinesiology, University of Split.

### Variables

Apart from age (in years) and length of participation in recreational exercise (in months), the variables observed in this study included evaluation of participants' mood state immediately before and after physical exercise and their physical literacy.

Mood state was assessed using the Brunel Mood Scale (BRUMS), a widely used instrument designed to evaluate transient affective states in both physically active and general populations. Due to its brevity, ease of administration, and sensitivity to transient psychological changes, the BRUMS is considered particularly suitable for studies examining acute affective responses to physical exercise in older adults. The BRUMS consists of 24 items divided into six subscales representing different mood dimensions: tension, depression, anger, vigor, fatigue, and confusion. Each subscale contains four items, and participants were asked to indicate the extent to which they experience each feeling “right now” using a 5-point Likert scale ranging from 0 (“not at all”) to 4 (“extremely”). Scores for each mood dimension are calculated by summing responses to the corresponding four items, resulting in subscale scores ranging from 0 to 16 and total scores ranging from 0 to 96 (6 times 16 = 96). Higher scores indicate greater intensity of the specific mood state. In the present study, the BRUMS was administered immediately before (preexercise) and immediately after (postexercise) each recreational exercise session to evaluate acute changes in mood state induced by physical activity. This repeated-measures approach enabled the assessment of short-term affective responses to exercise across multiple mood dimensions. The BRUMS has demonstrated satisfactory psychometric properties, including good internal consistency, factorial validity, and sensitivity to exercise-induced mood fluctuations across diverse populations and cultural contexts (Terry et al., 2022; Zhang, Si, Chung, Du, & Terry, 2014).

Physical literacy was assessed using the Perceived Physical Literacy Questionnaire for South Eastern Europe (Gilić et al., 2025). The original version of the instrument consists of 24 items distributed across six domains: physical competence, understanding, motivation, confidence, knowledge, and physical activity behavior. Items assessing physical competence, understanding, motivation, and confidence are rated using a six-point Likert scale ranging from 0 to 5, with response options reflecting levels of agreement or disagreement. The knowledge domain consists of items with dichotomous true–false response categories designed to evaluate participants’ understanding of concepts related to physical activity and exercise. Although the questionnaire results include different domain-specific scores, in this study, only the total score was observed.

### Exercise program

The recreational exercise program was conducted in a public park. The program itself is generally organized three

times per week as a free community-based physical activity initiative for older women. The program had been continuously implemented for more than three years prior to the present study, providing participants with regular opportunities for recreational exercise in an outdoor environment. Participation was voluntary and flexible, allowing women to attend sessions according to their personal availability and to perform exercises in accordance with their individual physical capacities and current health status. Each session lasted approximately 60 minutes and included a combination of Nordic walking, strength exercises, mobility exercises, balance training, and flexibility activities. The program was designed to promote functional fitness, safe movement, and long-term engagement in physical activity among older adults within a supportive and socially interactive setting.

### Statistics

Data distribution normality was evaluated using the Kolmogorov–Smirnov test. Descriptive statistics for study variables are presented as arithmetic means and standard deviations. Associations between physical literacy and BRUMS subscores and total score were analyzed using Pearson’s correlation coefficients. Correlation analyses were conducted separately for preexercise and postexercise BRUMS scores to examine the relationships between physical literacy and mood states before and after recreational exercise sessions. Following the initial analyses, partial correlation analyses between the BRUMS total score and physical literacy were performed while controlling for (i) participants’ age and (ii) previous exercise experience as covariates. These analyses aimed to determine the independent associations between physical literacy and BRUMS after accounting for the potential influence of demographic and exercise-related factors. Statistica version 14.5 (Tibco Inc., Palo Alto, CA, USA) was used for all analyses, and a p-level of 95% was applied.

### Results

Descriptive statistics for the study variables are presented in Table 1. With regard to study aims, the most interesting is the fact that study participants had almost two years of experience in organized recreational programs on average, with substantial variability (from one month to almost four years), with relatively large variability in age (60–80 years of age). Therefore, the participants’ age and experience in exercise participation were later included in the calculation of the partial correlations between physical literacy and mood state (please see later for details).

