How motivation influences physical activity engagement among active older adults: The contribution of identity and habit

Johan Caudroit[*1], Julie Boiché[2], Marine Vigneron[3], Paquito Bernard[4]

[1] Laboratory of Vulnerabilities and Innovation in Sport (UR 7428), Université Claude Bernard Lyon 1, Lyon, France
[2] Laboratoire EUROMOV, University of Montpellier, Montpellier, France
[3] Comité départemental de la Retraite Sportive du Rhône et de Lyon métropole, French Federation of Sport Retirement, Lyon, France
[4] Inserm, EHESP, IRSET (Institut de Recherche en Santé, Environnement et Travail), Université Rennes, UMR_S1085, Rennes, France

[*] johan.caudroit@univ-lyon1.fr

ORIGINAL ARTICLE

Submitted: June 2, 2024

Accepted: February 28, 2025

Published: May 2, 2025

ABSTRACT

Objective: Using a moderated mediation model, the present study investigated whether the mediation of physical activity (PA) habit into PA level via PA identity depends on the levels of both autonomous and controlled motivation among active older adults.

Method: A one-month prospective study was conducted among 220 French physically active older adults. They were administrated measures of sociodemographic variables, self-determination, habit, and identity at baseline as well as PA level one month later.

Results: PA identity partially mediated the positive relationship between PA habit and PA level. In addition, moderated mediation analysis revealed that PA identity and the interaction between habit and motivation were positively and significantly associated with PA level. More precisely, PA habit was related to PA level only for older adults with both high level of controlled motivation and moderated or high level of autonomous motivation.

Conclusion: The results highlighted the crucial role of PA identity in the prediction of PA level among physically active older adults. They also revealed the importance to consider various types of motivations in the maintenance of PA.

Citation:

Caudroit, J., Boiché, J., Vigneron, M., & Bernard, P. (2025). How motivation influences physical activity engagement among active older adults: The contribution of identity and habit. *Current Issues in Sport Science*, *10*(1), Article 003. https://doi.org/10.36950/2025.10ciss003

Keywords

identity, self-determination, habit, active older, physical activity

Introduction

Maintaining physical function, independence, and quality of life among people aged 60 years or more represents both a public health priority and an economic imperative (Piercy et al., 2018). To this end, performing physical activity (PA), a behavior recognized to improve physical and mental functions and to maintain the mobility and independence of older people (Cunningham et al., 2020; Sun et al., 2013 for systematic reviews), is deemed increasingly important (McPhee et al., 2016). However, the majority of the positive health outcomes of PA require long-term maintenance (Shortreed et al., 2013), and many older adults do not meet or maintain the recommended World Health Organization (WHO) PA guidelines (A. Bauman et al., 2016). For example, Clemente Remón et al. (2021) revealed that only 55.5% of European older adults meet the WHO PA recommendations (WHO 2010), and the mean prevalence of physical inactivity in older Europeans varies from 5% to 29% (Gomes et al., 2017). As a consequence, it appears crucial, beyond the interest in getting inactive older people to initiate PA, to investigate the psychological processes underlying PA maintenance, to help older adults who are already physically active to perform this behavior on a regular and sustainable basis.

According to the dual-process (e.g., Maintain IT models; Caldwell et al., 2018) and the multi-process action control model (M-PAC; Rhodes, 2017) approaches, PA maintenance involves a decrease in the use of self-regulation and executive function processes, leading to the development of automatic processes (e.g., habit) and the emergence of an identity specific to this behavior. Moreover, in line with self-determination theory (SDT; Deci & Ryan, 2002), it is assumed that PA maintenance results from a transition from extrinsic motivation to more self-determined motivation (Ryan & Deci, 2000). It is important to note that individuals could also report self-determined and non-self-determined forms of motivation for a given domain (Fairchild et al., 2005; Vallerand, 1997). Indeed, distinctive combinations of motivation among different groups of physically active older adults emerged from previous studies, examining motivational profiles based on SDT using cluster analysis (Ferrand et al., 2012, 2014; Stephan et al., 2010). Thus, the present research aimed to investigate the interplay between habit, identity, and motivation in predicting PA levels among physically active older adults.

Habit, defined as a pattern of behavior that is regularly performed over time within a similar context and eventually requires little conscious decision-making (Gardner et al., 2011), is considered a key concept in PA maintenance (Gardner & Lally, 2018). Verplanken and Orbell (2003) summarize the basic features of habit as follows: a history of repetition, features of automaticity (i.e., lack of control, lack of awareness, efficiency), and their reflection of someone's identity. In their meta-analysis, Gardner et al. (2011) found that habit presents a moderate-to-strong correlation with PA level (r = .43; CI = .39 - .47). This result was corroborated by longitudinal studies, revealing that older adults with more vigorous habits for PA are more likely to engage in being physically active (Arnautovska et al., 2017; Van Bree et al., 2017). As suggested by Verplanken and

Sui (2019), one possible explanation of this relationship is that PA habit may serve as a potential source of the development of a specific identity toward PA, facilitating the maintenance of this behavior over time. In this approach, the relationship between habit and identity occurs through a self-perception (Bem, 1972). For example, the perception of one's own frequently performed behaviors may lead to the inference that these behaviors are important to the individual and may therefore be considered as a part of the individual's identity (e.g., Neal et al., 2012; Wood & Rünger, 2016).

Identity theory (Burke & Reitzes, 1981; Stryker & Burke, 2000) posits that people are driven by a fundamental need to maintain a coherence and consistent sense of self. People may partly construct this sense of self or identity by reflecting on their own behavior, that is, when a behavior is frequently performed, it is more likely to become part of a person's self-concept (Bem, 1972). The term self-identity has been introduced to refer to the extent to which a particular behavior is a salient part of one's self-concept (Sparks & Shepherd, 1992). Thus, identity predicts behavior when the meaning of the behavior is aligned with the meaning ascribed to an individual's identity (Burke & Reitzes, 1981). The exercise identity concept refers to the extent to which one holds the role of "exerciser" as a core aspect of one's identity (Anderson & Cychosz, 1995). Individuals who identify as "exercisers" are expected to seek congruency between this identity and their behavior. It is important to note that there are some nuances in terms of how older populations might view exercise and PA. Indeed, some authors found that older adults find the term PA to be more inclusive of their activities than the term exercise by allowing for more choice regarding how they incorporate PA into their lives (Ory, 2003; Whaley & Ebbeck, 2002). As such, they associate themselves more with a PA identity than with an exerciser identity (Strachan et al., 2010; Whaley & Ebbeck, 2002). A meta-analysis by Rhodes et al. (2016), revealed a medium-sized correlation between PA or exercise identity and PA level (r = .44; CI = .38 - .48). This result is in line with studies, conducted in the context of aging, which found a significant and positive relationship between identity scores and PA level (Sincharoen, 2005; Strachan et al., 2010). A meta-analysis on the role of self-identity in the theory of planned behavior, also reported a correlation of .33 between self-identity and past behavior, which is often considered as a proxy of habit (Rise et al., 2010). This result may suggest that the repetition of the behavior, which is one of the characteristics of habit, may contribute to the development of a strong identity toward a specific behavior. In line with social cognitive models (Deci & Ryan, 2002; Fishbein & Ajzen, 1975; Rise et al., 2010), habit may become part of self-identities through the end result of enacted motivations. A strong motivation, anchored in self-identity, may instigate repeated action, which may then become a habit. Thus, the relationship between habit and identity in the prediction of PA level may depend on the type of motivation developed by an individual toward PA.

