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The relationship between the environment and physical activity-related motivational trajectories

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ABSTRACT

The study explores motivational profiles for physical activity, using self-determination theory's full continuum of motivational regulations, and examines their stability over three months. Furthermore, it investigates whether physical environment and community characteristics are associated with transitioning between profiles, as well as the sociodemographic differences in these motivational transition pathways. Data were collected from 305 U. S. residents at three time points. The three profiles—'low in motivation' (23.5 % of the sample in wave 1), 'self-determined motivation' (41.4 %), and 'ambivalent motivation' (35.0 %)—were relatively stable. Staying in the low-in-motivation profile was negatively associated with being active in social settings, community support, perceived environmental restorativeness, and availability of physical activity opportunities. Having a higher education and income, being male, employed, married or in a partnership, and identifying as White were associated with being in a motivationally positive profile in the last wave of the study. These profiles reported higher activity and life satisfaction.

The importance of regular physical activity for physical and mental health and well-being is widely recognized (Anderson & Durstine, 2019). Despite this, the Centers for Disease Control and Prevention reported that only 24.2 % of U.S. adults met the 2018 Physical Activity Guidelines for Americans (Elgaddal et al., 2022). Additionally, sociodemographic disparities in physical activity are prevalent across North America. For example, Black and Hispanic adults, women, older adults, and individuals with low socioeconomic status tend to be less physically active (Elgaddal et al., 2022; Patel et al., 2022).

Extant literature has addressed this public health issue by assessing the impact of neighborhood environments on physical activity levels, including the availability of physical activity opportunities (Pyky et al., 2019) and community support and cohesion (Duncan et al., 2002). Furthermore, being physically active outdoors as compared to indoors (Noseworthy et al., 2023), in informal public places rather than private spaces (Salvo et al., 2017), and in social environments (Burke et al., 2006) can promote physical activity. However, this environment-behavior relationship may vary across different subgroups (Cronin-de-Chavez et al., 2019; Lakerveld et al., 2012; Yang & Xiang, 2021). To date, it remains largely unclear which environmental factors, such as community support, availability of physical activity opportunities, and restorativeness of the physical activity environment, matter for individuals with varying levels of motivation for physical activity, whether they are amotivated, controlled, or self-determined, for example. Creating environments that are conducive to increasing physical activity levels among the general population while addressing differences in subgroup activity within these environments is crucial for promoting physical activity.

Socioecological models emphasize that health behaviors can be influenced by multiple levels: intrapersonal, interpersonal, physical environmental, community, organizational, and policy (Sallis et al., 2015). The unique characteristics of these levels influence physical activity behavior (King et al., 2000, 2002). Yet, "a challenge for research is to expand understanding of these interactions across levels" (Sallis et al.,

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2015, p. 470). The present study explores interactions between both the physical environmental and community levels and the intrapersonal level.[1]

With regards to the intrapersonal level, we consider *motivation*, which, according to self-determination theory, exists along a continuum of regulations ranging from the most self-determined (intrinsic) to the least self-determined (external), as well as amotivation, which represents a lack in motivation to engage in any activity. Motivation is key to the long-term adoption of a physically active lifestyle (Teixeira et al., 2012), and self-determination theory allows for consideration of not only the quantity but also the quality of motivation for physical activity (Deci & Ryan, 2008). When behaviors are driven by pure enjoyment (intrinsic motivation), have been fully integrated with a person's identity (integrated regulation), or are strongly valued for their benefits (identified regulation), this is seen as self-determined or autonomous motivation. Conversely, exercising to avoid feelings of guilt (introjected regulation) or for external reward or consequence (external regulation) is considered controlled motivation.

The clustering of individuals using the six domains of self-determination theory (intrinsic, integrated, identified, introjected, external regulation, and amotivation) (Howard et al., 2016) helps discern motivational profiles of physical activity. Self-determined profiles (i.e., those that score high on intrinsic, integrated, and identified regulation, and low on introjected, external regulation, and amotivation) are the most active, while profiles with low levels of self-determination (i.e., those that score low on all dimensions or on autonomous motivation, as indicated by intrinsic and integrated regulation) are the least active (Castonguay & Miquelon, 2018; Emm-Collison et al., 2020; Valenzuela et al., 2021).

Recent evidence suggests that certain features in the environment can be crucial in helping individuals become more self-determined in their motivation, thereby increasing and sustaining their physical activity levels. For example, environmental restorativeness (Cleary et al., 2017; Yang et al., 2022) and community characteristics, such as perceptions of the neighborhood (e.g., absence vs. presence of speeding cars) (Gay et al., 2011), the availability of community-organized sports classes (Edmunds et al., 2006), and access to physical activity facilities (Haughton McNeill et al., 2006) have all been shown to influence motivation. Despite the evidence for the interaction between the levels of the socioecological model on physical activity behavior—often examined using variable-centered approaches like path analyses and regressions—the dynamic nature of *motivational profiles* in relation to physical environmental and community levels is not well understood.

