# Exercise Identity and Physical Activity Behavior During Late Adolescence: A Four Wave Cross-lagged Panel Model

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## Abstract

Research has shown that physical activity behavior tends to decline across adolescence before stabilizing in adulthood. Identifying salient factors underlying these behavioral changes is therefore imperative for informing intervention development. This study explored the temporal nature of the relationship between exercise identity and physical activity behavior during the transition out of high school. An analysis of data from the Application of integrated Approaches to understanding Physical activity during the Transition to emerging adulthood (ADAPT) prospective cohort study was conducted, involving 1,451 Canadian adolescents ($M_{age}$ = 15.93 ± 0.53 years; 52.4% female). Participants completed the International Physical Activity Questionnaire-Short Form to report weekly moderate-to-vigorous physical activity and an abbreviated version of the Exercise Identity Scale yearly for four years beginning in Grade 11. A four-wave cross-lagged panel model was used to test bi-directional associations between exercise identity and physical activity behavior. Significant auto-regressive effects for exercise identity and physical activity were observed across all four time points. Significant positive cross-lagged paths were observed for exercise identity predicting future physical activity at all time points; however, none of the cross-lagged paths with physical activity predicting future exercise identity were significant. Collectively, these findings support existing theory that emphasizes the role that identity plays in physical activity behavior. Interventions seeking to attenuate the physical activity declines typically observed during the transition to emerging adulthood should therefore consider adopting behavior change techniques that target identity, as it appears to be an important psychological determinant underlying future physical activity engagement.

## Introduction

Engaging in physical activity has been associated with many benefits for physical and mental health during adolescence (Biddle et al., 2019; García-Hermoso et al., 2021), and is associated with a higher likelihood of a healthy adulthood (Reiner et al., 2013). Despite the well-established benefits of physical activity, most adolescents – roughly 80% of the global population – do not engage in enough physical activity for optimal health benefits (Guthold et al., 2020). Furthermore, evidence at the population level has shown that physical activity levels tend to peak during early adolescence and decline with age, before stabilizing later in adulthood (Gordon-Larsen et al., 2004; van Sluijs et al., 2021). The persistence of low activity levels following the sharp declines in physical activity during adolescence is a substantial public health issue, as it is likely to persist into adulthood (Reiner et al., 2013). Simply stated, engaging in insufficient amounts of physical activity during adolescence could pose a significant burden on the health care system later in life. Such evidence highlights the importance of understanding factors that can promote the adoption and maintenance of a physically active lifestyle during adolescence for the purpose of informing intervention development.

The field of exercise psychology has put forth many theories and models to try to explain physical activity behavior (e.g., Social Cognitive Theory, Theory of Planned Behavior, Transtheoretical Model) with social cognitive theories having received the most attention (Rhodes et al., 2019). A key criticism of social cognitive theories is that they tend to emphasize the importance of intention as the most proximal determinant of behavior, even though intentions alone often fall short of being translated into action (Feil et al., 2023). This phenomenon is known as the intention-behavior gap (Sheeran & Webb, 2016). The intention-behavior gap has sparked the development of action control theories such as Rhodes' (2017) Multi-Process Action

Abbreviations:

1. Multi-Process Action Control (M-PAC)
2. Application of intergrateD Approaches to understanding Physical activity during the Transition to emerging adulthood (ADAPT)