**Table 1.** Descriptive statistics for the study variables at baseline

	Mean	Minimum	Maximum	Std.Dev.
Age (years)	70.88	60.00	80.00	5.94
Experience in exercising (months)	23.40	1.00	44.00	11.90
Physical literacy total (score)	65.86	40.00	90.00	10.10

The mood status of the participants significantly improved as a result of the exercise program, with significant t test differences between pre- and posttesting (43.6±5.5 and

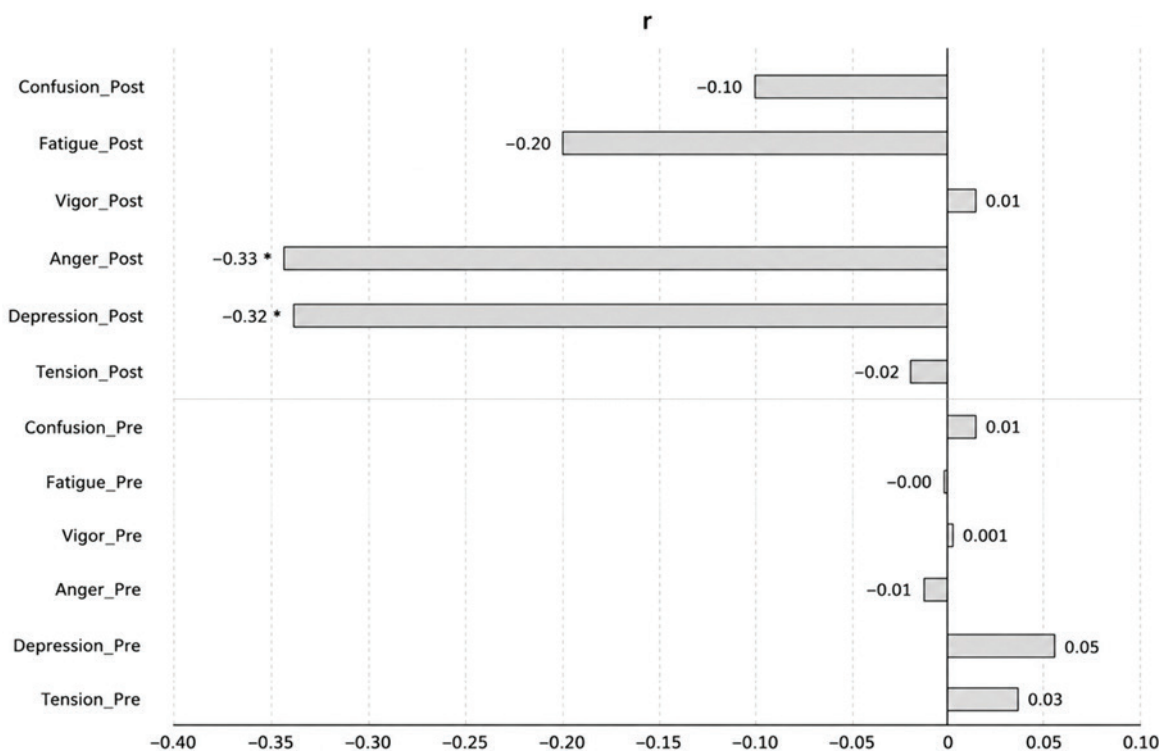
37.2±7.1 at pretest and posttest, respectively: t test =7.11, p<0.05). Additionally, significant pre- to post-testing differences were evidenced for all BRUMS subscales (Table 2).