In general, there are two different approaches to studying the dynamic nature of motivational profiles in the context of interactions with other levels. First, under the assumption that motivation remains constant, changes in physical activity can be assessed over time based on individuals' initial belonging to different motivational profiles (Castonguay & Miquelon, 2018; Moore et al., 2023; Ostendorf et al., 2021; Wasserkampf et al., 2018). The limitation of this approach is that motivation can arguably change over time. For example, Hagerman et al. (2023) found that during a six-month weight loss treatment, 43 % of participants who initially belonged to a low-motivation profile transitioned to a high self-determination profile. Although such transitions may be more common in intervention settings than in daily life (see Emm-Collison et al.'s [2020] study), transitions can also occur as a function of physical environmental factors. These factors may include climate and geography (Turrisi et al., 2021) and the availability of physical activity opportunities (Duncan et al., 2002). For example, if sports clubs are located near people's homes and they are aware of these opportunities, they might be more inclined to try out new sports or engage in activities with others, such as sports club members, friends, or a coach.

Second, under the assumption that motivation changes over time, researchers can explore both shifts in individuals' motivational profiles and the associated changes in physical activity. To our knowledge, Emm-Collison et al. (2020) were the first to apply this approach in an adult population. They utilized latent profile transition analysis (LPTA) to study changes in motivational profiles (i.e., so-called transitions) over a five-year period among U.K. residents. Their findings indicated that the likelihood of transitioning between profiles was higher (53 % and 55 % for the two time points that they considered) than remaining in the same profile. More self-determined profiles were associated with higher levels of moderate and vigorous physical activity, lower body mass index, and were the most stable over time. Hagerman et al. (2023) found that 26 % of the participants in a six-month behavioral weight loss program transitioned across profiles. The most common transitions observed were from a mixed motivation profile to a self-determined profile and from a low motivation profile to a self-determined profile.

This study aims to address the call for a deeper understanding of the interactions among the levels outlined by socioecological models (Sallis et al., 2015) by extending the work of Emm-Collison et al. (2020) and Hagerman et al. (2023) to consider individuals' relationships with different levels beyond the intrapersonal. In the context of socioecological models and self-determination theory, this involves identifying potential environmental factors that might be associated with motivational transitions. Additionally, this study responds to calls for insights into disparities across sociodemographic groups regarding physical activity and how these disparities can be mitigated (Elgaddal et al., 2022; Patel et al., 2022). Specifically, this study explores motivational profiles for physical activity and life satisfaction among U.S. residents, using self-determination theory's full continuum of motivational regulations, and examines their stability over a three-month period.[2] Furthermore, it investigates whether physical environments, along with community characteristics, are associated with the likelihood of individuals transitioning between motivational profiles, as well as the sociodemographic differences in these motivational transition pathways.

1. Methods

1.1. Institutional review board statement and survey administering

Approval for the study was granted through a presentation to the Faculty Board of the Technical University of Munich. The Faculty Board is authorized to provide internal approval for empirical studies involving healthy individuals. The author team ensured adherence to the 1964 Helsinki Declaration and its later amendments, as well as to established good practices in social science research. Participants were given detailed information about the study, and informed consent was obtained from all participants. The information sheet included an explanation of the data-handling procedures, and assurances of anonymity and confidentiality were provided. Participants were informed that they could withdraw from the study at any time, without providing a reason and facing any penalty. At the end of the survey, participants were thanked for their participation and debriefed, along with the email

[1] We note that both the physical environmental and the community levels encompass interpersonal aspects, as individuals are often physically active with others. In the methods section, we describe our measurement approach, where we assess perceptions and, as recommended by authors who developed the respective scales, incorporate interpersonal-level characteristics into the measures.

[2] Based on Emm-Collison et al.'s (2020) and Hagerman et al.'s (2023) evidence on the likelihood of transitions, we expected transitions of 10–20 % of the participants during the three-month period. Note, however, that LPTA allow for the assessment of *transition likelihoods*. Thus, individual differences in transitions can be described in percentages (ranging from 0% to 100 % for each possible transition).

address of a contact person (the first author of the manuscript) for any further questions. Additionally, participants were informed during the initial survey that a follow-up data collection would occur in four weeks, and they would be invited to participate online.

1.2. Sample size justification

To our knowledge, no prior studies have utilized LPTA in the context of physical activity and environmental features. Based on the number of variables included in the analysis (i.e., six motivational factors, self-reported physical activity, life satisfaction; two physical environmental and two community-related variables), the number of time points (three), the study duration (three months), the potential number of profiles and transitions, as well as constraints in financial resources, we determined that a sample size of 300 would be appropriate. This estimate considers previous evidence on profile membership and transitioning probability (Emm-Collison et al., 2020; Hagerman et al., 2023), reported effect sizes (mostly from variable-centered research), a significance level of .05 (two-sided), and a statistical power of .80. The target sample size of 300 exceeds Nylund et al.'s (2007) recommendation based on Monte Carlo simulations, which suggests a sample size of at least 200 participants.[3]

1.3. Participants and procedure

Data were collected using the recruiting software Amazon Mechanical Turk (MTurk). Surveys were administered at three time points: November 14–21, 2022 (T1), December 14–21, 2022 (T2), and January 14-February 14, 2023 (T3)—a period when physical activity in the U.S. tends to decline (Turrisi et al., 2021). T2 served as a mid-point assessment, included alongside T1 and T3, to not only identify transitions (or lack thereof) but also gain further insights into the dynamics of these transitions. For instance, a participant might be self-determined for physical activity at T1, experience a disruption in their routine during the festive season at the end of the year (T2), and then regain self-determination at T3. Understanding these patterns, including how individuals may fall back into 'good' or 'bad' habits and their correlations with physical environmental and community variables, is helpful in personalizing interventions.