Control (M-PAC) framework, which extends beyond reflective processes (e.g., attitudes and perceived behavioral control) known to play a role in intention formation to incorporate post-intentional (regulatory and reflexive) processes that help to explain why individuals often struggle to translate their intentions into action. Specifically, regulatory processes are behaviors or thoughts that individuals engage in to convert their intentions into physical activity, such as goal setting, planning, and monitoring. Reflexive processes such as identity and automaticity (i.e., habit), on the other hand, are automatic and less conscious processes that help bridge the intention-behavior gap through learned associations and are triggered by particular situations (Rhodes, 2017). According to the M-PAC model (Rhodes, 2017), a sustained pattern of physical activity results from a combination of reflective, regulatory, and reflexive processes that facilitate the transition from initial intention to successful ongoing behavior. An analysis of constructs included in Rhodes' M-PAC framework found the strongest correlate of translating physical activity intentions into action was identity ($d = 0.73$), whereas smaller effects were observed for other M-PAC constructs ($d = 0.21$ to 0.66) (Rhodes, 2021). A key shortcoming of the M-PAC framework, however, is that it does not consider the potential for physical activity to reinforce psychological antecedents such as exercise identity when our current understanding of different aspects of identity would support this line of theorizing.

Identity refers to a person's sense of self, including their characteristics, beliefs, values, and behaviors (Marcia, 1980), and is often considered a central aspect of an individual's self-concept, the mental representation people have of themselves organized hierarchically (Stets & Burke, 2003). Due to this hierarchical structure, individuals can possess multiple identities concurrently, each carrying distinct values and norms that shape their actions. Deviations from these standards can alter an identity's position in this hierarchical structure (Burke, 2006).

Importantly, identity is an ongoing, evolving process throughout a person's lifetime, meaning that identities are not rigid but amenable to change. Role Identity Theory supports the notion that engaging in behavior consistent with one's identity would reinforce that identity (Stryker & Serpe, 1982). Role identities not only give meaning and value to previous behavior but also shape future behavior such that individuals behave consistently with their identity or otherwise may experience distress (Rhodes, 2017; Stets & Burke, 2003). One such identity that people adopt is an exercise identity, defined as "an individual's identification with exercise is an integral part of their concept of self" (Anderson & Cychosz, 1994, p. 749-750). Exercise identity reflects an individual's attitudes and beliefs toward physical activity and is thought to play a crucial role in regulating motivation for regular physical activity (Rhodes et al., 2016; Strachan et al., 2013). Exercise identity has been shown to be associated with frequency, intensity, and duration of physical activity behavior (Rhodes et al., 2016; Strachan et al., 2015). Simply stated, people with a strong exercise identity are more likely to engage in regular physical activity than those who do not see themselves as exercisers (de Bruijn & van den Putte, 2012; Kendzierski & Morganstein, 2009). In fact, meta-analytic evidence from 32 studies suggests exercise identity is one of the strongest ($r = 0.44$) predictors of physical activity behavior (Rhodes et al., 2016).

Despite the fact that exercise identity has shown promise for its predictive utility with regard to physical activity behavior (Rhodes et al., 2016), existing studies have primarily used cross-sectional designs, thus limiting our understanding of the temporal relationship between these constructs. For example, of the 32 studies included in Rhodes' (2016) meta-analysis, 75% ($n = 24$) were cross-sectional. Furthermore, all of these studies were conducted with adult samples. This is important to note because adolescence is recognized as a crucial period in which one's sense of identity becomes coherent (Kroger, 2006). From this standpoint, the lack of longitudinal studies and sample diversity indicates a critical knowledge gap – we are a long way from understanding the complex and potentially dynamic relationship between physical activity and identity, particularly as it relates to the transition from adolescence to emerging adulthood.

Of the longitudinal studies that exist, the findings are mixed with regards to if changes in identity are associated with changes in physical activity behavior. Most of these studies have been randomized controlled trials (RCTs), which offer valuable insight into whether identity plays a role in driving changes in behavior (Cardinal, 1997; Cardinal & Cardinal, 1997; Jenum et al., 2009; Tsorbatzoudis, 2005). However, RCTs typically have limited follow-up periods, making it difficult to fully grasp how physical activity and identity evolve together over time. Prospective cohort study designs offer an opportunity to gain a better understanding of the interplay between physical activity and identity given these studies follow individuals over an extended period, with multiple observations. Unfortunately, existing prospective studies have generally focused on predicting future physical activity behavior based on exercise identity measured at baseline, with evidence yielding mixed results (Paziraei, 2021; Strachan et al., 2015). To the best of our knowledge, no prospective cohort studies have examined the relationship between physical activity and exercise identity during adolescence, let alone explored bi-directional associations between these constructs over multiple waves. Therefore, further research is clearly warranted.