**Table 2.** Descriptive statistics for BRUMS variables and t test differences between pre- and post-testing

	Pre-		Post-		T test	
	Mean	Std.Dev.	Mean	Std.Dev.	t value	p
Tension subscale (score)	7.00	2.41	6.38	2.86	1.81	0.01
Depression subscale (score)	5.69	2.63	3.93	2.97	2.72	0.01
Anger subscale (score)	6.98	2.45	5.07	2.74	3.35	0.01
Vigor subscale (score)	8.52	2.36	11.00	2.38	-4.74	0.01
Fatigue subscale (score)	6.19	2.57	5.50	2.80	1.85	0.01
Confusion subscale (score)	7.14	2.37	5.29	2.86	3.24	0.01
BRUMS total (score)	41.55	5.52	37.18	7.12	5.11	0.01

Correlations between physical literacy and BRUMS subscales at pretest and posttest are presented in Figure 1. As is evident, the physical literacy score was not significantly correlated with the BRUMS subscales at pretest, with negligible

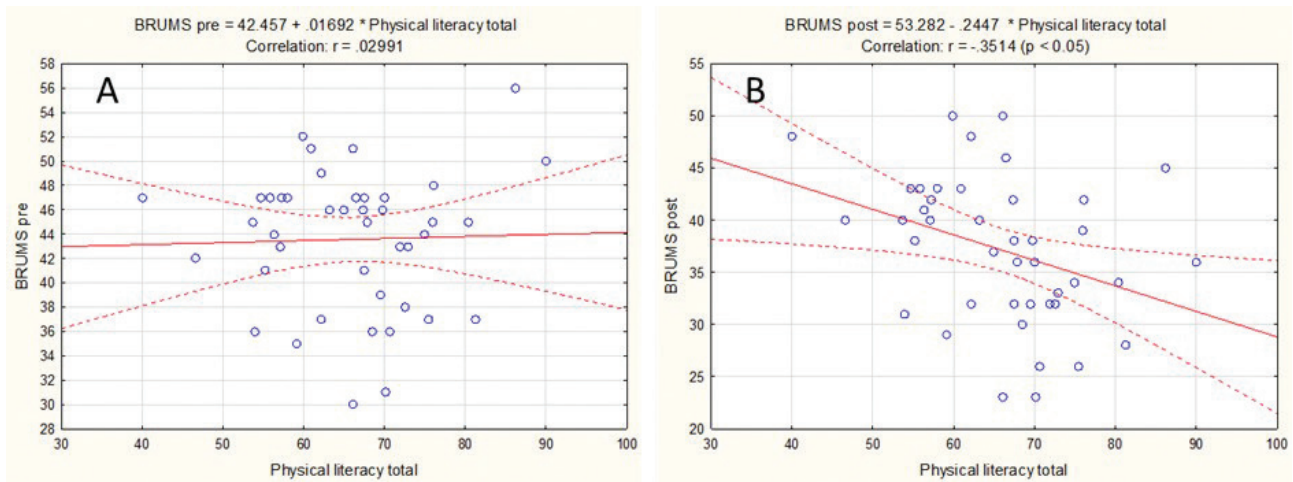
correlation coefficients. On the other hand, the physical literacy of the participants was significantly correlated with the tension subscale (r=-0.32, p<0.05) and depression subscale result (r=-0.33, p<0.05) obtained after the exercise session.



**Figure 1.** Correlations between physical literacy and BRUMS subscales at pre- and post-testing

The physical literacy score was not significantly correlated with the total BRUMS score obtained before the testing ses-

sion (Figure 2A), but a significant correlation was evidenced between variables at posttesting (Figure 2B; r=0.35, p<0.05)



**Figure 2.** Correlations between physical literacy and BRUMS total score at pre- and post-testing

When the correlation between physical literacy and postexercise BRUMS scores was partialized while controlling for exercise experience (duration of involvement in the recreational program), the correlation coefficient slightly decreased but remained statistically significant ( $r=0.32$ ,  $p<0.05$ ). In contrast, partialization controlling for participants' age did not result in any meaningful change in the correlation coefficient.

## Discussion

The main findings of this study indicate that physical literacy was not significantly associated with mood state prior to participation in recreational exercise sessions. However, significant associations were observed between physical literacy and postexercise mood state variables, with participants demonstrating higher levels of physical literacy generally reporting more favorable affective responses following exercise. Therefore, our initial study hypothesis can be partially accepted.