Participants were recruited to equally represent seven regions in the U.S. (New England, Mid-Atlantic, Southeast, Midwest, Rocky Mountains, Southwest, Pacific Coast). This regional diversity is important due to differences in temperature, precipitation, and photoperiod across these areas (Turrisi et al., 2021). Quota sampling was used based on age groups (18–24, 25–29, 30–34, 35–44, 45–54, 55+ years) and gender (male, female) (Appendix A). Participants received US-$1.80 as compensation at each time point upon completing the survey. To ensure continuity, participants were matched using their ID code, a unique code assigned by the software.

In total, 1334 individuals were invited to participate at T1. It was estimated that about 15 % would report a medical doctor's objection to physical activity or a change in residence, and we anticipated a drop-out of approximately 30 % at each time point. We also expected that data from stylistic responders or participants with suspicious responses—potentially indicative of bot use—would need to be excluded. Appendix B outlines the exclusion criteria, the number of participants excluded, and reasons (medical recommendations against physical activity; change in residence at T2 or T3; drop-out at T2 or T3; inability to match participants). Additionally, participants were excluded if they completed the surveys in less than half of the median time ($t_{T1} = 462$ s; $t_{T2} = 362$ s; $t_{T3} = 325$ s), showed no variation in responses on the Self-determined Motivation Scale for Exercise-2 (SMSE-2), or provided nonsensical answers to a human intelligence task (specific numbers can be found in Appendix B).[4]

1.4. Measures

The 22-item, six-dimensional SMSE-2 (Matsumoto et al., 2021) was used to measure intrinsic, integrated, identified, introjected, and external regulation, as well as amotivation. Details about the items and their anchors are provided in Appendix C, which also includes information on the reliability of the scales. Physical activity was assessed using a modified version of the International Physical Activity Questionnaire (IPAQ) (Booth, 2000), with overall metabolic equivalent of task (MET) minutes per week used in the analysis. The five-item scale from Diener et al. (1985) measured life satisfaction.

The availability of physical activity opportunities in the community was calculated as the sum of reported presence of 27 physical activity facilities. These facilities were selected based on the most prominent sports in the U.S. (Mercier, 2022). Community support was measured using the 14-item Community Support Questionnaire (Herrero & Gracia, 2007; Peng et al., 2021).

The 26-item scale from Hartig et al. (1997) was used to measure the perceived restorative quality of the physical activity environment. The setting of the physical activity environment was assessed through five semantic differentials: indoors vs. outdoors; private vs. public access; alone vs. with other people; solo sport vs. as part of a team; without vs. with an instructor. The latter three differentials included interpersonal characteristics. Participants were asked to refer to the time they spent being physically active in each setting over the past seven days.

The human intelligence task required participants to enter a code consisting of three numbers and three letters and participants who made incorrect entries were excluded. At the end of the survey, participants were asked about their age, gender, education, employment, marital status, ethnicity, annual personal income before tax, and state of residence.

1.5. Data analysis

Mplus, version 8 (Muthen & Muthen, 2017), was used to analyze the data. A confirmatory factor analysis (CFA) was conducted at all three time points to assess the measurement model, which provided weighted factor scores for each construct of the SMSE-2. Model fit was evaluated using the criteria for good fit outlined by Hu and Bentler (1999): comparative fit index (CFI; CFI $>.90$), standardized root mean square residual (SRMR; SRMR $<.08$), root mean square of approximation (RMSEA; RMSEA $<.06$), and Tucker-Lewis index (TLI; TLI $>.90$).

The six motivational dimensions were used as indicator variables in a latent profile analysis (LPA) to explore the latent structure at each time point. LPTA was employed to estimate the prevalence of latent classes at each time point and to determine the probability of transitions between profiles across different time points. In the final step, associations between the profiles and environmental factors were examined. Correlations for all variables are reported in Appendix D.

First, the number of profiles was determined by comparing a series of tentative models with increasing number of profiles to ascertain whether a more complex model or a more parsimonious model best fit the data (Nylund et al., 2007). Several criteria were used for model fit evaluation (Tein et al., 2013), and all models were estimated using multiple start values (500 starts and 100 sets) to avoid local maxima solutions. This included the log-likelihood (LL), the Bayesian information criterion (BIC), and the sample-adjusted Bayesian information criterion (aBIC), with lower values indicating better model fit (Henson et al., 2007). The

[3] In Tein et al.'s (2013) review, the median sample size for LPA was 377. In their simulation study, the authors considered common sample sizes of 250, 500, and 1000 and concluded that having a larger sample size did not result in better power.