The aim of the present study was to investigate the relationship between exercise identity and physical activity over time among a group of Canadian adolescents transitioning out of high school. It was hypothesized that exercise identity and physical activity would positively predict future exercise identity and physical activity behavior, respectively. Furthermore, building on the Role Identity Theory, which suggests that identification with a specific role or behavior, such as an exerciser, should predict future engagement in that behavior, and this engagement should in turn bolster one's identity; we hypothesized that a mutually reinforcing relationship would be observed. Thus, we anticipated that identity would positively predict future physical activity behavior and physical activity behavior would positively predict future exercise identity.

# Method

## Data Source and Study Design

The present study utilized data from the Application of intergrateD Approaches to understanding Physical activity during the Transition to emerging adulthood (ADAPT) study. ADAPT was a prospective open cohort study that was developed to examine physical activity determinants among a group of Grade 11 students for four years during their transition from adolescence to emerging adulthood. As a school-based study, ADAPT recruited students from the seven secondary schools within one school board in Southern Ontario, Canada. More information regarding the study design, methods, and development is outlined by Kwan and colleagues (2020). All study protocols received approval from both the Hamilton Integrated Research Ethics Board and the Hamilton-Wentworth Catholic District School Board.

## Participants

At Time 1 (Fall 2019), the survey was administered to 2,412 students across the seven schools, with 1,585 responding (66% response rate). Of the 1,585 who responded, 347 were excluded for completing less than 5% of the survey or due to no parental consent. The final sample size at Time 1 included a total of 1,238 Canadian adolescents. A total of 213 participants joined the study after Time 1. Thus, the final analytic sample included 1,451 adolescents. Out of the initial 1,238, a total of 588 participants completed Time 2, 387 at Time 3, and 333 at Time 4. Participants self-reported their age, grade, gender, ethnicity, and highest level of parental education at Time 1. The sample mean age was 15.93 years (*SD* = 0.53) with no significant difference between genders (45.5% male and 52.4% female; 2.1% missing/prefer not to answer). Among the sample, 50.9% identified as White, 11.5% as Asian, and 9.3% as Black. Roughly two-thirds (68.6%) of participants' parents or caregivers completed post-secondary education, with 17.8% having completed high school and 12.5% having completed less than high school. Missing data ranged from 0.2% for gender to 1.1% for parental education.

## Measures

### *Physical Activity*

Physical activity behavior was assessed using the International Physical Activity Questionnaire-Short Form (IPAQ-SF; Booth, 2000; Craig et al., 2003). The IPAQ-SF captures one's frequency (days) and duration (hours and/or minutes on an average day) of physical activity over the previous seven days. Specifically, the IPAQ-SF asks participants if they engaged in vigorous physical activity, moderate physical activity, and walking (at least 10 minutes at a time). If they indicate yes to any of these categories of physical activity, then they answer a follow-up question where they report the duration of that activity. In accordance with the public health recommendations for physical activity, which are specific to moderate and vigorous physical activity, but not walking, the present study focused on only moderate-to-vigorous physical activity (MVPA). MVPA was computed by multiplying the reported frequency of days of vigorous and moderate physical activities by their corresponding durations. The resulting products were then summed, and the total was divided by 60 to determine each participant's weekly MVPA in hours. According to the scoring protocol for the IPAQ-SF, participants' MVPA was capped at a maximum of 180 minutes each day.

