Asian Journal of Sport and Exercise Psychology 3 (2023) 107–113

Contents lists available at ScienceDirect

Asian Journal of Sport and Exercise Psychology

journal homepage: www.elsevier.com/locate/ajsep

Physical activity and health-related fitness among Chinese older women: A test of self-determination theory☆

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ARTICLE INFO

Keywords:
Self-determined theory
Physical activity
Older women
Health-related fitness

ABSTRACT

Regular physical activity (PA) contributes to maintaining health and improving the quality of life among older people. This cross-sectional study investigates the associations between motivations derived from self-determination theory (SDT) and physical activity levels, as well as health-related fitness indices, in older Chinese women. We recruited 92 retired older women (range: 60–85 years; mean age ± SD: 71.74 ± 5.39 years) from Hong Kong, China. We assessed participants' motivations (autonomous motivation, controlled motivation, and amotivation) using the Treatment Self-Regulation Questionnaire, and measured their moderate-to-vigorous intensity physical activity (MVPA) and weekly walking using the International Physical Activity Questionnaire. We also evaluated body fat (fat mass, fat percentage, and visceral fat) using the Tanita SC240MA, flexibility with the Back Scratch Test and Chair Sit-and-Reach Test, and muscle strength using the Five-Times Sit-to-Stand Test and "Timed Up and Go" Test. We analyzed the data using partial-least squares structural equation modeling with Warp PLS 8.0 software. The results showed that autonomous motivation was significantly and positively related to walking ($\beta = .24$, $p < .01$) and MVPA ($\beta = .23$, $p < .01$); controlled motivation was negatively associated with walking ($\beta = -.26$, $p < .01$) and positively associated with MVPA ($\beta = .21$, $p < .05$); and amotivation was significantly and negatively associated with walking and MVPA ($\beta = -.17$, $p < .05$; $\beta = -.16$, $p < .05$). The results also generally suggest that a higher PA level is linked to better health-related fitness. However, the expected indirect effects of motivation on health-related fitness outcomes were not statistically significant. Our results support SDT in explaining older women's participation in physical activity. Although physically active older women were more likely to be physically fitter, motivation in physical activity did not exert significant indirect effects on all health-related fitness outcomes.

Physical activity (PA) plays a crucial role in maintaining the physical and psychological well-being of older individuals. Numerous epidemiological studies have indicated that regular PA is associated with reduced risks of diseases, falls, and disability, as well as increased levels of independence among older people (Cicero et al., 2012; Chen et al., 2012; Choi et al., 2013; Santos et al., 2012). Among various levels of PA (i.e., walking, moderate intensity physical activity, and vigorous intensity physical activity), overall moderate-to-vigorous physical activity (MVPA) has been shown to reduce obesity and positively correlate with better functional fitness, such as flexibility and muscular strength. These factors are essential for performing daily activities and improving health-related quality of life among older adults (Baltaci et al., 2003; King et al., 2000; Nawrocka et al., 2017). Despite there being a variety of evidence to support the association between regular physical activity and a wide range of health indices, compared to men, older women are generally more sedentary and less active (Lee, 2005). Their PA participation severely decreases with age (Plonczynski, 2003), and fewer of them achieve the recommended levels of PA (Hughes et al., 2008). Understanding the motivational profiles of older women may be key to increasing their PA engagement. As a result, there is a need for theoretical research investigating the associations between motivation, different PA levels, and fitness outcomes to better characterise the psychological patterns of this population. The purpose of the current study is to apply self-determination theory (SDT) (Deci & Ryan, 1985) to

☆ The project of this paper was supported by the "Super Senior, Flash Mob" program of St. James' Settlement.
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https://doi.org/10.1016/j.ajsep.2023.08.001
Received 6 December 2022; Received in revised form 13 August 2023; Accepted 14 August 2023
Available online 29 August 2023

understand how motivation is related to older women's MVPA, walking, and health-related fitness.