[4] The latter criterion may have helped identify bots (Vazquez et al., 2024).

entropy criterion, which measures classification uncertainty (Celeux & Soromenho, 1996), was also considered, with values close to 1.0 indicating a good solution. The final model selection was guided by theoretical alignment, profile size, and interpretation. Robustness checks regarding the stability of the motivational profiles and the reliability of the final sample are detailed in Appendix E. We used criterion-related validity evidence as recommended by Spurk et al. (2020), and profile solutions were replicated with different samples (both with vs. without applying the exclusion criteria). Additionally, dropout rates across profiles from T1 to T2 and T3 were examined (Appendix F), and the distribution was found to be fairly consistent across all profiles.

Assumptions about variance were explored by comparing models with equal variances versus models with freely estimated variances across time points (Morin et al., 2016). Once the model was correctly identified, the probability of transitioning between profiles at each time point was estimated. Associations between latent profiles, physical activity, and life satisfaction were then assessed at each time point using a Wald test and the Bolck-Croon-Hagenaars (BCH) method, as proposed by Bakk and Vermunt (2016). This method incorporates covariances directly into the model, using estimated posterior probabilities to avoid bias associated with assigning individuals to a single profile based on their most likely profile membership. An annotated Mplus syntax can be found in Appendices G and H. To explore the associations between profile transitions and environmental factors, correlation analyses with individual transition probabilities were run. Probabilities were converted into binary variables based on most likely transition paths, and Welch's t-tests were conducted. Descriptive demographics were analyzed using chi-squared tests and independent samples t-tests.

2. Results

2.1. Sample description and CFA results

The mean age of the sample ($n = 305$; see Appendix I) was 44.4 years ($SD = 12.9$), with 54.1 % identifying as female. Appendix J provides an overview of self-reported physical activity across the seven U.S. regions, as well as information on temperature, rainfall, and snowfall, and the balance of indoor vs. outdoor physical activity. A comparison across the regions revealed no significant differences in physical activity ($F[6298] = .78$, $p = .58$]) or in the proportion of time spent being active outdoors vs. indoors ($F[6285] = .53$, $p = .79$]).[5]

On average, there were 29.9 ($SD = 2.1$) days between T1 and T2, and 32.2 ($SD = 3.6$) days between T2 and T3. Descriptive statistics and alpha values for indicator and auxiliary variables are presented in Table 1. Factor scores from SMSE-2 were derived using a CFA. After excluding one item for integrated regulation ('It is consistent with my values, goals, and aims in life') due to its low factor loading at all time points, the model demonstrated good fit at each time point (T1: $\chi^2 = 345.94$, $df = 171$, $p < .001$; $CFI = .95$, $TLI = .93$, $RMSEA = .06$ [90 % $CI = .05, .07$], $SRMR = .06$; T2: $\chi^2 = 341.02$, $df = 174$, $p < .001$; $CFI = .95$, $TLI = .93$, $RMSEA = .06$ [90 % $CI = .05, .06$], $SRMR = .07$); and T3: $\chi^2 = 344.09$, $df = 173$, $p < .001$; $CFI = .95$, $TLI = .94$, $RMSEA = .04$ [90 % $CI = .04, .05$], $SRMR = .06$).

2.2. Model selection

The indicators of model fit for two to seven profiles are presented in Table 2. As is typical in LPA, values of LL, BIC, and aBIC decreased as the number of profiles increased, indicating a constant improvement of the model as additional profiles were added. The entropy index was closest to 1.0 for solutions with three and four profiles. Profiles were examined in detail for membership probability and interpretability, with a particular focus on the three- and four-profile solutions. When moving from the three-profile to the four-profile solution, a profile with a small membership probability emerged. This new profile was substantively very similar to the self-determined profile from the more parsimonious model and did not provide additional insights.

When assessing measurement invariance, models with freely estimated variances resulted in worse fit statistics compared to models with equal variances across time points (Appendix K). The profiles were similar across the three time points (Appendix L). Consequently, the authors opted for the model that assumed the motivation differed between the three profiles but remained consistent across the three time points.

Table 1
Means, standard deviations and internal consistency measures of indicator variables and auxiliary variables.

Time Point	Time 1		Time 2		Time 3	
Variable	M (SD)	α	M (SD)	α	M (SD)	α
Physical activity	1238 (1545)	–	1133 (1280)	–	1109 (1213)	–
Life satisfaction	4.95 (1.40)	.89	4.94 (1.39)	.90	4.93 (1.37)	.89
Intrinsic motivation	3.67 (.89)	.81	3.68 (.89)	.82	3.69 (.86)	.81
Integrated motivation	3.39 (1.16)	.91	3.47 (1.17)	.91	3.44 (1.15)	.91
Identified motivation	4.08 (.80)	.82	4.16 (.69)	.75	4.12 (.72)	.78
Introjected motivation	3.21 (1.09)	.88	3.27 (1.05)	.86	3.25 (1.14)	.89
External motivation	2.45 (1.20)	.87	2.44 (1.18)	.89	2.49 (1.23)	.91
Amotivation	1.95 (1.12)	.90	1.92 (1.08)	.90	1.96 (1.13)	.90

Note. M = Mean. SD = Standard deviation. α = Cronbach's alpha. Time 1 = November 14–21, 2022; Time 2 = December 14–21, 2022; Time 3 = January 14 - February 14, 2023.