### *No association between physical literacy and mood state prior to the exercise session*

One possible explanation for the absence of significant associations between physical literacy and preexercise mood state is that baseline affective status in older adults may be more strongly influenced by immediate everyday circumstances than by relatively stable exercise-related characteristics. Mood states assessed prior to exercise are likely affected by factors such as sleep quality, daily stress, interpersonal interactions, health-related symptoms, fatigue, or environmental conditions experienced on the day of testing (Lane & Lovejoy, 2001; Stewart, Kelemen, & Ewart, 1994). Such short-term influences may overshadow the potential contribution of physical literacy to participants' emotional functioning before exercise participation. Consequently, although physical literacy reflects important personal capacities and dispositions related to movement and physical activity, its influence on mood may be less detectable in resting conditions where transient situational factors play a dominant role.

In addition, the absence of associations between physical literacy and preexercise mood state may also be explained

by the conceptual nature of physical literacy itself. Although physical literacy encompasses motivation, confidence, physical competence, and understanding related to physical activity participation, it does not necessarily represent a direct indicator of general emotional functioning or stable psychological well-being. Rather, physical literacy reflects a person's capacity and readiness to successfully engage in movement-related experiences (Boldovskaia, Dias, Silva, & Carraca, 2023; Gilic et al., 2025). Therefore, while individuals with higher physical literacy may possess more positive attitudes toward exercise and greater confidence in movement settings, these characteristics may not automatically translate into more favorable mood states before the onset of physical activity. This interpretation complements the previously discussed influence of situational and day-to-day factors on baseline mood. Specifically, transient emotional states experienced before exercise may be primarily shaped by immediate life circumstances, whereas the psychological benefits associated with physical literacy may emerge more strongly in contexts where individuals actively participate in movement and can behaviorally express their competence, motivation and confidence.

Another important consideration relates to the conceptual difference between the constructs assessed in this study. Specifically, the Brunel Mood Scale evaluates transient affective states by asking participants to report how they feel "right now," thereby capturing short-term emotional fluctuations that may vary substantially from day to day (Zhang et al., 2014). In contrast, physical literacy represents a broader and relatively stable multidimensional construct developed through lifelong experiences with movement and physical activity (Gilic et al., 2025; Huang, Sum, Yang, & Chun-Yiu Yeung, 2020). As a result, the temporal mismatch between these constructs may partially explain the absence of significant associations observed before exercise. While physical literacy may influence how individuals perceive, experience, and respond to physical activity situations, it may not necessarily predict momentary mood states assessed under resting conditions. Its effects may instead become more evident in situations involving active movement participation, where motivational, cognitive, and physical dimensions of physical literacy are directly engaged.

### *Significant correlation between physical literacy and postexercise mood state*

The significant associations between physical literacy and postexercise mood state appear logically consistent with the previously discussed absence of relationships before exercise participation. While preexercise mood states are likely influenced predominantly by immediate situational and day-to-day factors unrelated to movement itself, postexercise mood reflects an acute affective response directly connected to the exercise experience (Weinstein et al., 2024). In such circumstances, the relevance of physical literacy becomes substantially more pronounced because participants are actively engaged in movement-related behaviors that involve competence, motivation, confidence, and self-regulation. Consequently, the multidimensional characteristics underlying physical literacy may directly shape how individuals experience and emotionally respond to recreational exercise sessions.

The evidence shows that exercise improves mood in older adults, but direct evidence linking physical competence specifically to postexercise mood improvements is limited and mixed. A meta-analysis of 32 studies found effect sizes of 0.34–0.47 for mood improvements (Arent et al., 2000). Acute exercise studies support this finding: 16 trained older women (mean age 64.5 years) showed significant decreases in tension, depression, fatigue, and anger after 75 minutes of aerobic activity, and 54 older women (60+) showed increased positive mood after acute exercise (Christofoletti et al., 2019; Pierce & Pate, 1994). However, the direct link between physical competence and mood is unclear. In 79 postmenopausal women (mean age 70.3 years), better functional capacity showed no association with improved mood profiles (de Souza Zanini et al., 2023). Conversely, physical competence correlated with physical well-being in 97 older adults (60+), and perceived competence predicted physical activity engagement in 72 older adults (Huang, Sum, Yang, & Yeung, 2022; Overdorf, Coker, & Kollia, 2016). The evidence suggests that exercise benefits mood, but whether physical competence directly mediates this relationship requires further investigation.