SDT proposes a multidimensional conceptualization of motivation with autonomous and controlled motivation representing the two main types (Deci & Ryan, 2002). This theory suggests that individuals' motivation varies along a continuum of relative autonomy of self-regulation, including more or less autonomous (i.e., engaging in a behavior because of personal interest or perceived value) versus controlled (i.e., engaging in a behavior because of a sense of external or internal pressure) motives. Previous research using this framework supports the view that individuals are more likely to simultaneously hold different motivations for a given context, toward which they can be, to a certain extent, intrinsically motivated, extrinsically motivated, and/or amotivated (Deci & Ryan, 2000; Vallerand, 1997). When a person engages in autonomously regulated behavior, it could be due to the inherent interest and enjoyment it provides (i.e., intrinsic motivation), the fact that the individual recognizes its importance although he/she may not enjoy performing it (i.e., identified regulation), or because the person integrates the behavior as inherent to him/herself and perceives it as being aligned with his/her own values (i.e.,

integrated regulation). However, individuals can also be motivated to engage in behavior for controlled reasons, such as doing it out of guilt or shame (i.e., introjected regulation) or because others pressure them to engage in the behavior (i.e., external regulation) (Deci & Ryan, 2000). A meta-analysis suggests that older adults who present a high level of autonomous and a low level of controlled motivation are those who tend the most to maintain their PA level over time (Huffman et al., 2021). However, previous studies also found distinct motivational profiles among physically older adults (Ferrand et al., 2012, 2014; Stephan et al., 2010). For example, Ferrand et al. (2014) identified two distinct profiles, i.e., "Highly self-determined profile" (characterized by high levels of intrinsic motivation, identified regulation and introjected regulation and low level of external regulation) and "low to moderate introjected profile" (characterized by low scores of intrinsic motivation and external regulation and moderate score of introjected regulation). Those results suggest that the level of self-determination alone does not account for the motivational dynamics underlying the adoption and maintenance of behaviors such as PA (Hagger & Chatzisarantis, 2009; Rhodes & De Bruijn, 2013). In this vein, some studies have considered the interplay between motivation and habit (e.g., Gardner & Lally, 2013; Hopkins et al., 2022; Radel et al., 2017) or identity (Ntoumanis et al., 2018; Reifsteck et al., 2016; Strachan et al., 2013; Vlachopoulos et al., 2011) to better understand the psychological processes underlying the adoption and maintenance of PA.

Several studies revealed that autonomous motivation is significantly and positively correlated with the level of PA habit (Gardner & Lally, 2013; Hawlader et al., 2023; Hopkins et al., 2022; Maltagliati et al., 2025; Mullan et al., 2021; Radel et al., 2017). The literature indicates that autonomous motivation is associated with the enactment of behaviors in the absence of external cues, thereby reducing the likelihood of the potential temptation (Leduc-Cummings et al., 2022; Milyavskaya et al., 2015; Werner et al., 2016), which is expected to facilitate the development of habit (Verplanken & Orbell, 2022; Wood & Neal, 2016). Contradictory results are observed regarding the association between controlled motivation and PA habit. Indeed, available studies reported either a non-significant (Maltagliati et al., 2025), a significant and positive (Radel et al., 2017), or a significant and negative (Gardner & Lally, 2013) relationship between these constructs. The conceptualization of controlled motivation suggests that individuals should primarily rely on reflective processes to anticipate the consequences associated with the enactment of the behavior (Ryan & Deci, 2000). However, as suggested by Radel et al. (2017), a certain degree of automaticity may also be involved in the regulation of extrinsically motivated behaviors. One potential explanation is that individuals may initially rely on a reflective process when they engage in a behavior, but over time, they may no longer require this process to regulate their behavior. Another possibility is that a substantial part of the decision-making process associated with extrinsic motivation may occur automatically (Bijleveld et al., 2009; Pessiglione et al., 2007).

A separate line of research found that autonomous motivation is also directly and positively associated with PA identity (Ntoumanis et al., 2018; Reifsteck et al., 2016; Strachan et al., 2013; Vlachopoulos et al., 2011). Interestingly, integrated regulation seems to be particularly relevant to the PA identity construct since it captures the incorporation of role meaning into the self. However, PA identity is about more than engaging in physical activities, in permeating people's lives in terms of their daily conversation, how they carry themselves, and their social activities and relationships. Indeed, a strong PA identity may be infiltrating areas of people's lives other than behavioral engagement, such as their social interaction or how they present themselves (Strachan et al., 2016). By contrast, mixed results have been found on the relationship between controlled motivation and PA identity. Indeed, no relationship was found between external regulation and PA identity, whereas small positive correlations were found between introjected regulation and PA identity (Ntoumanis et al., 2018; Reifsteck

et al., 2016; Strachan et al., 2013; Vlachopoulos et al., 2011). This result suggests that, for people with strong PA identity, avoidance of the negative affective reactions of not behaving consistently with one's identity may be a viable factor in regulating PA behavior.

To our knowledge, no study has yet examined how these PA maintenance constructs work together in facilitating PA participation among physically active older adults. This suggests integrating key constructs of the maintenance phase of the M-PAC (i.e., habit and identity) and the SDT (i.e., autonomous and controlled motivations) into one model to improve our understanding of PA behavior. In line with previous studies (Rise et al., 2010; Verplanken & Sui, 2019), we consider, within the M-PAC, that PA habit could be an antecedent of PA identity in the prediction of PA level, even if this relationship could be bi-directional. Moreover, a meta-analysis that integrated the theory of planned behavior (TPB; Ajzen, 1991) with the SDT did not find any direct effects of self-determined motivation on PA behavior (Hagger & Chatzisarantis, 2009), suggesting a potential indirect effect of motivation on PA level via social cognitive variables of the TPB. Research has investigated the potential moderating role of autonomous (or controlled) motivation between the intention and PA behavior (Chatzisarantis et al., 1997; Fortier et al., 2009; Mullan et al., 2021; Orbell, 2003), even if no significant interaction effects were found. In the same vein, we consider that autonomous and controlled motivations could also act as moderators of the relationship between habit or identity and PA level, such that a high autonomous motivation will amplify the positive contribution of habit or identity to PA level. Conversely, a highly controlled motivation will weaken these relationships.

Thus, the aim of the present study is to test if PA identity mediates the association between PA habit and PA level one month later as a function of the underlying levels of autonomous and controlled motivations, among a sample of physically active older adults. Those associations were tested controlling for PA covariates (i.e., sex and age; A. E. Bauman et al., 2012; Koeneman et al., 2011; Van Stralen et al., 2009).

We formulated two hypotheses to test this moderated mediation model (see Figure 1).

Hypothesis 1: The positive relationship between PA habit and further level of PA is mediated by PA identity. In other words, older adults who developed PA habit are more likely to define themselves as people who are physically active, which, in turn, encourages the engagement in PA.

Hypothesis 2: The strength of the mediation of PA identity in the relationship between PA habit and PA level depends on the level of autonomous and controlled motivation. In line with the SDT approach, we suggest that, when older adults have a low level of controlled motivation and a high level of autonomous motivation, PA habit has a stronger association with PA level through PA identity.

Methods

Participants and procedure

Participants were retired older individuals, members of the French Federation of Sport Retirement (FFSR), who were invited via email to take part in a two-wave survey on their leisure activities. The FFSR proposes different sports and physical activities including cycling, Nordic walking, hiking, strength training, gymnastics, dancing, yoga, golf, tennis, aquatic activities, and martial arts. All activities are supervised by an adapted PA or sport professional. Given that the FFSR is not an intervention program, affiliated individuals are free to participate or not in the proposed activities.