2.3. Interpretation of profiles

The three profiles are described as follows: Profile 1, characterized as *low in motivation*, Profile 2, marked by *self-determined motivation*, and Profile 3, exhibiting *ambivalent motivation* (Figure 1 and Appendix M). Profile 1 shows generally low motivation across all dimensions except for identified motivation, which remains slightly above the mid-point of the rating scale (i.e., 3.0). Profile 2 is characterized by high levels of autonomous motivation, with intrinsic, integrated, and identified motivation scoring 4.04 or higher, and both external motivation and amotivation being very low ($M = 1.92$ and $M = 1.18$, respectively). Profile 3 exhibits relatively high levels of all types of motivation, with means ranging between 3.19 and 3.83. In line with Hagerman et al. (2023), this profile is labeled the ambivalent motivation profile. Individuals in this profile may see potential for self-determined motivation for physical activity but also perceive constraints, resulting in relatively high scores for introjected and external regulation as well as amotivation.

2.4. Transitions between profiles across time points

Across the three time points, 85.4 % of the participants remained in the same profile. The distribution of profiles at each time point and the patterns of transitions are detailed in Table 3 and Appendices M and N. Profiles 2 and 3 were more stable than profile 1. Specifically, 13.3 % of Profile 2 and 12.7 % of Profile 3 transitioned at either T2 or T3, compared to 19.5 % of participants in Profile 1 who transitioned during the same periods.

[5] Thirteen participants did not report any physical activity, which precluded analysis of their indoor versus outdoor activity.

Table 2
Fit indices for two to seven latent profile solutions.

No. of profiles	No. of free parameters	Log-Likelihood	AIC	BIC	a-BIC	Entropy
2	36	−7125.21	14322.42	14456.23	14342.06	.931
3	**51**	**−6456.72**	**13015.44**	**13205.01**	**13043.26**	**.957**
4	70	−6221.98	12583.96	12844.15	12622.14	.952
5	93	−6016.34	12218.68	12564.37	12269.42	.938
6	120	−5864.16	11968.33	12414.37	12033.79	.938
7	Not identified					

Note. No. = Number. AIC = Akaike information criterion. BIC = Bayesian information criterion. a-BIC = Adjusted Bayesian information criterion. Row in **bold** refers to the number of profiles selected.

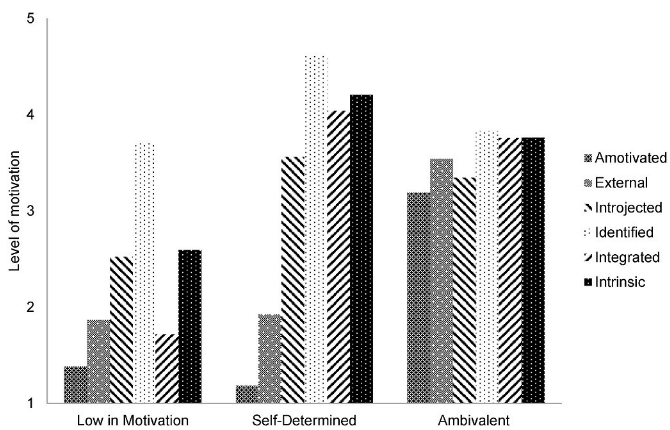

Figure 1. Motivational profiles for the three-profile solution
Note. The 22-item, six-dimensional SMSE-2 (Matsumoto et al., 2021) was used to measure intrinsic, integrated, identified, introjected, and external regulation and amotivation. 1 = lowest level of motivation, 5 = highest level of motivation.

2.5. Physical activity and life satisfaction of the profiles

The associations between profile membership and both physical activity and life satisfaction are shown in Table 4. At all three time points, Profile 1 showed significantly lower scores for both physical activity and life satisfaction compared to Profiles 2 and 3. Therefore, in relative terms, Profiles 2 and 3 can be considered *motivationally positive* profiles.

2.6. Environmental correlates of the trajectories

Next, we explored the associations between community and physical activity environmental factors and the different trajectories (Table 5). This analysis is limited to participants who remained in Profile 1, Profile 2, or Profile 3, throughout the study. This restriction is due to the very low percentages of individual transitions observed. Specifically, only 12 participants transitioned from Profile 1 at T1 to Profile 2 or 3 at T3, indicating a significant increase in self-determined motivation. Seven participants transitioned from Profile 2 or 3 at T1 to Profile 1 at T3, reflecting a significant decrease in self-determined motivation. Additionally, two (one) participant(s) fell back into good (bad) motivational habits, that is, they transitioned from Profile 2 or 3 at T1 to Profile 1 at T2 and back to Profile 2 or 3 at T3 [Profile 1 at T1 to Profile 2 or 3 at T2 and Profile 1 at T3]). Eighteen participants transitioned between the self-determined and ambivalent motivation profiles (i.e., the motivationally positive profiles) at any of the time points.