Theoretical framework

Self-determination theory (SDT) is a widely used psychological framework for explaining the role of motivation in human behaviour. According to the theory, the quality of motivation may determine how well individuals adhere to certain advised behaviours (Vansteenkiste et al., 2006). Specifically, it proposes a multidimensional conceptualisation of motivation and distinguishes between three broader and qualitatively different forms of motivation, namely, autonomous motivation, controlled motivation, and amotivation (Deci & Ryan, 2002). Autonomous forms of motivation are driven by intrinsic motivation, usually out of personal interest and pleasure, to achieve personally valued goals with psychological freedom, experiences of volition and reflective self-recognition. Behaviour driven by controlled motivation is usually caused by external events, such as avoiding punishment or being pressured by society, or regulated by introjected reasons such as avoiding guilt and shame. Amotivation characterises individuals who do not possess clear motives or purposes behind their actions, and they do not understand why they undertake certain behaviours (Deci & Ryan, 2000). According to SDT, a self-determined profile of motivation is often regarded as adaptive, as it is characterised by high autonomous motivation, low controlled motivation, and low amotivation. The central premise of SDT is that individuals' motivational profile is that as individuals become more self-determined in their motivational profile, the more likely they are to experience positive emotional, cognitive and behavioural consequences (Vallerand, 1997); thus, autonomous motivation was expected to be correlated with higher levels of PA engagement. However, less self-determined forms of motivation, i.e., controlled and amotivation, were expected to be linked to lower levels of PA engagement.

Hypothesis development

SDT has been widely applied in the setting of sports and exercise (Boiché & Sarrazin, 2007; Ryan et al., 1997; Ryan & Deci, 2019; Standage & Ryan, 2020; Teixeira et al., 2012). The results from systematic reviews show synthesised evidence and consistent support for a positive relationship between autonomous motivation and PA (Teixeira et al., 2012; Fortier et al., 2012), thus supporting the central tenet of SDT. Collectively, the existing research verified that higher levels of self-determined motivation predicted higher levels of participation in PA across different populations. However, studies using SDT to investigate older individuals' PA and the motivational nature of this population are limited (Duncan et al., 2010). In the systematic review of Teixeira and colleagues (Teixeira et al., 2012), it was found that the sampling populations of SDT-based studies in exercise settings mainly comprise students, healthy adults, and rehabilitation patients. Indeed, few studies applied SDT as the theoretical framework for the understanding of how autonomous motivation can contribute to PA among older adults. For example, in Ferrand et al. (Ferrand et al., 2012)'s study, older people aged 70 and beyond who were categorised into the highly self-determined group reported a higher level of PA than their low self-determined counterparts. Another study using a structural equation model found that older adults' autonomous motivation is positively associated with their PA behaviour (Arnautovska et al., 2019). Moreover, studies focusing on older women using the tenets of SDT are still scarce (Stephan et al., 2010), making SDT's explanatory power in this population largely unknown. To our best knowledge, no existing research is yet to test whether different types of motivation in physical activity are related to health-related fitness in older women. As a result, the current understanding of SDT's potential in elucidating motivation towards physical activity among older women remains limited, highlighting the need for further research in this area.

Thus, by drawing on SDT, we focused on older women's motivational profile and extended the previous research by exploring the dynamics underlying this psychological process with PA levels and health-related fitness. Using the objective measurement of health-related fitness, our study makes an original contribution to the literature by providing initial evidence regarding the relationship between motivations, PA level, and objective assessment of health-related fitness outcomes. It is important to note that the benefits of PA are not solely limited to MVPA. Light-intensity PA, such as walking, has been shown to have positive effects on health outcomes such as reducing the risk of chronic diseases and improving cognitive function among older adults (Hamer et al., 2014). In our study, we used walking and MVPA as two indicators of PA to capture a range of activity levels among older women. The findings might shed light on the understanding of how self-determined motivational profiles are related directly and indirectly to PA level and health-related fitness among older women. Such findings can provide insights for promoting the PA level or health-related fitness of older women in future fitness interventions.

Based on the previous literature and the tenets of SDT about the relationship between motivations and level of physical activity (Standage & Ryan, 2020), and the evidence showing the relationships between PA and health-related fitness among older women (Nawrocka et al., 2017), we formed the following hypotheses:

H1: Autonomous motivation in PA would be positively associated with the physical activity level (i.e., walking and MVPA).

H2: Controlled motivation and amotivation would show either a negative or nonsignificant relationship with PA level.

H3: PA level would be positively associated with muscle strength (H3a) and flexibility (H3b) and negatively associated with body fat (H3c).