To begin with, a message gave information on the aim of the study, i.e., to gather information about leisure activities, and FFSR members were informed that their participation was completely anonymous and voluntary. The study was approved by the University Departmental Ethics Committee and written informed consent was obtained by email. The inclusion criteria were that participants had to be fully retired, aged more than 60 years old and have a license from the FFSR for the year 2021-2022.

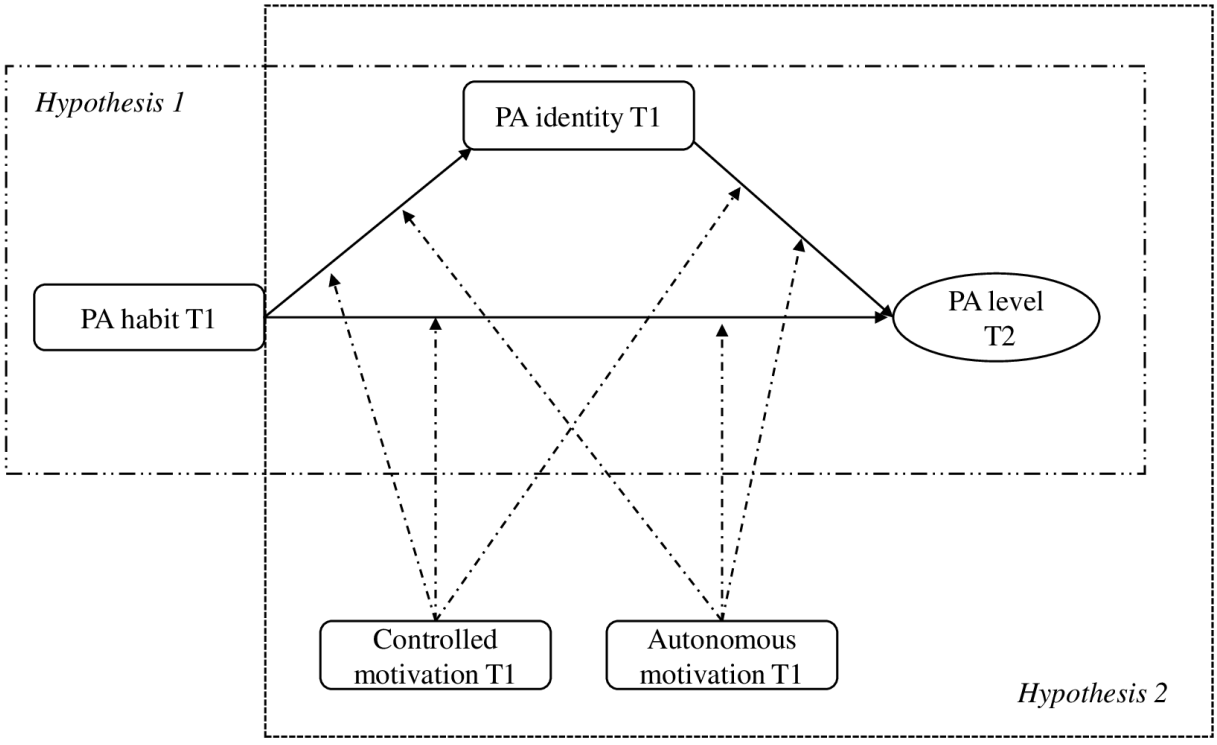

Figure 1 *Hypothesized moderated mediation model*

A link embedded in the email presentation of the study took them directly to the first online survey (Time 1) which assessed socio-demographic characteristics (i.e., age, sex, marital status, education level, last occupational status, time since retirement), number of years as member of the FFSR, and questions about PA motivation, identity, and habit. Between April and May 2022, the e-mail was sent to the 1900 members of the FFSR. Among the 1900 members, 303 responded to the first survey, among which six participants did not meet the inclusion criteria (four participants were not retired, and two participants were under 60 years old) and were excluded from the analyses. One month later (June 2022), a new email was sent to the 297 respondents, containing a link to the second online survey (Time 2), in order to obtain information about their level of PA during the last month. Due to methodological constraints, a delay of one month was chosen between T1 and T2 because the activities proposed by the FFSR stop at the end of June and, during the summer period, people are less available to answer a survey and may change their practices. The final sample was composed of 220 participants who completed both Time 1 and Time 2 questionnaires (see Table 1 for the characteristics of the final sample). The average response delay between Time 1 and Time 2 was 43 days.

Table 1
Characteristics of the final sample

Characteristics (N = 220)	Mean (SD)	Range (years)	Percentage
Age	71.25 (5.88)	60 to 91	

Characteristics (N = 220)	Mean (SD)	Range (years)	Percentage
Sex			
Male			37
Female			63
Marital Status			
Living with a partner			59.5
Single			40.5
Education			
Elementary school			1.4
High school diploma			31.8
University of college degree			66.8
Professional status			
Administrative, sales or service occupations			54.1
Managers, accredited professions			26.8
Intermediate occupations			12.7
Other professions			6.4
Time since retirement (in years)	10.3 (6.48)	0.5 to 30	
Number of years as member of the FFSR (in years)	8 (6.53)	0.1 to 30	

The retention rate of participants from Time 1 to Time 2 is equal to 64.55%. Participants who were lost to the follow-up (n = 77) were compared with those who were retained (n = 220) on all baseline variables. Non-parametric Kruskal-Wallis analyses revealed no significant differences with regard to most variables, i.e., to age (χ^2 = 1.96; p = .16), sex (χ^2 = 0.00; p = .94), marital status (χ^2 = 0.50; p = .48), occupational status (χ^2 = 3.74; p = .42), time since retirement (χ^2 = 0.66; p = .42), number of years as member of the FFSR (χ^2 = 0.67; p = .41), PA habit (χ^2 = 3.14; p = .08), autonomous motivation (χ^2 = 0.09; p = .76) and controlled motivation (χ^2 = .68; p = .41), but significant differences for education level (χ^2 = 4.08; p = .04) and PA identity (χ^2 = 6.51; p = .01). Individuals, in the final sample, were significantly more educated and had a stronger PA identity than those who provided data at Time 1 but not Time 2.

Measures

Self-determination for PA

Motivation was measured using the short French version of the Behavioral Regulation in Exercise Questionnaire (BREQ-2 Markland & Tobin, 2004), used in Milyavskaya & Koestner (2011) study. Although the fourth version of the BREQ was available, we used this short version to avoid cognitive overload when filling out the questionnaire. This scale consists of 6 items with a 7-point Likert scale ranging from 1 (*Not very true of me*) to 7 (*Very true of me*), measuring the six dimensions of motivation conceptualized by SDT. Adopting a dualistic perspective of self-determination, an autonomous motivation score was calculated as the average of intrinsic motivation ("I find PA a pleasurable activity"), identified ("It's important to me to engage in a PA regularly") and integrated ("I consider PA consistent with my values") regulations. A controlled motivation score was calculated as the mean of external ("I engage in PA because other people say I should") and introjected ("I feel ashamed when I miss A PA session") regulations. Moderate to high correlations were found between intrinsic, identified, and integrated items (r = .28 to .50) and between external and introjected items (r = .30). Spearman correlation also revealed that autonomous motivation was negatively and significantly correlated with controlled motivation (r = -.14, p < .05) as hypothesized by SDT.

Habit

PA habit was assessed with the French adaptation of the Self-Report Behavioral Automaticity Index (SRBAI; Gardner et al., 2012), validated by Boiché et al. (2016), including four items which were answered on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The items stem "PA is something…" was followed by: "… (a) I do automatically, (b) I do without having to consciously remember, (c) I do without thinking, (d) I start doing before I realize I'm doing it". The scores were averaged for each participant to create an average habit score, with a higher score showing a stronger PA habit (Cronbach's α = .81).