Interestingly, as shown in Table 5, the correlations between the likelihood of remaining in Profile 1 (the low motivation profile) and community and physical activity environmental factors were predominantly negative, with two of these correlations being non-significant. In contrast, for Profile 3 (the ambivalent motivation profile), five correlations were positive and three non-significant. For Profile 2 (the self-determined profile), the correlations were mixed: some were positive, some negative, and some non-significant.

To explore which environmental factors were associated with a positive motivational trajectory, a complementary analysis was conducted focusing on individuals who transitioned to, returned to, or stayed in, Profile 2 or Profile 3. The findings indicated a positive

Table 3
Probabilities of all possible transitions between the three profiles across the three time points.

Time 1	Time 2	Time 3	Proportion of sample (%)
Self-determined	Self-determined	Self-determined	35.89
Self-determined	Self-determined	Ambivalent	1.87
Self-determined	Self-determined	Low in motivation	.58
Self-determined	Ambivalent	Self-determined	.09
Self-determined	Ambivalent	Ambivalent	1.24
Self-determined	Ambivalent	Low in motivation	.01
Self-determined	Low in motivation	Self-determined	.17
Self-determined	Low in motivation	Ambivalent	.02
Self-determined	Low in motivation	Low in motivation	1.56
Ambivalent	Self-determined	Self-determined	1.05
Ambivalent	Self-determined	Ambivalent	.06
Ambivalent	Self-determined	Low in motivation	.02
Ambivalent	Ambivalent	Self-determined	2.31
Ambivalent	Ambivalent	Ambivalent	30.57
Ambivalent	Ambivalent	Low in motivation	.35
Ambivalent	Low in motivation	Self-determined	.07
Ambivalent	Low in motivation	Ambivalent	.01
Ambivalent	Low in motivation	Low in motivation	.60
Low in motivation	Self-determined	Self-determined	1.47
Low in motivation	Self-determined	Ambivalent	.08
Low in motivation	Self-determined	Low in motivation	.02
Low in motivation	Ambivalent	Self-determined	.04
Low in motivation	Ambivalent	Ambivalent	.58
Low in motivation	Ambivalent	Low in motivation	.01
Low in motivation	Low in motivation	Self-determined	2.10
Low in motivation	Low in motivation	Ambivalent	.29
Low in motivation	Low in motivation	Low in motivation	18.95

Note. Time 1 = November 14–21, 2022; Time 2 = December 14–21, 2022; Time 3 = January 14 - February 14, 2023.

Table 4
Differences across profiles in terms of physical activity and life satisfaction.

Profiles	Profile 1: Low in Motivation	Profile 2: Self-Determined	Profile 3: Ambivalent Motivation
Time Points Variables	M (SE)	M (SE)	M (SE)
Time 1			
Physical activity	216.44 (49.86)[a]	1369.99 (119.20)[b]	1772.67 (186.35)[b]
Life satisfaction	3.97 (.19)[a]	5.12 (.11)[b]	5.41 (.11)[b]
Time 2			
Physical activity	167.69 (30.89)[a]	1319.98 (103.14)[b]	1568.69 (145.94)[b]
Life satisfaction	4.00 (.18)[a]	5.12 (.11)[b]	5.40 (.10)[b]
Time 3			
Physical activity	212.78 (38.61)[a]	1231.05 (93.45)[b]	1527.54 (139.35)[b]
Life satisfaction	4.17 (.19)[a]	4.98 (.11)[b]	5.37 (.11)[c]

Note. M = Mean. SE = Standard error. Physical activity is measured in MET min/week, [a,b,c] indicate differences in means between profiles based on significant Wald's tests ($p < .05$; Appendix Q). Time 1 = November 14–21, 2022; Time 2 = December 14–21, 2022; Time 3 = January 14 - February 14, 2023.

Table 5
Correlations of physical environmental and community levels with the likelihood of profile membership.

Variables		Profile 1: Low in Motivation	Profile 2: Self-Determined Motivation	Profile 3: Ambivalent Motivation
Being physically active outdoors	*r*	.05	−.11	.07
	p	.44	.07	.26
Being physically active in a public space	*r*	.02	−.03	.01
	p	.68	.57	.85
Being physically active with others	*r*	−.25***	−.29***	.43***
	p	<.001	<.001	<.001
Being physically active as part of a team	*r*	−.43***	−.44***	.71***
	p	<.001	<.001	<.001
Being physically active with an instructor	*r*	−.44***	−.46***	.74***
	p	<.001	<.001	<.001
Restorativeness of the exercise environment	*r*	−.28***	.29***	−.07
	p	<.001	<.001	.24
Community support	*r*	−.44***	.15*	.15**
	p	<.001	.01	.009
Physical activity opportunities	*r*	−.29***	.02	.22***
	p	<.001	.75	<.001

Note. Correlation using Spearman's Rho: ***$p < .001$, **$p < .01$, *$p < .05$ level (2-tailed). The columns refer to only those who belonged to the profile at all three time points based on the highest probability membership.

association between transitioning to, returning to, or staying in motivationally positive profiles with number of physical activity opportunities in the neighborhood (r = .03, p < .001), community support (r = .41, p < .001), and the following physical activity environment characteristics: being active with other people (r = .20, p < .001), being active as part of a team (r = .34, p < .001), being active with an instructor (r = .36, p < .001), and perceived restorativeness of the physical activity environment (r = .30, p < .001). In contrast, being active outdoors (r = .04, p = .48) or in a public place (r = .08, p = .19) did not show significant correlations with the probability of transitioning to, returning to, or staying in motivationally positive profiles (Appendix 0).