H4: The indirect effect of autonomous motivation on health-related fitness outcomes would be positive.

H5: The indirect effect of controlled motivation and amotivation on health-related fitness outcomes would be either negative or nonsignificant.

Methods

This study received ethical approval from the Human Research Ethics Committee of the Education University of Hong Kong.

Participants and procedures

In May 2021, Participants were recruited from 14 elderly centres of St. James' Settlement, which is one of the major nonprofit organisations in Hong Kong that provide a comprehensive range of elderly-related services, including elderly care. The elderly centres were not for residential or medical purposes, rather, they were community service centres where senior citizens could gather for social, educational, and other volunteering activities. The participant's inclusion criteria were as follows:

(1) Women aged 60 years or older

(2) No illness or disability prevented them from performing moderate-to-vigorous intensity movement or exercise.

It is important to note that our age threshold of 60 years for defining older adults is a widely adopted threshold in ageing research and is supported by various studies (Chatterji et al., 2015). Furthermore, in Hong Kong, the official retirement age for many occupations, including civil servants, is 60 years old. This local context further justifies our inclusion criterion of participants aged 60 years and older, as our study focuses on retired older women.

The final sample for this study consisted of 92 retired older women, ranging in age from 60 to 85 years (mean age = 71.74 ± 5.39 SD). 23% of the participants reported chronic diseases such as hypertension and diabetes, but they did not see these conditions affecting their PA participation (were suitable for engaging in physical assessment and

MVPA). We ensured that the purpose of the study, the process and the right to participate were clear to each participant. Participants must sign the consent form before starting the survey. We gave no inducements to the participants, and the participation was completely voluntary. Before our testing, all participants gave written informed consent. Volunteers who assisted with data collection were trained on how to collect survey data and conduct physical assessments of older participants.

We first conducted physical assessments on the older women, and the order of completing the study's various behavioural or fitness assessments was randomised to minimise any order effects. After the physical assessment, a survey of physical activity level and motivation was conducted. Demographic information, height and weight of each participant were also measured. All data were collected from May 6th to 28th, 2021.

Measures

Self-determined motivation

The Treatment Self-Regulation Questionnaire (TSRQ) for Physical Activity was used to assess motivation to exercise. The scale consists of 15 items, each assessing one of three forms of motivation: 1) autonomous motivation (6 items, e.g., "I want to do adequate physical activity because it is consistent with my life goals"); 2) controlled motivation (6 items, e.g., "I want to do adequate physical activity because I feel pressure from others to do so"); 3) amotivation (3 items, e.g., "I want to do adequate physical activity because it is easier to do what I am told than think about it"). We followed the standard translate-back-translate procedure (Hambleton et al., 2004) to translate the English items of TSRQ into Chinese, the first language of the participants, using other Chinese versions of TSRQ in different health settings as references (Chan et al., 2020; Lee et al., 2020). Participants rated each item on a 7-point Likert scale ranging from 1 (not at all true) to 7 (very true). The Chinese version of TSRQ used in this study is a reliable measure of PA motivation, demonstrated by acceptable internal consistency with each construct's Cronbach alpha $> .80$.

Physical activity

Physical activity was assessed with a modified version of the "International Physical Activity Questionnaire – Short Form" (IPAQ-SF). This questionnaire evaluated participants' physical activity in terms of 1) vigorous intensity physical activity, 2) moderate intensity physical activity, and 3) walking. The IPAQ has been widely used and validated across diverse cultures, including Chinese populations (Lee et al., 2011), and has been shown to be valid among older populations (Craig et al., 2003; Deng et al., 2008). According to the IPAQ algorithm, participants' time spent in each physical activity level was recalculated into the metabolic equivalent of task (MET) (Fan et al., 2014). Participants' PA level variables were categorised into MET in walking and MET in moderate-to-vigorous intensity physical activity (MVPA; the sum of total METs of moderate intensity PA and vigorous intensity PA).

Body fat

Fat mass, fat percentage and visceral fat were measured using TANITA SC240MA bioimpedance digital scales. This bioelectric impedance scale is commonly a measure of body composition when given height, age and gender. It can quantify the participant's body composition using electric conductivity. This result enables us to understand the participant's composition, in particular, body fat and visceral fat.