Identity

The measure of PA identity was adapted from the 6-item Canadian French version of the Athletic Identity Questionnaire (Anderson, 2004; Yao et al., 2018), in replacing the term "exercise" with "PA". Using a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), participants rated the extent to which they identified with being a physically active person. The items are "I consider myself physically active", "I have numerous goals related to my PA", "Most of my friends are physically active", "PA is the most important part of my life", "I spend more time thinking about my PA than anything else" and "I would very depressed if I were injured and could not participate to my PA". The scores were averaged for each participant to create an average identity score, with a higher number showing a stronger PA identity (Cronbach's α = .74).

PA level

Data on PA level was collected using the French version of the Global Physical Activity Questionnaire (GPAQ) to assess the PA performed by the person during the previous 7-day (Rivière et al., 2018; Wanner et al., 2017). This questionnaire presents a good validity compared with accelerometer in the French context (Rivière et al., 2018) and is stated as an adequate measurement tool of PA for older adults (Bull et al., 2009; Mengesha et al., 2019). It collects information on PA participation in three domains (PA at work, transport, and recreational PA) as well as on sedentary behavior. Given the aim of the study and the characteristics of our sample, only the recreational domain and transport questions were assessed. For the analyses, GPAQ data were prepared according to the GPAQ analysis guide (WHO, 2010). Total time spent and energy expenditure in MET were calculated for recreational moderate and vigorous intensity PA and for transport and summed to obtain an index of total MET·min/week for each participant, which was our indicator of PA

level. In addition, the score of four participants, who were identified as outliers (> 3SD above the mean), was changed by the higher score of PA level in the current sample, as recommended by the (WHO, 2010).

Data Analysis

Hypothesis 1: A mediation analysis was conducted using Hayes' (Hayes, 2013, 2018) PROCESS version 4.2 computational tool for SPSS (Model 4) to examine the mediating effect of PA identity on the association between PA habit and PA level. In this analysis, PA habit was entered as the independent variable (IV), PA identity as the mediator (Med), PA level as the dependent variable (DV) and age and sex as the covariates.

Hypothesis 2: We also used the PROCESS MACRO for SPSS (Model 76; Hayes, 2018) to compute the indirect effect of PA habit on PA level through PA identity for several values of both autonomous and controlled motivations. In this analysis, PA habit was entered as the IV, PA identity as the Med, autonomous (Mod1) and controlled (Mod2) motivations as the moderators, the level of PA one month later as the DV, and sex and age as the covariates. Model 76 specifies that the moderators impact all pathways of the mediation model. To avoid potential problems associated with multicollinearity, all variables were mean-centered (Aiken & West, 1991).

This macro facilitates the implementation of a bootstrapping method, which does not impose distributional assumptions. This represents a considerable advantage, because the assumption that the indirect effect is normally distributed is often violated (Shrout & Bolger, 2002). For both analyses, a bootstrap (n = 5000) resample procedure to estimate the indirect effect and 95% confidence intervals (CI) was used. An effect is considered significant if the 95% CI does not include zero (Preacher & Hayes, 2008). The mediation occurs when the 95% CI of the indirect effect estimated from the bootstrap procedure excludes zero (Preacher & Hayes, 2008). For the moderated mediation analysis, Preacher et al. (2007) recommend estimating conditional indirect effects and testing whether these indirect effects differ from zero at specific values of the moderator using a bootstrap CI. We used the mean as well as one standard deviation above and below the mean of the controlled and autonomous motivations scores to represent moderate, high and low values of controlled and autonomous motivations, respectively.

Results

Means, standard deviations, kurtosis, skewness and Spearman's correlation coefficients between the variables of the study are presented in Table 2.

Table 2
Spearman correlations and other characteristics of the variables in the model

Variables	Mean	SD	Range	Skewness	Kurtosis	1	2	3	4	5	6	7
1. Sex	-	-	-	-	-	-						
2. Age	71.25	5.88	60-91	0.54	0.06	-.09	-					
3. Controlled motivation T1	1.9	1.65	1-6.5	1.31	1.40	-.18**	-.14*	-				
4. Autonomous motivation T1	6.39	0.76	4-7	-1.25	0.9	-.02	-.02	-.14*	-			
5. PA habit T1	3.24	1.03	1-5	-.09	-0.71	.02	-.04	.06	.43***	-		
6. PA identity T1	4.62	1.05	2.17-7	-.10	-0.46	-.08	-.01	.00	.53***	.41***	-	
7. PA level T2	3418	2242	0-11386	.96	.72	-.14*	-.06	-.09	.27***	.28***	.30***	-

*p < .05, **p < .01, **p < .001.

PA = Physical activity

The scores of PA level are expressed in MET·min per week.

Before hypothesis testing, multicollinearity was tested with Variance Inflation Factors (VIF). If VIF 5 to 10, there will be multicollinearity among the IV (e.g., age, sex, autonomous and controlled motivations, habit and identity) in the models (Belsley, 1991; Shrestha, 2020). The analysis revealed no evidence of collinearity among the variables included in both models. For the mediation model, mean VIF value obtained = 1.12; the highest individual VIFs were 1.22 for PA identity and 1.21 for PA habit. For the moderated mediation model, mean VIF value obtained = 1.27; the highest individual VIFs were 1.61 for autonomous motivation and 1.52 for PA identity. If the value of VIF is 1 < VIF > 5, it only specifies that the variables are moderately correlated to each other.

Hypothesis 1

Table 3 reports the results of the mediation analysis. Positive and significant paths were found from PA habit to PA identity (B = .41, p < .001, CI = .292 - .534) and from PA identity to PA level one month later (B = .20, p < .01, CI = .059 - .341).

Table 3

Mediation analysis of PA habit on PA level via PA identity, controlling for age and sex

Variables	Coeff	SE	*p*	LLCI	ULCI
Sex	-.09	.14	.14	-.467	.068
Age	-.00	.01	.77	-.025	.019
PA habit	.15	.07	.04	.008	.287
(Total effect)	.23	.07	.00	.101	.359
PA identity	.20	.07	.01	.059	.341
(Indirect effect)				.027	.158

PA = Physical activity; SE = Standard errors; LLCI = Lower limit confidence interval; ULCI = Upper limit confidence interval

The bootstrap procedure revealed that the total contribution of PA habit on the level of PA one month later was significant (B = .23, p < .001, CI = .101 - .359) and decreased when the mediator was included in the model (B = .15, p < .05, CI = -.008 - .287). This suggests that the contribution of PA habit on PA level is partially mediated by PA identity. The results of the bootstrapping analysis confirmed that the indirect contribution of PA habit on PA level through PA identity was significant with a point estimate of .08 (95%CI = .027 - .158) controlling for age and sex (see Table 3).

Hypothesis 2

Table 4 reports the results of the moderated mediation analysis. Positive and significant paths were found from PA identity (B = .18, p < .05, CI = .026 - .343) and from the interaction between PA habit and controlled motivation (B = .16, p < .05, CI = .002 - .305) to PA level.

Table 4
Direct effects of the moderated mediation analysis on PA level controlling for age and sex

Variables	Coeff	SE	*p*	LLCI	ULCI
Sex	-.20	.14	.14	-.475	.068
Age	-.00	.01	.73	-.026	.018
PA habit (IV)	.13	.08	.08	-.017	.281
PA identity (Med)	.18	.08	.02	.026	.343
Autonomous motivation (Mod1)	.02	.09	.83	-.171	.213
Controlled motivation (Mod2)	-.01	.07	.94	-.139	.129
Interaction IV*Mod1	.05	.08	.52	-.101	.198
Interaction IV*Mod2	.16	.08	.04	.002	.305
Interaction Med*Mod1	-.06	.07	.39	-.211	.082
Interaction Med*Mod2	-.03	.07	.65	-.177	.110

PA = Physical activity; SE = Standard errors; LLCI = Lower limit confidence interval; ULCI = Upper limit confidence interval

Although no moderated mediation was found, the analysis still showed a simple moderating effect of controlled motivation between PA habit and PA level.