### *Exercise Identity*

Exercise identity was assessed using an abbreviated version of the Exercise Identity Scale (EIS) that was modified to be specific to physical activity (Anderson & Cychosz, 1994). The original EIS contains nine items that capture individuals' identification with exercise (or physical activity in this case) as it relates to the concept of self. However, only five of the nine items were used in the ADAPT study. Furthermore, while the EIS was originally written to be specific to exercise, it has been adapted in recent years to be specific to the broader domain of physical activity, as supported by recent work by Brown and Meca (2022), which shows that exercise identity and physical activity identity may represent a single or at the very least a highly inter-related identity domain among youth populations. The following five modified items were included in the present study: "*I consider myself as someone who is physically active"*, "*When I describe myself to others, I usually include my involvement in physical activity"*, "*Others see me as someone who does physical activity regularly"*, "*I would feel a real loss if I were forced to give up physical activity",* and "*Engaging in physical activity is something I think about often"*. Participants responded to each item on a 7-point Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Participants' responses to the five items were averaged to provide a value representing their exercise identity.

**Covariates**

Self-reported gender (male/female/other), race/ethnicity (White/BIPOC), and highest level of parental education (More than high school/High school or less) were included in our models as covariates. Each of these variables has been found to be correlated with physical activity during adolescence (Sterdt et al., 2014).

**Data Analysis**

All analyses were performed using Mplus Version 8 (Muthén & Muthén, 2017). First, descriptive statistics and frequencies were computed for each variable in the study, and distributions were examined. Coefficient alphas and correlations of all key variables were also computed to examine the measures' reliability across the four time points. It is important to note that the ADAPT dataset was collected from students enrolled in schools and there was a possibility of nesting effects. However, multilevel models with fewer than 20 clusters bias standard errors (Lai & Kwok, 2015). Given there were an insufficient number of clusters ($n = 7$), no nesting was required.

Before computing our CLPM, we first established longitudinal invariance for the EIS. This was necessary because longitudinal analyses hinge upon the assumption that the same underlying construct is consistently measured over time (Little, 2013). Additionally, it is imperative to ascertain that any observed changes in a latent construct across time genuinely reflect true changes, rather than the construct measuring something different at each time point (Little, 2013). To address these concerns, we evaluated configural invariance, metric invariance, and scalar invariance. We began with the least restrictive model for the EIS, the configural model. Building on this model, we examined metric invariance model by constraining factor loadings to equality across time, and then scalar invariance by constraining intercepts and factor loadings to equality across time. To assess the goodness of fit for each of these models, we relied on the Comparative Fit Index (CFI) with a criterion of $\Delta$CFI < .010 and the Root Mean Square Error of Approximation (RMSEA) with a threshold of $\Delta$RMSEA < .010 (Little, 2013).

Next, a cross-lagged panel model (CLPM) was computed to examine the bi-directional relationship between exercise identity and physical activity over four time points, with adjustment for gender, race/ethnicity and parental education. The CLPM can be used to examine the direction and strength of relationships between two or more variables over two or more time points at the between-participant level (Kenny, 1975), which assumes there is a general pattern of change over time that is similar for everyone in the cohort. This model can demonstrate whether mean values in one variable (i.e., exercise identity) are associated with mean values in another variable (i.e., MVPA) at a subsequent time point (hypothesis two), and vice versa. The model's autoregressive paths indicate stability in the specified variables (i.e., exercise identity, MVPA) over time (hypothesis one). CLPMs assume that the relationship between variables of interest are linear, and in this case, previous cross-sectional research on exercise identity and physical activity supports a linear relationship (Rhodes et al., 2016). The CLPM also assumes measurement synchronicity in that all assessments at each time point occur at the same time (Kenny & Harackiewicz, 1979), as was the case in the present study. Another assumption relates to the time between measurement intervals, which was consistently one year in the ADAPT study, and therefore no model adjustments were needed (Baribeau et al., 2022).