One possible explanation for the partial inconsistency between previous findings and the results of the present study may lie in the methodological differences in the assessment of physical literacy. Specifically, most previous studies focused primarily on isolated indicators of physical competence or functional capacity rather than evaluating physical literacy as a multidimensional construct encompassing motivation, confidence, understanding, knowledge, and perceived competence related to physical activity (Arent et al., 2000; de Souza Zanini et al., 2023). Although physical competence represents an important component of physical literacy, it does not fully capture the broader psychological and behavioral dimensions that may be particularly relevant for affective responses to exercise. Consequently, studies relying exclusively on measures of functional or physical performance may have underestimated the potential relationship between physical literacy and postexercise mood state.

Unlike the lack of correlation between physical literacy and preexercise mood state, significant associations observed after exercise suggest that the psychological relevance of

physical literacy becomes more pronounced in contexts involving actual movement participation. Because physical literacy is inherently movement-related, its motivational, cognitive, and affective dimensions are likely activated during physical activity itself rather than under resting conditions – even before exercising (Gilic et al., 2025). In other words, individuals with higher physical literacy may perceive exercise as more enjoyable, meaningful, and manageable, which can contribute to more favorable emotional responses following participation (Yücekaya et al., 2025). Furthermore, the multidimensional assessment of physical literacy used in the present study may help explain differences compared with previous research that focused predominantly on isolated indicators of physical competence or functional capacity. While physical competence represents an important component of physical literacy, broader dimensions such as confidence, motivation, understanding, and knowledge related to physical activity may be particularly important for shaping acute affective responses to exercise.

It is also logically consistent that previous exercise experience partially moderated the relationship between physical literacy and postexercise mood state (please see results of partial correlations for details). Greater experience in this specific form of recreational exercise likely contributes to increased familiarity with the exercise environment, movement patterns, and social dynamics of the program, thereby enhancing feelings of safety, comfort, and self-confidence during participation (Raedeke, 2007). Such familiarity may allow individuals with higher physical literacy to more fully express the motivational, cognitive, and affective capacities associated with physically active engagement. In contrast, participants with less experience may still experience uncertainty, insecurity, or reduced confidence during exercise participation, which could attenuate the positive emotional effects associated with higher physical literacy. Therefore, accumulated exercise experience may strengthen the capacity of physical literacy to positively influence affective responses following recreational physical activity.

### *Limitations and strengths*

Several limitations of this study should be noted. First, the sample included only older women from one urban region in southern Croatia, which limits the generalizability of the findings to other populations and settings. Second, only acute changes in mood state were observed, without follow-up or retention testing, so long-term effects remain unclear. Finally, only age and exercise experience were included as covariates, while other factors that may influence mood responses to exercise were not controlled for.

On the other hand, this is one of the first studies to examine physical literacy as a potential factor influencing mood state before and after recreational exercise in older women. An additional strength of the study is the specific context of the recreational program, which was conducted in an open public space and reflected a realistic community-based exercise setting. Furthermore, the relatively large number of participants involved in the same long-term exercise program strengthens the consistency and practical relevance of the findings.

## Conclusions

Participants with higher levels of physical literacy demonstrated more favorable mood states following exercise participation. These results indicate that the psychological relevance of physical literacy may become particularly evident in contexts involving active movement participation rather than under resting conditions before exercise.

The results suggest that greater familiarity with the recreational exercise program may enhance confidence, comfort, and engagement during participation, thereby strengthening the positive emotional effects associated with higher physical literacy. This finding highlights the importance of long-term involvement and continuity in community-based physical activity programs for older adults.

Overall, the present study contributes to the growing body of literature emphasizing the multidimensional importance of physical literacy in older adulthood. Beyond its established role in promoting physical activity participation, physical literacy may also influence the quality of psychological experiences associated with exercise.

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### Conflict of interest

The authors declare no conflicts of interest.

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