Conditional effects of the moderated mediation analysis revealed that the contribution of PA habit on PA level is only significant for older individuals with a combination of high level of controlled motivation with medium (B = .28, SE = .11, CI = .068 - .501) or high (B = .32, SE = .12, CI = .080 - .566) levels of autonomous motivation. All significant effects on PA level of the moderated mediation analysis are presented in Figure 2.

Discussion

The present study aimed to examine the interplays between motivation, habit and identity in the prediction of PA level among physically active older adults. The results confirmed our first hypothesis and revealed that PA identity acts as a partial mediator of the association between PA habit and PA level one month later, controlling for age and sex. In other words, older adults who develop strong habit toward PA were more likely to engage and maintain their PA level, in part because they create an identity of physically active person. Beyond the confirmation of the established links between PA habit or PA identity with PA level among older adults, this result highlighted a positive and significant correlation between PA habit and PA identity, which, to our knowledge, has not been demonstrated before. Nevertheless, this result should be taken with caution because of the prospective design of the present study. Indeed, in line with previous studies (e.g., Verplanken & Sui, 2019; Willmott et al., 2021), we have only considered habit as a potential antecedent of the formation of PA identity. However, the relationship between habit and identity may be bi-directional. An identity may instigate behavior and thus maintain a habit while the self-perception of a habit may feed into self-identity (Wood & Rünger, 2016). Moreover, the development of those two concepts differs significantly according to time where it takes only a few weeks to form a habit, whereas several months or years are required to the formation of

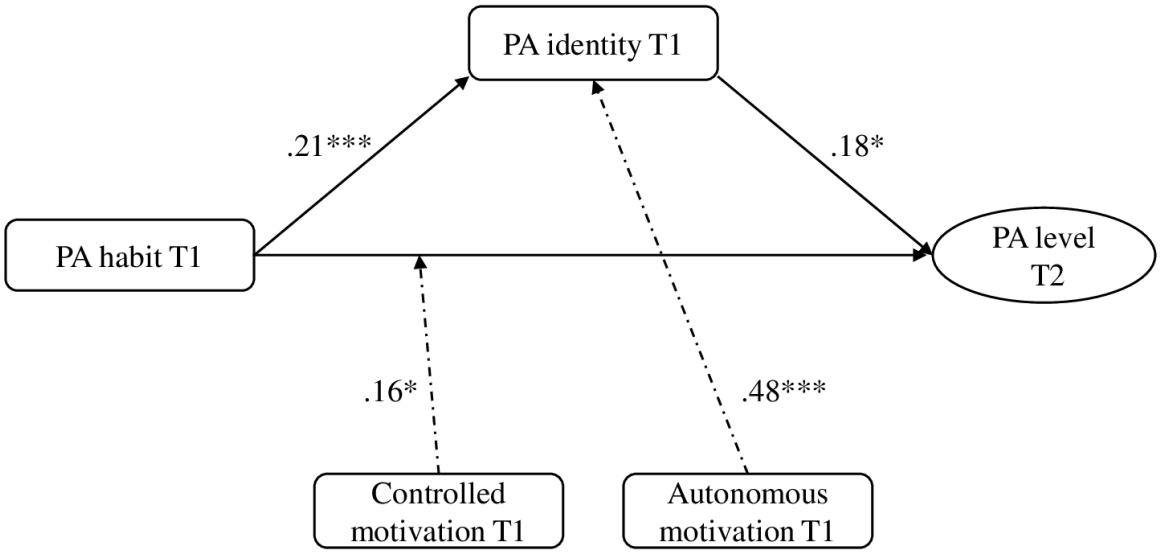

Figure 2 Moderated mediation model

Unstandardized beta coefficients are displayed for only statistically significant paths. To see parameter estimates for all pathways, see Table 4. PA = Physical activity. *p < .05. ***p < .001.

an identity. Future research should explore this specific relationship between PA habit and PA identity with an appropriate method (e.g., longitudinal design with ecological momentary assessments) to have a better comprehension of how those two constructs interact.

Our second hypothesis concerned the potential moderating role of both autonomous and controlled motivations in the interplay between PA habit, PA identity and PA level, using a moderated mediation analysis. Our results did not confirm this hypothesis but showed that PA identity and the interaction term between PA habit and controlled motivation significantly and positively predicted PA level one month later. In line with previous studies (Sincharoen, 2005; Strachan et al., 2010), this result reinforces the crucial role of PA identity on PA engagement among active older adults, but it is also innovative because this link was found beyond the contribution of the two forms of motivation and PA habit. It is also interestingly to note that, in this model, PA habit is associated with PA level only for older adults with both high level of controlled motivation and medium or high level of autonomous motivation.

Thus, these two combinations of motivation emphasize the association between PA habit and PA level one month later and may provide more information on the processes leading to the formation of habit. When the behavior is performed for autonomous reasons (pleasure, satisfaction, interest, value), it provides a natural reinforcement that may help the habit process. However, when the behavior is performed for controlled reasons, after a first decisional phase where a cost/benefit analysis has been done, individuals may then stick with their decision and start to perform the behaviors more automatically without the need to reconsider the value of the behavior every time. This last explanation is in line with Radel et al. (2017) study, which found a positive correlation between con-

trolled motivation and habit, but it needs to be replicated to better understand the role of this type of motivation on PA level and its proximal determinants. More broadly, this finding provides support for studies examined the potential moderating role of motivation in the relationship between conscious or automatic variables and PA behavior (Chatzisarantis et al., 1997; Fortier et al., 2009; Mullan et al., 2021; Orbell, 2003).

Several theoretical implications emerge from the pattern of results. Our findings contribute to extend the literature on the identification and interplay of psychological constructs underlying the maintenance of PA among older adults. The results highlight, in a final model comprising the three main PA maintenance variables, the crucial role of PA identity in the prediction of PA level among active older adults. In addition, this study reinforces the idea that it is common for an individual to report a combination of multiple motivations for a specific domain at the same time (Deci & Ryan, 2002). More precisely, among our sample of physically active older adults, autonomous motivation is positively and significantly related to PA identity while controlled motivation has an indirect contribution on PA engagement via PA habit. Finally, although our hypothesis on a moderated mediation model was not confirmed, this research emphasized the importance of studying health behavior initiation and maintenance through further statistical analysis such as moderated mediation (e.g., Caudroit et al., 2014; Maltagliati et al., 2022) rather than simple mediation or moderation. These analyses provide a better understanding of behavior change by taking into account that mediation or moderation mechanisms might differ in subgroups of participants.

On a more applied perspective, the present results provide evidence that the development of PA habit and identity are crucial to maintain a regular PA among older adults. Incorporating strategies that support the formation of habit (e.g., problem solving techniques) (Ma et al., 2023) and identity (e.g., identification of self as role model) (Michie et al., 2013) may help physically active older adults to sustain their PA engagement. The findings also suggest creating a motivational climate to reinforce autonomous motivation toward PA (Quested et al., 2021) to support the development of PA habit and identity. In addition, holding controlled motivation is not necessarily problematic as long as autonomous regulations are also held. If older people present high score of controlled motivation combined with high or medium levels of autonomous motivation, it appears important to develop, through repeated experience of the activity in stable context (Hagger, 2019), habit toward PA to maximize the chance that older individuals sustain their PA engagement.