The Chi-square test was used to evaluate the overall goodness-of-fit of the CLPM. A nonsignificant p-value indicates an acceptable fit to the data; however, significant p-values are common due to sensitivity associated with larger sample sizes (Zheng & Valente, 2022). Due to the sensitivity of the Chi-square test, Standardized Root Mean Squared Residual (SRMR), Tucker-Lewis Index (TLI), CFI and RMSEA were also evaluated to examine the model fit. CFI and TLI values >.95 indicate excellent model fit, and .90-.95 is considered acceptable, whereas RMSEA and SRMR values below .05 and .08, respectively, are considered to indicate acceptable model fit (Kline, 2016). Modification indices were examined and adopted to improve the model fit if theoretically relevant.

## Results

## Data inspection

The extent of missing data for exercise identity and MVPA differed across variables and time points. Time 1 had the lowest amount of missingness, with only 15% missing for either variable. However, as time progressed through the study, the amount of missing data increased, with 58.6% missingness for exercise identity in Time 4. Predictors of missingness were examined, and data were determined to be MAR. Therefore, missing data was handled using full information maximum likelihood (FIML), which is a widely accepted missing data technique that is considered a best practice for handling missing data (Enders, 2022).

Pearson correlations between exercise identity and MVPA are presented in Supplemental Materials Table 1. The EIS demonstrated excellent internal consistency across all four time points (Cronbach's $\alpha = 0.90$-$0.92$). Closer inspection of the distributions of exercise identity and MVPA revealed acceptable skewness, whereas kurtosis values were slightly outside of the acceptable range for MVPA at one time point and exercise identity at all time points (Supplemental Materials Table 2). Additionally, the histograms of MVPA (Supplemental Materials Figure 1) demonstrated a non-normal distribution, so maximum likelihood estimation with robust standard errors and a mean- and variance-adjusted chi-square test statistic (MLR) was used to estimate the parameters in our CLPM. MLR is a robust estimation method that is recommended when data are not normally distributed or when there are outliers present. MLR adjusts the standard errors of the parameter estimates to account for non-normality and/or non-independence of the data, and it uses a robust chi-square test statistic to assess model fit (Rosseel, 2010).

## Measurement invariance

The configural invariance model for the EIS demonstrated good fit, $\chi^2$ (134) = 465.283, p < .001; CFI = .969; RMSEA = .041 (Table 1). The assumption of metric variance was satisfied, $\Delta\chi^2$ (15) = 20.370, p < .001; ΔCFI = -.002; ΔRMSEA = .001. Lastly, the assumption of scalar invariance was supported, $\Delta\chi^2$ (15) = 81.300, p < .001; ΔCFI = -.006; ΔRMSEA = -.002.

**Main analysis**

The CLPM model that was adjusted for covariates demonstrated excellent fit to the data, as indicated by the chi-square test of model fit $\chi^2(8) = 18.12$, $p = .02$, the SRMR = .019, RMSEA = .030, TLI = .958 and the CFI = .993. For hypothesis one, the CLPM indicated that exercise identity (*β* = .14 to .69, *SE* = .03 to .06, all *p*'s < .01) and MVPA (*β* = .21 to .30, *SE* = .05, all *p*'s < .001) had significant autoregressive effects across all time points, indicating that those who had higher exercise identities or high levels of MVPA at one time point were likely to maintain their exercise identity or MVPA at subsequent time points. For hypothesis two, exercise identity was found to positively predicted MVPA at each subsequent time point (*βs* = .12 to .18, *SE* = .04, *p's* < .01). However, contrary to expectations, none of the cross-lagged paths with MVPA predicting future exercise identity were not found to be significant: Time 1 to Time 2 (*β* = -.02, *SE* = .04, *p* = .698), Time 2 to Time 3 (*β* = .04, *SE* = .04, *p* = .409), and Time 3 to Time 4 (*β* = .01, *SE* = .03, *p* = .701). The CLPM is presented visually in Figure 1.