Flexibility

Upper body flexibility is assessed by the Back Scratch Test. The participant is asked to perform the attempt by placing his/her hands behind his/her back. The distance between the tips of the middle fingers was measured, and the result was negative in centimetres if the participant could not bring the hands together and positive if the fingers overlapped each other (Rikli & Jones, 2013). The Chair-Sit-and-Reach Test examines participants' lower body flexibility while sitting on a chair and is designed for less mobile participants who find it difficult to get up/down from the floor. With both the palms facing down and hands stacked, they can proceed to reach towards the extended leg, and the distance between their fingertips and toes will be recorded.

Muscle strength

The Timed Up-and-Go Test is a performance-based measure of muscle strength, balance impairments and functional mobility among older adults (Bohannon, 2006). In the Timed Up-and-Go Test, the participants first need to rise from an armchair and walk to a 3-metre-away marker. They then walk back and sit down on the chair again. The time taken to complete the process is recorded in seconds. The Five Times Sit-to-Stand Test is often used to measure lower limb muscle strength and has demonstrated good validity among older women (Whitney et al., 2005). Each participant needs to cross their arms and place them in front of their chest and then sit up straight against the back of the chair. The time spent by the participants was noted in seconds.

Data analysis

To test the hypothesised relationships between motivations, physical activity, and health-related fitness, we conducted partial-least squares structural equation modelling (PLS-SEM) using Warp PLS 8.0 software. Partial least squares is a distribution-free modelling analysis that enables researchers to examine complex psychological pathways using small samples. It does not take into account the complexity of the model, the non-normality of the data and the small sample size, so its estimation algorithm allows for the estimation of error-free latent variables (Kock, 2014). In the context of our study, we employed SEM to analyze the relationships among variables, as well as the direct and indirect pathways within the model. We tested our hypothesised relationships and indirect effects simultaneously in one model (i.e., motivations → physical activity levels → health-related fitness). We evaluated "model fit" using a number of fit indices, including averaged R-squared (ARS), averaged variance inflation factor (AVIF), the goodness-of-fit (GoF) index and averaged path coefficient (APC). If the p values of ARS and APC are lower than .05, the AVIF is less than 5, and the GoF index (for medium effect size) exceeds .25, the global fit will be considered acceptable.

Results

Data screening and model fit

The results of the PLS-SEM model measurement level showed that the reliability, the latent variables' convergent and discriminant validity in our study were acceptable. According to Wetzels et al. (2009), Cronbach's alpha(from .64 to.98), composite score reliability (.81 to.99) and AVE (from .58 to.97) met the published criteria for acceptable reliability. The results of the cross-loadings and combined loadings obtained from the confirmatory factor analysis with values ranging from .67 to .98 indicated strong correlations between the variables and their respective constructs. The cross-loadings were relatively small, with values ranging from -.02 to .31, suggesting minimal overlap between the constructs (all loadings were significant at the $p < .001$ level). Our results suggest that the psychometric properties of the latent variables in this study was acceptable.

The correlations of latent variables and square roots of the average variances extracted (AVE) are shown in Table 1. In this study, the square root of the AVE for all latent variables was greater than the correlation involving each latent variable, indicating good discriminant validity of the measurement instrument (Fornell & Larcker, 1981; Kock, 2011). According to the model fit index published criteria for a PLS-SEM, the goodness-of-fit indicators (APC = .22, $p < .01$; GoF =.31; ARS =.12, $p <$

Table 1
Correlations among latent variables and coefficients with square root of AVEs are shown on the diagonal in the brackets.