Some limits of the present study should be acknowledged. Although prospective, the non-experimental design of the study does not allow for the test of causal relationships among the variables under consideration. This is especially true for the bi-directional relationship between habit and identity and future research should explore how habit and identity interact to predict the PA maintenance. The results should also be taken with caution given the scales used for this study and the measure of all psychological variables at the same time point. Although GPAQ is a validated scale, an overestimate of self-reported PA could be possible and only an objective measure by accelerometer could limit this bias. This is especially true here given the high levels of PA reported by our sample. Autonomous forms of motivation and, more precisely, integrated regulation has been shown to be strongly correlated with PA identity which is in line with previous studies (Ntoumanis et al., 2018; Reifsteck et al., 2016), even if values of VIF revealed no evidence of multicollinearity in our final model. A greater examination of the discriminant validity of the two measures is nevertheless required. Finally, the results are specific to a limited sample of French retired older adults, members of the FFSR, and are not generalizable to the entire population.

Despite these limitations, the present study contributes to extend the literature on the psychological determinants of PA maintenance among physically active older adults in highlighting the mediating role of PA identity in the association between PA habit and

PA level and the moderating role of controlled motivation in the relationship between PA habit and PA level.

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage Publications.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Anderson, C. B. (2004). Athletic identity and its relation to exercise behavior: Scale development and initial validation. *Journal of Sport and Exercise Psychology*, *26*(1), 39–56. https://doi.org/10.1123/jsep.26.1.39

Anderson, Dean F., & Cychosz, C. M. (1995). Exploration of the relationship between exercise behavior and exercise identity. *Journal of Sport Behavior*, *18*(3), 159–166.

Arnautovska, U., Fleig, L., O'Callaghan, F., & Hamilton, K. (2017). A longitudinal investigation of older adults' physical activity: Testing an integrated dual-process model. *Psychology & Health*, *32*(2), 166–185. https://doi.org/10.1080/08870446.2016.1250273

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J., Martin, B. W., & Lancet Physical Activity Series Working Group. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Bauman, A., Merom, D., Bull, F. C., Buchner, D. M., & Fiatarone Singh, M. A. (2016). Updating the evidence for physical activity: Summative reviews of the epidemiological evidence, prevalence, and interventions to promote "active aging." *The Gerontologist*, *56*, S268–S280. https://doi.org/10.1093/geront/gnw031

Belsley, D. A. (1991). *Conditioning diagnostics: Collinearity and weak data in regression*. John Wiley & Sons, Inc., New York.

Bem, D. J. (1972). Self-perception theory. In *Advances in experimental social psychology* (Vol. 6, pp. 1–62). Elsevier. https://doi.org/10.1016/S0065-2601(08)60024-6

Bijleveld, E., Custers, R., & Aarts, H. (2009). The unconscious eye opener: Pupil dilation reveals strategic recruitment of resources upon presentation of subliminal reward cues. *Psychological Science*, *20*(11), 1313–1315. https://doi.org/10.1111/j.1467-9280.2009.02443.x

Boiché, J., Marchant, G., Nicaise, V., & Bison, A. (2016). Development of the generic multifaceted automaticity scale (GMAS) and preliminary validation for physical activity. *Psychology of Sport and Exercise*, *25*, 60–67. https://doi.org/10.1016/j.psychsport.2016.03.003

Bull, F. C., Maslin, T. S., & Armstrong, T. (2009). Global physical activity questionnaire (GPAQ): Nine country reliability and validity study. *Journal of Physical Activity and Health*, *6*(6), 790–804. https://doi.org/10.1123/jpah.6.6.790

Burke, P. J., & Reitzes, D. C. (1981). The link between identity and role performance. *Social Psychology Quarterly*, *44*(2), 83. https://doi.org/10.2307/3033704

Caldwell, A. E., Masters, K. S., Peters, J. C., Bryan, A. D., Grigsby, J., Hooker, S. A., Wyatt, H. R., & Hill, J. O. (2018). Harnessing centred identity transformation to reduce executive function burden for maintenance of health behaviour change: The maintain IT model. *Health Psychology Review*, *12*(3), 231–253. https://doi.org/10.1080/17437199.2018.1437551

Caudroit, J., Boiché, J., & Stephan, Y. (2014). The role of action and coping planning in the relationship between intention and physical activity: A moderated mediation analysis. *Psychology & Health*, *29*(7), 768–780. https://doi.org/10.1080/08870446.2014.884223

Chatzisarantis, N. L. D., Biddle, S. J. H., & Meek, G. A. (1997). A self-determination theory approach to the study of intentions and the intention–behaviour relationship in children's physical activity. *British Journal of Health Psychology*, *2*(4), 343–360. https://doi.org/10.1111/j.2044-8287.1997.tb00548.x

Clemente Remón, Á. L., Jiménez Díaz-Benito, V., Jiménez Beatty, J. E., & Santacruz Lozano, J. A. (2021). Levels of physical activity among older adults in the european union. *Journal of Aging and Physical Activity*, *29*(2), 242–249. https://doi.org/10.1123/japa.2020-0177

Cunningham, C., O' Sullivan, R., Caserotti, P., & Tully, M. A. (2020). Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. *Scandinavian Journal of Medicine & Science in Sports*, *30*(5), 816–827. https://doi.org/10.1111/sms.13616

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2002). An overview of self-determination theory: An organismic dialectical perspective. In *Handbook of self-determination research* (pp. 3–36). Rochester, NY: University of Rochester Press.

Fairchild, A. J., Horst, S. J., Finney, S. J., & Barron, K. E. (2005). Evaluating existing and new validity evidence for the academic motivation scale. *Contemporary Educational Psychology*, *30*(3), 331–358. https://doi.org/10.1016/j.cedpsych.2004.11.001

Ferrand, C., Martinent, G., & Bonnefoy, M. (2014). Exploring motivation for exercise and its relationship with health-related quality of life in adults aged 70 years and older. *Ageing and Society*, *34*(3), 411–427. https://doi.org/10.1017/S0144686X12001092

Ferrand, C., Nasarre, S., Hautier, C., & Bonnefoy, M. (2012). Aging and well-being in french older adults regularly practicing physical activity: A self-determination perspective. *Journal of Aging and Physical Activity*, *20*(2), 215–230. https://doi.org/10.1123/japa.20.2.215

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior : An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fortier, M. S., Kowal, J., Lemyre, L., & Orpana, H. M. (2009). Intentions and actual physical activity behavior change in a community-based sample of middle-aged women: Contributions from the theory of planned behavior and self-determination theory. *International Journal of Sport and Exercise Psychology*, *7*(1), 46–67. https://doi.org/10.1080/1612197X.2009.9671892

Gardner, B., Abraham, C., Lally, P., & De Bruijn, G.-J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 102. https://doi.org/10.1186/1479-5868-9-102

Gardner, B., De Bruijn, G.-J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine*, *42*(2), 174–187. https://doi.org/10.1007/s12160-011-9282-0

Gardner, B., & Lally, P. (2013). Does intrinsic motivation strengthen physical activity habit? Modeling relationships between self-determination, past behaviour, and habit strength. *Journal of Behavioral Medicine*, *36*(5), 488–497. https://doi.org/10.1007/s10865-012-9442-0

Gardner, B., & Lally, P. (2018). Modelling habit formation and its determinants. In B. Verplanken (Ed.), *The psychology of habit* (pp. 207–229). Springer International Publishing. https://doi.org/10.1007/978-3-319-97529-0_12