# Discussion

The purpose of the current study was to investigate the temporal relationship between exercise identity and physical activity over four time points among a sample of Canadian adolescents during their transition out of high school. Significant autoregressive correlations were observed at all time points; however, a mutually reinforcing relationship was not evident in the cross-lagged paths. Instead, evidence only demonstrated a significant positive association between exercise identity and future physical activity behavior, whereas physical activity was not found to be associated with future exercise identity. These findings address the dearth of knowledge surrounding our understanding of the interplay between exercise identity and physical activity over time. Overall, these results have implications for current theorizing in exercise psychology as physical activity engagement does not appear to predict stronger exercise identity one year later, which lends support for directional pathways outlined within the M-PAC framework in that reflexive processes such as identity may not be bolstered further by simply engaging in physical activity behavior (Rhodes, 2017).

The present study addressed a critical knowledge gap regarding the temporal nature of the relationship between exercise identity and physical activity. Contrary to expectations of a mutually reinforcing relationship, exercise identity was found to positively predict future physical activity across all three cross-lagged paths, whereas null effects were observed for each of the paths from physical activity to future exercise identity. These results contradict the principles of Role Identity Theory (Stryker & Serpe, 1982), which would support a reciprocal relationship between identity and behavior. The theory posits that one's self-perception and identification with a specific role or behavior, such as being an exerciser, should predict future engagement in that behavior, and engagement in that behavior would reinforce one's identity. Findings from these data suggest this does not appear to be the case for physical activity behavior though. A possible explanation for the lack of observation of this effect could be attributed to the substantial gap between assessments, with annual assessments being insufficient to capture this relationship. In other health behavior and identity research that has supported mutually reinforcing effects such as alcohol consumption and identity, the interval between assessments has been around three months (Lindgren et al., 2018; Shono et al., 2022). Specific to physical activity, Paziraei (2021) revealed that exercise identity among non-exercisers changed between six and nine weeks, which would suggest that adopting a shorter temporal frame between assessments might be more suitable for investigating a reinforcing relationship. Another potential factor contributing to the absence of observed effects could be that a large portion of the sample may have already endorsed a relatively robust exercise identity. Previous work supports this notion in that qualitative data has suggested identity development over time in response to a physical activity intervention despite quantitative data failing to capture deviations, which may ultimately be attributable to a ceiling effect for baseline identity scores (Oliver et al., 2016). Therefore, with many adolescents reporting a strong sense of exercise identity, it is possible that the reinforcing relationship with physical activity behavior was masked by ceiling effects.

Despite the lack of alignment with predictions rooted in Role Identity Theory, the present findings demonstrating identity plays a crucial role in future physical activity – but not vice versa – are supported by the M-PAC framework. Specifically, the M-PAC framework suggests that physical activity is sustained foremost by reflexive processes, such as identity and habit, and does not currently outline a reinforcing effect of physical activity on identity or habit (Rhodes, 2017). Simply stated, physical activity behavior sits at the pinnacle of the M-PAC framework, and evidence to date has yet to support mutually reinforcing relationships between physical activity behavior and the constructs that facilitate behavioral adoption and maintenance. Nevertheless, Rhodes and colleagues (2021) have acknowledged the possibility that repeated behavior may lead to the development of physical activity habits and identity (i.e., reflexive processes). Reflexive processes are ultimately posited to be essential for sustaining physical activity behavior, with identity impacting action control by enhancing motivation for a particular behavior. This motivation stems from the dissonance that arises when there is an increasing mismatch between one's recognized sense of self and their actual behavior (Burke & Stets, 2009). Moving forward, further longitudinal investigation of the M-PAC framework is needed, particularly as it relates to whether physical activity behavior may have a reinforcing effect on psychological antecedents.