Correlations	1	2	3	4	5	6	7	8
1. Autonomous Motivation	(.80)							
2. Controlled Motivation	.01	(.76)						
3. Amotivation	.03	.53	(.76)					
4. Walking	.23	-.13	-.09	(1.00)				
5. MVPA	.17	.00	-.09	.01	(1.00)			
6. Body Fat	.10	.16	.10	-.20	-.04	(.98)		
7. Muscle Strength	-.00	-.14	.08	.241	.07	-.28	(.87)	
8. Flexibility	.14	.07	-.03	.013	.36	-.43	.33	(.78)
Coefficients								
Composite reliability	.92	.89	0.81	1.00	1.00	.99	.86	.86
Cronbach's alpha	.89	.85	0.64	1.00	1.00	.98	.68	.78
Average Variance Extracted	.64	.58	0.58	1.00	1.00	.97	.76	.61
Full Collinearity VIF	1.17	1.48	1.49	1.23	1.20	1.43	1.29	1.64
Q-square	-	-	-	0.14	0.11	0.12	0.08	0.16

Note. MVPA = Moderate and Vigorous Intensity Physical Activity.
Correlations among latent variables and square roots of their average variances extracted are shown at the top part of the table. Several latent variable coefficients and test results are provided at the bottom part.

.01; AVIF = 1.03) suggested that our model supported these data well.

Main findings

Autonomous motivation was positively (β = .24, $p < .01$; β = .23, $p < .01$) associated with walking and MVPA, supporting **H1**. Amotivation was significantly and negatively (β = -.17, $p < .05$; β = -.16, $p < .05$) associated with walking and MVPA. Controlled motivation was negatively (β = -.26, $p < .01$) associated with MET Walking but positively (β = .21, $p < .05$) associated with MVPA. These results partially supported **H2**.

For **H3a**, walking was positively (β = .24, $p < .01$) associated with muscle strength (H3a); however, the association between MVPA and muscle strength was not significant (β = .12, $p > .05$). **H3a** is only partially supported. For **H3b**, the link between walking and flexibility was not significant (β = .11, $p > .05$), while MVPA was positively associated (β = .35, $p < .01$) with flexibility, which partially supports our **H3b**. For H3c, walking and MVPA were both negatively (β = -.24, $p < .01$) associated with body fat (BF), supporting our H3c. Overall, our **H3** was partially supported.

Unfortunately, the expected indirect effects of self-determined motivation (autonomous, controlled and amotivation) on all health-related fitness outcomes were not statistically significant, which led to a lack of support for **H4**. In contrast, **H5** is supported. The path coefficients of each hypothesised direct effect and the respective significance levels in our PLS-SEM model are shown in Fig. 1 (*$p < .01$; ** $p < .001$).

Discussion

Although engaging in regular PA has shown to be important for older adults' health (Williams et al., 2014), older women were less likely to engage in PA than males (Lee, 2005), making it important to explore their motivation profiles for PA. Thus, it is essential to explore the motivation profiles for PA in this demographic. Drawing from self-determination theory (SDT), this study investigated the associations between SDT-based motivations and physical activity levels, as well as objectively measured indices of health-related fitness among older Chinese women. Consistent with our hypothesis, older women's autonomous motivation towards PA exhibited positive relationships with both walking and MVPA. Our findings align with the fundamental principles of SDT and previous research examining the role of autonomous motivation in older individuals' PA behaviour (Ferrand et al., 2012; Arnautovska et al., 2019).

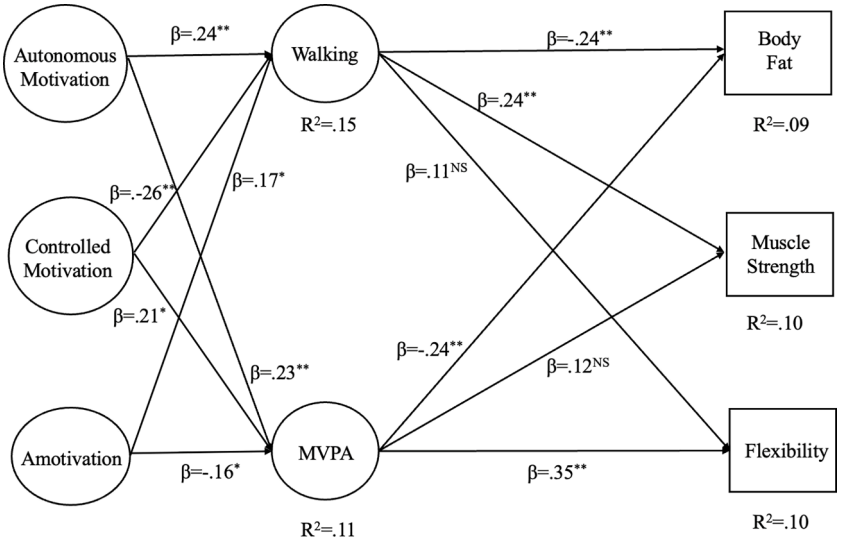

Fig. 1. *PLS-SEM Results.*
Note. MVPA =Moderate and Vigorous Intensity Physical Activity
* $p < .05$, ** $p < .01$; NS= not significant.