Gomes, M., Figueiredo, D., Teixeira, L., Poveda, V., Paúl, C., Santos-Silva, A., & Costa, E. (2017). Physical inactivity among older adults across europe based on the SHARE database. *Age and Ageing*, *46*(1), 71–77. https://doi.org/10.1093/ageing/afw165

Hagger, M. S. (2019). Habit and physical activity: Theoretical advances, practical implications, and agenda for future research. *Psychology of Sport and Exercise*, *42*, 118–129. https://doi.org/10.1016/j.psychsport.2018.12.007

Hagger, M. S., & Chatzisarantis, N. L. D. (2009). Integrating the theory of planned behaviour and self-determination theory in health behaviour: A meta-analysis. *British Journal of Health Psychology*, *14*(2), 275–302. https://doi.org/10.1348/135910708X373959

Hawlader, M. D. H., Mozid, N.-E., Sharmin, S., Monju, I. H., Ahmed, S. B., Sarker, W., Amin, M. A., Jhumur, S. S., & Dalal, K. (2023). The art of forming habits: Applying habit theory in changing physical activity behaviour. *Journal of Public Health*, *31*(12), 2045–2057. https://doi.org/10.1007/s10389-022-01766-4

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Press.

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach (methodology in the social sciences) (2nd ed.)*. Guilford Press.

Hopkins, N., Benstead, J., Wardle, M., & Divine, A. (2022). Associations between motivation, attitudes, and habit strength in physical activity behaviour. *Journal of Physical Activity Research*, *7*(2), 74–80. https://doi.org/10.12691/jpar-7-2-1

Huffman, M. K., Reed, J. B., Carpenter, T. K., & Amireault, S. (2021). Maintenance motives for physical activity among older adults: A systematic review and meta-analysis. *Health Psychology Review*, *15*(4), 593–612. https://doi.org/10.1080/17437199.2020.1858926

Koeneman, M. A., Verheijden, M. W., Chinapaw, M. J. M., & Hopman-Rock, M. (2011). Determinants of physical activity and exercise in healthy older adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 142. https://doi.org/10.1186/1479-5868-8-142

Leduc-Cummings, I., Werner, K. M., Milyavskaya, M., Dominick, J. K., & Cole, S. (2022). Experiencing obstacles during goal pursuit: The role of goal motivation and trait self-control. *Journal of Research in Personality*, *99*, 104231. https://doi.org/10.1016/j.jrp.2022.104231

Ma, H., Wang, A., Pei, R., & Piao, M. (2023). Effects of habit formation interventions on physical activity habit strength: Meta-analysis and meta-regression. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1), 109. https://doi.org/10.1186/s12966-023-01493-3

Maltagliati, S., Sarrazin, P., Isoard-Gautheur, S., Pelletier, L., Rocchi, M., & Cheval, B. (2022). Action planning makes physical activity more automatic, only if it is autonomously regulated: A moderated mediation analysis. *SportRXiv*. https://doi.org/10.51224/SRXIV.152

Maltagliati, S., Sarrazin, P., Isoard-Gautheur, S., Pelletier, L., Rocchi, M., & Cheval, B. (2025). Automaticity mediates the association between action planning and physical activity, especially when autonomous motivation is high. *Psychology & Health*, *40*(1), 67–83.

Markland, D., & Tobin, V. (2004). A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. *Journal of Sport and Exercise Psychology*, *26*(2), 191–196. https://doi.org/10.1123/jsep.26.2.191

McPhee, J. S., French, D. P., Jackson, D., Nazroo, J., Pendleton, N., & Degens, H. (2016). Physical activity in older age: Perspectives for healthy ageing and frailty. *Biogerontology*, *17*(3), 567–580. https://doi.org/10.1007/s10522-016-9641-0

Mengesha, M. M., Roba, H. S., Ayele, B. H., & Beyene, A. S. (2019). Level of physical activity among urban adults and the socio-demographic correlates: A population-based cross-sectional study using the global physical activity questionnaire. *BMC Public Health*, *19*(1), 1160. https://doi.org/10.1186/s12889-019-7465-y

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J., & Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, *46*(1), 81–95. https://doi.org/10.1007/s12160-013-9486-6

Milyavskaya, M., Inzlicht, M., Hope, N., & Koestner, R. (2015). Saying "no" to temptation: Want-to motivation improves self-regulation by reducing temptation rather than by increasing self-control. *Journal of Personality and Social Psychology*, *109*(4), 677–693. https://doi.org/10.1037/pspp0000045

Milyavskaya, M., & Koestner, R. (2011). Psychological needs, motivation, and well-being: A test of self-determination theory across multiple domains. *Personality and Individual Differences*, *50*(3), 387–391. https://doi.org/10.1016/j.paid.2010.10.029

Mullan, B., Olivier, C., & Thøgersen-Ntoumani, C. (2021). Mind the gap: Habit and self-determined motivation predict health behaviours in middle-aged and older adults. *British Journal of Health Psychology*, *26*(4), 1095–1113. https://doi.org/10.1111/bjhp.12522

Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology*, *48*(2), 492–498. https://doi.org/10.1016/j.jesp.2011.10.011

Ntoumanis, N., Stenling, A., Thøgersen-Ntoumani, C., Vlachopoulos, S., Lindwall, M., Gucciardi, D. F., & Tsakonitis, C. (2018). Longitudinal associations between exercise identity and exercise motivation: A multilevel growth curve model approach. *Scandinavian Journal of Medicine & Science in Sports*, *28*(2), 746–753. https://doi.org/10.1111/sms.12951

Orbell, S. (2003). Personality systems interactions theory and the theory of planned behaviour: Evidence that self-regulatory volitional components enhance enactment of studying behaviour. *British Journal of Social Psychology*, *42*(1), 95–112. https://doi.org/10.1348/014466603763276144

Ory, M. (2003). Challenging aging stereotypes strategies for creating a more active society. *American Journal of Preventive Medicine*, *25*(3), 164–171. https://doi.org/10.1016/S0749-3797(03)00181-8

Pessiglione, M., Schmidt, L., Draganski, B., Kalisch, R., Lau, H., Dolan, R. J., & Frith, C. D. (2007). How the brain translates money into force: A neuroimaging study of subliminal motivation. *Science*, *316*(5826), 904–906. https://doi.org/10.1126/science.1140459

Piercy, K. L., Troiano, R. P., Ballard, R. M., Carlson, S. A., Fulton, J. E., Galuska, D. A., George, S. M., & Olson, R. D. (2018). The physical activity guidelines for americans. *JAMA*, *320*(19), 2020. https://doi.org/10.1001/jama.2018.14854

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891. https://doi.org/10.3758/BRM.40.3.879

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, *42*(1), 185–227. https://doi.org/10.1080/00273170701341316

Quested, E., Kritz, M., Hancox, J., Ntoumanis, N., & Thøgersen-Ntoumani, C. (2021). Promoting self-determined motivation for physical activity: From theory to intervention work. In Z. Zenko & L. Jones (Eds.), *Essentials of exercise and sport psychology: An open access textbook* (pp. 37–61). Society for Transparency, Openness, and Replication in Kinesiology. https://doi.org/10.51224/B1003

Radel, R., Pelletier, L., Pjevac, D., & Cheval, B. (2017). The links between self-determined motivations and behavioral automaticity in a variety of real-life behaviors. *Motivation and Emotion*, *41*(4), 443–454. https://doi.org/10.1007/s11031-017-9618-6

Reifsteck, E. J., Gill, D. L., & Labban, J. D. (2016). "Athletes" and "exercisers": Understanding identity, motivation, and physical activity participation in former college athletes. *Sport, Exercise, and Performance Psychology*, *5*(1), 25–38. https://doi.org/10.1037/spy0000046