Findings from the present study also demonstrated significant autoregressive effects for both physical activity behavior and identity across all time points, which provides insight into the degree of stability among these constructs during adolescent development. From a theoretical standpoint, these findings align with Identity Theory in that if a behavior is thought of as an expression of the self, then individuals are more likely to maintain that behavior over time (Burke & Stets, 2009). One important finding which should be noted pertains to the fact that the autoregression correlations for identity were much stronger than those for physical activity. This disparity in construct stability may not be surprising for several reasons. First, identity is understood to be a rather stable construct (Burke & Stets, 2009), and the items on the EIS tap into the salience of identifying with physical activity as an integral portion of their self-concept. Physical activity, on the other hand, was measured using an instrument that asks individuals to report their behavior over the past seven days, which could render measurement susceptible to deviations from typical behavioral patterns due to extraneous events such as poor weather or prior commitments. It is, however, worthwhile to recognize the impact of the COVID-19 pandemic – which occurred between the first and second wave of the ADAPT study (Kovacevic et al., 2022) – and has been associated with significant reductions in physical activity behavior (Neville et al., 2022; Wunsch et al., 2022). Additionally, the reduction in construct stability from Time 2 to Time 3 may also reflect the transition out of high school, in which changes in life circumstances (e.g., moving away to attend university, beginning full-time employment) among many participants may have changed not only their physical activity behavior, but also their self-views related to being an active individual. Taken together, it was in many ways expected that physical activity behaviors would vary more than physical activity cognitions across the study period.

Collectively, the present findings have implications for public health, specifically as it relates to health promotion strategies that aim to facilitate the adoption and maintenance of physical activity behavior. Interventionists focused on changing physical activity behavior should strongly consider targeting identity related to physical activity as the present results suggest it may be a key intermediary mechanism for facilitating physical activity engagement. Behavior change techniques that have been mapped to exercise identity, such as self-re-evaluation, self-affirmation, and anticipated regrets deserve attention in the intervention development process (Kok et al., 2016). Including these techniques could be highly valuable in the development and maintenance of exercise identity. Considering evidence in the present study indicates exercise identity is relatively stable over time and positively predicts future physical activity behavior, developing a strong exercise identity represents an excellent opportunity to establish long-held behavioral maintenance after the adoption phase. Attempting to prevent exercise identity from dissolving during adolescence may be one way in which we can attenuate the declines in physical activity typically observed during this life stage, including during the transition out of high school, which is known to be a turbulent time associated with many life changes that could uproot positive health habits such as physical activity engagement.

While this study has many strengths, there are also several limitations that should be considered when interpreting these findings. First, it should be noted that self-reported physical activity is prone to bias and recall errors (Sallis & Saelens, 2000). However, the IPAQ-SF has demonstrated good psychometric properties when used with adolescents (Guedes et al., 2005; Hidding et al., 2018) and has been shown to correlate with device-measured behavior (Rääsk et al., 2017; Welk et al., 2023). Nevertheless, moving forward researchers are encouraged to use device-based measures of physical activity, such as accelerometers or commercial wearables, to overcome the limitations of self-reported physical activity. Second, the utilization of only five out of the nine EIS items in this study is worth acknowledging, as it may have implications for the scale's psychometric properties. Cronbach alphas for the EIS at each time point did, however, demonstrate excellent internal consistency for this instrument. Third, the COVID-19 pandemic occurred after the first wave of data collection and may partially explain the high levels of attrition across the four waves of this study. Best practices for handling missing data (i.e., FIML) were implemented to address this limitation. Fourth, it should be acknowledged that the ADAPT study sample was not nationally representative, thus limiting the generalizability of the findings. Finally, it is important to note that CLPMs provide inferences at the between-person level as opposed to the within-person level. Despite this limitation, we chose to use a CLPM as it was the best analysis to explore exercise identity and physical activity behavior at a population level.