Motivation and PA

The positive relationship between controlled motivation and self-reported MVPA was however contrary to the predictions of SDT and our hypothesis. One possible explanation for this unexpected effect would be that, according to previous research, preventive health goals (i.e., maintaining health and decreasing health risks), which can be categorised as controlled motivation, are the main reasons older adults engage in PA, especially MVPA (Dacey et al., 2008; Netz & Raviv, 2004). A qualitative study investigating the motivation of older people to participate in physical activity also showed that they tended to view physical activity as preventing or reducing their risk of developing potentially age-related or specific diseases. (Arnautovska et al., 2017). Considering the constraints that older people often face in relation to ageing and disease (Williams et al., 2014), enhancing controlled motivation may be useful in promoting their PA level. At the same time, the results showed that older women who were more amotivated tended to walk more. The positive correlation between amotivation and walking was contrary to our hypothesis; however, this result demonstrates the pathway of implicit motivational processes underpinning older women's PA, indicating that older people may engage in walking out of habit and hardly ever consider the reasons or justifications for doing so. This pattern of results may be congruent with the view from the literature about the automaticity of human health behaviours (Chan et al., 2018; Keatley et al., 2014). Sometimes individuals' behaviours are not only intrigued by the explicit psychological process (Hamilton et al., 2013; Rhodes et al., 2010) but can also be triggered by some environmental cues, which can prompt preexisting habit patterns and, through automaticity, lead to spontaneous activation of the represented behaviour (e.g., going for a walk with spouses). However, MVPA was not significantly correlated with amotivation, which might be due to the possibility that MVPA demands higher functional fitness and more physical and psychological energy than walking (Burton et al., 2013; Chen, 2010), where automaticity or nonconscious processes are more likely to take place (Chan et al., 2017; Hagger et al., 2016). However, previous studies have shown inconsistent results regarding the positive relationships between amotivation and health behaviours (Biedenweg et al., 2014). It is crucial for future research to examine the orientation and function of amotivation within the self-determination spectrum and better understand how this motivational construct may be linked to health behaviours through habit formation or implicit processes.

PA and health-related fitness

The results generally suggest that the more older women walk and engage in MVPA, the better their health-related fitness. Both walking and MVPA are correlated with less body fat, walking is associated with better muscle strength, and MVPA is linked to improved flexibility, which is consistent with numerous studies (Santos et al., 2012; Nawrocka et al., 2017; Mendonca et al., 2016). However, we did not observe a significant relationship between walking and flexibility. This lack of correlation may be due to the fact that improving flexibility often requires targeted training (e.g., dynamic stretching) for improvement (Mendonca et al., 2016). Likewise, the absence of a significant relationship between MVPA and muscle strength may support the notion that strength training or weightlifting is more effective for building muscle strength (Martins et al., 2013). This aligns with the WHO's recommendation that older adults engage in muscle-strengthening exercises at least twice a week in addition to meeting the recommended level of MVPA (Bull et al., 2020). Based on these findings, it may be beneficial for older adults to incorporate both MVPA and targeted strength/weight training into their exercise routines to maximize the health benefits of physical activity. Our expected significant indirect correlations from autonomous motivation to fitness outcomes were insignificant. After all, older people's health-related fitness is a complex variable influenced by numerous external and personal factors (K et al., 2004). Motivation is often regarded as the distal psychological antecedent of health behaviour, so its association with health outcomes, such as fitness, could be mediated by other psychological and behavioural factors (Baert et al., 2011). Future studies may consider incorporating other proximal psychological predictors, such as social cognitive beliefs and intention, in predicting health-related fitness.