Rhodes, R. E. (2017). The evolving understanding of physical activity behavior. In *Advances in motivation science* (Vol. 4, pp. 171–205). Elsevier. https://doi.org/10.1016/bs.adms.2016.11.001

Rhodes, R. E., & De Bruijn, G. (2013). How big is the physical activity intention–behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology*, *18*(2), 296–309. https://doi.org/10.1111/bjhp.12032

Rhodes, R. E., Kaushal, N., & Quinlan, A. (2016). Is physical activity a part of who i am? A review and meta-analysis of identity, schema and physical activity. *Health Psychology Review*, *10*(2), 204–225. https://doi.org/10.1080/17437199.2016.1143334

Rise, J., Sheeran, P., & Hukkelberg, S. (2010). The role of self-identity in the theory of planned behavior: A meta-analysis. *Journal of Applied Social Psychology*, *40*(5), 1085–1105. https://doi.org/10.1111/j.1559-1816.2010.00611.x

Rivière, F., Widad, F. Z., Speyer, E., Erpelding, M.-L., Escalon, H., & Vuillemin, A. (2018). Reliability and validity of the french version of the global physical activity questionnaire. *Journal of Sport and Health Science*, *7*(3), 339–345. https://doi.org/10.1016/j.jshs.2016.08.004

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Shortreed, S. M., Peeters, A., & Forbes, A. B. (2013). Estimating the effect of long-term physical activity on cardiovascular disease and mortality: Evidence from the framingham heart study. *Heart*, *99*(9), 649–654. https://doi.org/10.1136/heartjnl-2012-303461

Shrestha, N. (2020). Detecting multicollinearity in regression analysis. *American Journal of Applied Mathematics and Statistics*, *8*(2), 39–42. https://doi.org/10.12691/ajams-8-2-1

Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, *7*(4), 422–445. https://doi.org/10.1037/1082-989X.7.4.422

Sincharoen, S. (2005). *Self -concept and change in stage of physical activity among older adults and college students* [PhD thesis]. https://www.proquest.com/openview/a83bb1844154a9145297e90cf79fe6ee/1?cbl=18750&diss=y&pq-origsite=gscholar

Sparks, P., & Shepherd, R. (1992). Self-identity and the theory of planned behavior: Assesing the role of identification with "green consumerism." *Social Psychology Quarterly*, *55*(4), 388. https://doi.org/10.2307/2786955

Stephan, Y., Boiché, J., & Le Scanff, C. (2010). Motivation and physical activity behaviors among older women: A self-determination perspective. *Psychology of Women Quarterly*, *34*(3), 339–348. https://doi.org/10.1111/j.1471-6402.2010.01579.x

Strachan, L., MacDonald, D. J., & Côté, J. (2016). Project SCORE! Coaches' perceptions of an online tool to promote positive youth development in sport. *International Journal of Sports Science & Coaching*, *11*(1), 108–115. https://doi.org/10.1177/1747954115624827

Strachan, S., Brawley, L., Spink, K., & Glazebrook, K. (2010). Older adults' physically-active identity: Relationships between social cognitions, physical activity and satisfaction with life. *Psychology of Sport and Exercise*, *11*(2), 114–121. https://doi.org/10.1016/j.psychsport.2009.09.002

Strachan, S., Fortier, M., Perras, M., & Lugg, C. (2013). Understanding variations in exercise-identity strength through identity theory and self-determination theory. *International Journal of Sport and Exercise Psychology*, *11*(3), 273–285. https://doi.org/10.1080/1612197X.2013.749005

Stryker, S., & Burke, P. J. (2000). The past, present, and future of an identity theory. *Social Psychology Quarterly*, *63*(4), 284. https://doi.org/10.2307/2695840

Sun, F., Norman, I. J., & While, A. E. (2013). Physical activity in older people: A systematic review. *BMC Public Health*, *13*(1), 449. https://doi.org/10.1186/1471-2458-13-449

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In *Advances in experimental social psychology* (Vol. 29, pp. 271–360). Elsevier. https://doi.org/10.1016/S0065-2601(08)60019-2

Van Bree, R. J. H., Bolman, C., Mudde, A. N., Van Stralen, M. M., Peels, D. A., De Vries, H., & Lechner, L. (2017). Modeling longitudinal relationships between habit and physical activity: Two cross-lagged panel design studies in older adults. *Journal of Aging and Physical Activity*, *25*(3), 464–473. https://doi.org/10.1123/japa.2016-0212

Van Stralen, M. M., De Vries, H., Mudde, A. N., Bolman, C., & Lechner, L. (2009). Determinants of initiation and maintenance of physical activity among older adults: A literature review. *Health Psychology Review*, *3*(2), 147–207. https://doi.org/10.1080/17437190903229462

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology*, *33*(6), 1313–1330. https://doi.org/10.1111/j.1559-1816.2003.tb01951.x

Verplanken, B., & Orbell, S. (2022). Attitudes, habits, and behavior change. *Annual Review of Psychology*, *73*(1), 327–352. https://doi.org/10.1146/annurev-psych-020821-011744

Verplanken, B., & Sui, J. (2019). Habit and identity: Behavioral, cognitive, affective, and motivational facets of an integrated self. *Frontiers in Psychology*, *10*, 1504. https://doi.org/10.3389/fpsyg.2019.01504

Vlachopoulos, S. P., Kaperoni, M., & Moustaka, F. C. (2011). The relationship of self-determination theory variables to exercise identity. *Psychology of Sport and Exercise*, *12*(3), 265–272. https://doi.org/10.1016/j.psychsport.2010.11.006

Wanner, M., Hartmann, C., Pestoni, G., Martin, B. W., Siegrist, M., & Martin-Diener, E. (2017). Validation of the global physical activity questionnaire for self-administration in a european context. *BMJ Open Sport & Exercise Medicine*, *3*(1), e000206. https://doi.org/10.1136/bmjsem-2016-000206

Werner, K. M., Milyavskaya, M., Foxen-Craft, E., & Koestner, R. (2016). Some goals just feel easier: Self-concordance leads to goal progress through subjective ease, not effort. *Personality and Individual Differences*, *96*, 237–242. https://doi.org/10.1016/j.paid.2016.03.002

Whaley, D. E., & Ebbeck, V. (2002). Self-schemata and exercise identity in older adults. *Journal of Aging and Physical Activity*, *10*(3), 245–259. https://doi.org/10.1123/japa.10.3.245

Willmott, T. J., Pang, B., & Rundle-Thiele, S. (2021). Capability, opportunity, and motivation: An across contexts empirical examination of the COM-b model. *BMC Public Health*, *21*(1), 1014. https://doi.org/10.1186/s12889-021-11019-w

Wood, W., & Neal, D. T. (2016). Healthy through habit: Interventions for initiating & maintaining health behavior change. *Behavioral Science & Policy*, *2*(1), 71–83. https://doi.org/10.1177/237946151600200109

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology*, *67*(1), 289–314. https://doi.org/10.1146/annurev-psych-122414-033417

World Health Organization. (2010). *Global physical activity questionnaire (GPAQ) analysis guide*. Geneva: World Health Organization.

Yao, P.-L., Laurencelle, L., & Trudeau, F. (2018). Anderson's athletic identity concept: French-canadian validation of the athletic identity questionnaire. *IJASS(International Journal of Applied Sports Sciences)*, *30*(2), 111–124. https://doi.org/10.24985/ijass.2018.30.2.111

Acknowledgements

Funding

The authors have no funding or support to report.

Competing interest

The authors have declared that no competing interests exist.

Data availability statement

All relevant data are within the paper.