2.7. Relationship between sociodemographics and motivational trajectories

The sociodemographic characteristics associated with the likelihood of remaining in Profile 1 (low in motivation), 2 (self-determined), or 3 (ambivalent motivation), or being in a motivationally positive profile at T3 is detailed in Appendix P. The findings suggest that being male, having an education level above a bachelor's degree, being employed at some capacity, having a higher income, being married or in a civil partnership, and identifying as White were all associated with being in a motivationally positive profile at T3.

3. Discussion

The present study offers a nuanced exploration of motivational profiles using LPTA, advancing the application of self-determination theory by revealing the dynamic nature of motivation over a shorter time scale than previously examined by Emm-Collison et al. (2020). The study extends beyond variable-centered analyses and provides insights into how environmental factors associate with motivational transitions.

Three motivational profiles were identified and assessed for their stability over time. First, individuals in the low in motivation profile exhibited low levels of motivation for physical activity. This profile was linked with lower levels of physical activity and life satisfaction. This highlights the relevance of being autonomously motivated for physical activity for psychological well-being and the findings add to research that used variable-centered approaches in these contexts (Sweet et al., 2014; Teixeira et al., 2012). Staying in this profile was negatively associated with being active with others, as part of a team, or with an instructor. Also, it was associated with lower perceived restorativeness of the physical activity environment, fewer physical activity opportunities, and less community support.

Second, individuals in the self-determined profile showed high levels of autonomous motivation (intrinsic, integrated, and identified motivation) for physical activity. Staying in the profile was positively correlated with the restorativeness of the physical activity environment and availability of physical activity opportunities. However, it was negatively correlated with being active with others, as part of a team, or with an instructor. This suggests that while individuals in this profile have high intrinsic motivation, they might prefer solitary physical activity settings.

Third, individuals in the ambivalent motivation profile reported high levels of all types of motivation, including autonomous and controlled forms. Individuals in this profile exhibited positive associations with all examined environmental and community factors, including the restorativeness of the exercise environment, physical activity opportunities, and community support. This indicates that despite experiencing a mix of motivational types, individuals in this profile benefit from supportive environmental and community contexts. The three motivational profiles were stable over the course of three months.

The profiles identified in the present study are largely consistent with those found in previous samples, such as that by Castonguay and Miquelon (2018). In agreement with previous studies (Gourlan et al., 2016; Hagerman et al., 2023; Miquelon et al., 2017; Saward et al., 2024; Wasserkampf et al., 2018), the ambivalent motivation profile reflects individuals who exhibited high levels across various motivational types, indicating a mix of autonomous and controlled motivations. The profile represents the complexity of motivational experiences where individuals may have had a range of motivational orientations coexisting.

One profile that was not found in this study, but has appeared in previous research, is one characterized by high levels of controlled and low levels of autonomous motivation. The absence of this profile may be attributed to the specific sample population in this study. In the study, there was no physical activity intervention, such as participation in a weight-loss program (as opposed to Ostendorf et al., 2021; Wasserkampf et al., 2018) and the study did not focus on individuals who are at health risk, such as people with chronic diseases (as opposed to Castonguay & Miquelon, 2018; Gourlan et al., 2016)—individuals who may have higher controlled motivation due to health-related concerns.

The findings on sociodemographic characteristics of the people who transitioned to, returned to, or remained in motivationally positive profiles reflect broader trends in physical activity inequities among North American residents (Patel et al., 2022), highlighting how sociodemographic factors can intersect with motivational dynamics. The findings of the present study align with existing literature on physical activity inequities, particularly among certain sociodemographic groups. Patel et al. (2022) noted that females, non-Whites, and those with lower education and income levels often face challenges in maintaining a physically active lifestyle. The higher prevalence of lower-quality motivational profiles among those at risk for low physical activity underscores the need for targeted interventions. Improving motivational strategies could help mitigate these disparities.

The findings of the present study are consistent with Haughton McNeill et al. (2006), who emphasized the role of perceptions of physical activity facilities for intrinsic motivation and engagement in physical activity. The present study's findings on individuals who belonged to the ambivalent profile also uncovered the importance of the perceived availability of facilities; there were positive associations between the likelihood to belong to the profile and the perceived number of physical activity facilities in their neighborhood. Gay et al. (2011) discussed the impact of positive perceptions of the built environment on people's motivation and physical activity. The current study extends this by showing that perceptions of physical activity facilities, along with other environmental factors like restorativeness and community support, were positively associated with fostering and maintaining self-determined motivation across different sociodemographic groups.