Implications of study findings

Given the complexity of influences that can affect health behaviour in later life (Ziegelmann & Knoll, 2015) and that a high proportion of older people remain inactive (Harvey et al., 2013), it is important to capture a holistic picture that reflects older adults' motivational process towards PA. Our study not only delineates the motivational profiles for PA of older women, but may also shed light on the design of future PA promotion programmes for this population. Previous studies have shown that the effectiveness of interventions can be improved by using theory to develop programmes (Noar et al., 2007) and tailoring programmes to the population of interest (Müller-Riemenschneider et al., 2008). The consistent positive associations between autonomous motivation and PA behaviours, in our study and also previous studies (Chang, 2012), might highlight the importance of helping older people to set goals that are consistent with their personal values and are considered to be motivated by enjoyment or personal free choice. On the other hand, the positive relationship between controlled motivation and MVPA in our findings suggested that future intervention studies should examine if promoting a controlled form of motivation, for instance, by highlighting the health benefits of physical activities, may enhance older women's participation in high-intensity PA. Previous studies have reported that older adults might hold negative personal beliefs against MVPA (e.g., MVPA is perceived as being dangerous and age-inappropriate) (Franco et al., 2015). Similarly, extant studies have shown that older adults are not interested in PA (Gellert et al., 2015), which could be caused by not perceiving it as having personal value and benefit. In fact, the majority of empirical studies emphasise the physical health benefits of regular PA rather than mental health when giving PA recommendations to older people (Arnautovska et al., 2018; Zubala et al., 2017), making older people less aware of the affective consequences of PA, such as increased life satisfaction, improved relationships, and enjoyment of exercise. This approach may trigger less autonomous motivation for PA and lead to a greater salience of controlled motivation in older people when exercising, which also points out the need for future studies to examine the combined effect of autonomous and controlled motivation in PA promotion among older individuals.

Another interesting findings of the current study is that amotivation is positively related to walking. A possible explanation is that they might have formed a habitual or automatic decision-making process to walk (Keatley et al., 2014); therefore, they did not consciously consider whether they were motivated to do so. Research has shown that habitual walking offers important benefits to health in terms of improving physical performance and fitness and preventing physical disability, especially for older women (Lee, 2005; Wong et al., 2003). However, we did not measure automaticity or any other 'implicit pathways of PA (Rebar et al., 2016). Hence, we recommend that future studies investigate the role of amotivation in older individuals' PA habit formation.

Study limitations

Despite the unique findings of this study, we have to acknowledge our study's limitations. First, due to the cross-sectional design of this study, we cannot establish causal relationships between self-determined motivation and PA in older women. Longitudinal follow-up assessments of PA and health-related fitness would be necessary to determine if motivation can increase PA levels and improve health-related fitness outcomes over time. Second, while we included objectively assessed

physical fitness data, participants' PA behaviours were measured using self-report questionnaires. Although self-report measurements have been shown to be a valid and reliable way to assess PA (Milton et al., 2011), they may be subject to recall bias and social desirability bias. To provide a more accurate assessment of PA behaviours, future studies may consider implementing objective measures of PA levels, such as pedometers or accelerometers, in addition to self-report questionnaires. Third, our sample was limited to older Chinese women in Hong Kong, and was relatively small in size (even though the sample size was considered adequate for our non-parametric analysis), which might restrict the generalizability of the study findings to other populations with different sampling characteristics or cultural backgrounds. Consequently, the generalizability of our study's results may be restricted. To enhance the generalizability of findings, future research should include samples from diverse cultural backgrounds and geographical locations (Chan et al., 2017).

Conclusion

In conclusion, the current study examined the relationships between self-determined motivation, PA levels, and objectively assessed health-related fitness indices among older Chinese women. The findings supported the central tenet of SDT, as older women who reported more autonomous motivation towards physical activity were more likely to engage in it than those with controlled motivation or amotivation. Furthermore, a higher level of walking was associated with lower body fat and better muscle strength, while moderate-to-vigorous physical activity was related to lower body fat and better flexibility. However, the nonsignificant indirect effects of motivation on health-related fitness may imply that the relationships of motivation and fitness-related outcomes appear to be trivial. Future studies may benefit from investigating potential mediating variables that may better explain the link between motivation and health-related fitness. Overall, our results provide an initial investigation into the motivational processes of older women's PA levels and health-related fitness. These findings may lay the groundwork for developing theory-driven interventions to promote the motivation and PA levels of older women using behavioral change strategies derived from SDT.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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