Furthermore, the study extends the work of D'Angelo et al. (2017) and Gay et al. (2011) by demonstrating that not only do positive perceptions of the environment strengthen the relationship between self-determined motivation and physical activity, but these perceptions also supported the maintenance of or transition towards self-determined motivation over time. This highlights the dynamic interplay between environmental factors and motivational profiles and underscores the importance of addressing these factors to enhance physical activity outcomes.

The present study also found that social support during physical activity, particularly through interactions with others, team-based activities, or guidance from an instructor, is positively associated with transitioning to, returning to, or maintaining in motivationally positive profiles, especially Profile 3 (ambivalent motivation). For Profile 3, interpersonal relationships and support play a significant role in fostering motivation and maintaining engagement in physical activity. According to self-determination theory, fulfilling the basic psychological need for relatedness (Deci & Ryan, 2000) can enhance self-determined motivation. The finding that social support was positively associated with motivationally positive profile membership aligns with this theory, as it highlights how relatedness can contribute to higher motivation levels and better psychological outcomes.

Although the present study supports the idea that social interaction is a key factor in motivating individuals for physical activity, rather than the physical characteristics of the exercise environment alone (e.g., being outdoors or in a private space) (Burke et al., 2006; Salvo et al., 2017), it also identifies important boundary conditions of the effect. Specifically, the present study found that individuals in Profile 2 (self-determined motivation) preferred to exercise alone, and social interaction was potentially less important to them. For these individuals, the restorativeness of the physical activity environment (e.g., being in a pleasant, rejuvenating space), but not social interactions, were positively associated with remaining in the self-determined profile. This suggests that while social support is beneficial for many, personal preferences and the quality of the physical activity environment also play a crucial role.

Attention Restoration Theory (Kaplan, 1995) posits that natural environments help restore cognitive resources and reduce mental fatigue, which can lead to enhanced well-being and motivation. The theory emphasizes that it is not merely the act of being outside, but the specific natural aspects of the environment that contribute to this restorative effect (Hartig et al., 2003; Kaplan & Berman, 2010). In the context of the present study, the positive association between the restorativeness of the physical activity environment and the belonging to motivationally positive profiles, especially Profile 2 (self-determined motivation), suggests that individuals who are active in environments that are perceived as restorative may experience greater motivation and life satisfaction. The discussion points out two possibilities regarding individuals in Profile 2: Individuals in this profile might actively choose to engage in physical activity in environments they find restorative. This intentional selection could contribute to their high levels of self-determined motivation, physical activity, and life satisfaction. Alternatively, these individuals might simply have access to higher-quality environments due to their residence or lifestyle, such as proximity to parks and habitual use of active transportation modes, which inadvertently promotes self-determined motivation, physical activity, and life satisfaction. Both possibilities are not mutually exclusive and highlight the potential influence of environmental quality on motivation.

3.1. Limitations

There are several limitations of the study that need to be acknowledged. The retention of MTurk participants has proved difficult (Chandler et al., 2014) and the MTurk sample is not representative for the U.S. This is also true for the present study. As regards the use of online surveys, there are data-quality concerns (Fricker & Schonlau, 2002). Even though we applied several measures to identify low-quality or bot-input data, some general limitations remain (e.g., the tendency toward stylistic responding). Another limitation concerns the measurement of the variables assessed in the surveys. There is a potential recall bias and there is the tendency of over estimation of physical activity levels from the self-report IPAQ (Lee et al., 2011; Sallis & Saelens, 2000). Objective physical activity assessments might reduce these biases. The physical activity opportunities in the neighborhood were also based on self-reports. Since individuals may only be aware of the opportunities because they are already using them, a true discernment of the relation between physical activity opportunities and the likelihood of belonging to a motivational profile is difficult. To overcome this, a validation of self-reported physical activity environment data using geographic information systems is desirable. Also, it would also be of interest to assess the role of satisfaction of basic psychological needs for the relationship between the environment and self-determination, which has been considered in previous studies (Cleary et al., 2017; Edmunds et al., 2008; Gay et al., 2011). Lastly, the present study connects relevant sociodemographics with motivational profiles, where lower quality profiles may perceive their environment to have less health-promoting characteristics. Unfortunately, the present study's sample size was too small to study the associations of sociodemographics with actual transitions between the low in motivation profile and the self-determined or ambivalent motivation profiles. Future studies might recruit more people to study the various transitions and their determinants. Despite these limitations, the study contributes to research into physical activity places because it is the first to describe the environmental features which correlate with low in motivation and positive motivational trajectories, respectively.

4. Conclusion

Motivation for physical activity is stable over the course of three months, as identified via the present study's person-centered approach. The work extends the knowledge that relevant environmental factors are associated with motivational transitions, which can be beneficial for physical activity and other health behaviors (Marentes-Castillo et al., 2022). This is particularly important as the world becomes increasingly efficient, for example, with the use of automated vehicles and the associated public health concerns (Spence et al., 2020).

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CRediT authorship contribution statement

Georgia Gidney: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jason N. Bocarro:** Writing – review & editing, Supervision. **Kyle Bunds:** Writing – review & editing, Supervision. **Joerg Koenigstorfer:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization.

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.

Data availability

Data will be made available on request.

Appendix. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2024.102719.

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