Overall, findings from the present study demonstrate that exercise identity and physical activity behavior are relatively stable constructs among adolescents during the transition out of high school, however, mutually reinforcing relationships were not observed over time. Exercise identity appears to be a promising predictor of future physical activity behavior, but physical activity does not appear to predict future exercise identity. Such evidence supports targeting exercise identity as a mechanism of action in interventions aiming to promote the adoption and maintenance of physical activity behavior. Future research using different measurement intervals and device-measured physical activity behavior is warranted for determining whether the present pattern of results replicates.

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**Table 1**

*Model Fit and Comparison for Longitudinal Invariance of Exercise Identity Scale*

| Model | $\chi^2(df)$ | $\Delta\chi^2(df)$ | CFI | ΔCFI | RMSEA | Δ RMSEA |
|---|---|---|---|---|---|---|
| Configural | 465.283 (134) | | .969 | | .041 | |
| Metric | 496.047 (149) | 20.370 (15) | .967 | -.002 | 0.040 | .001 |
| Scalar | 573.962 (164) | 81.300 (15) | .961 | -.006 | .042 | -.002 |

*Note.* CFI = comparative fit index; RMSEA = root mean square error of approximation

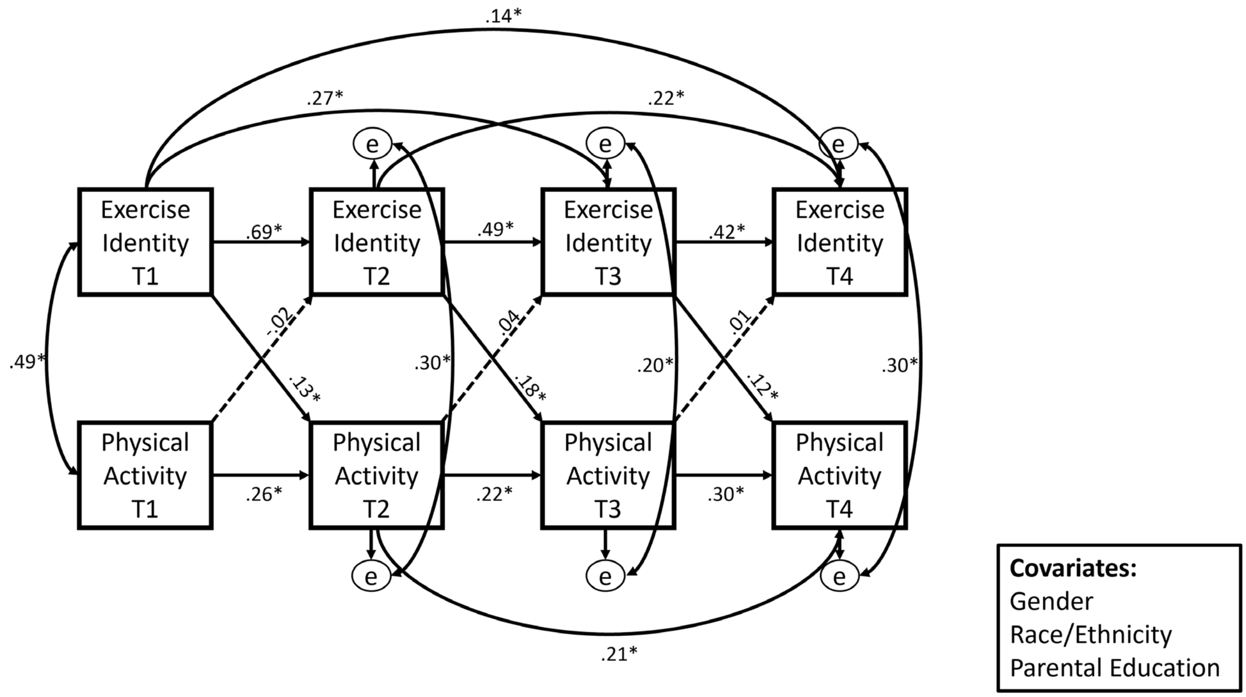
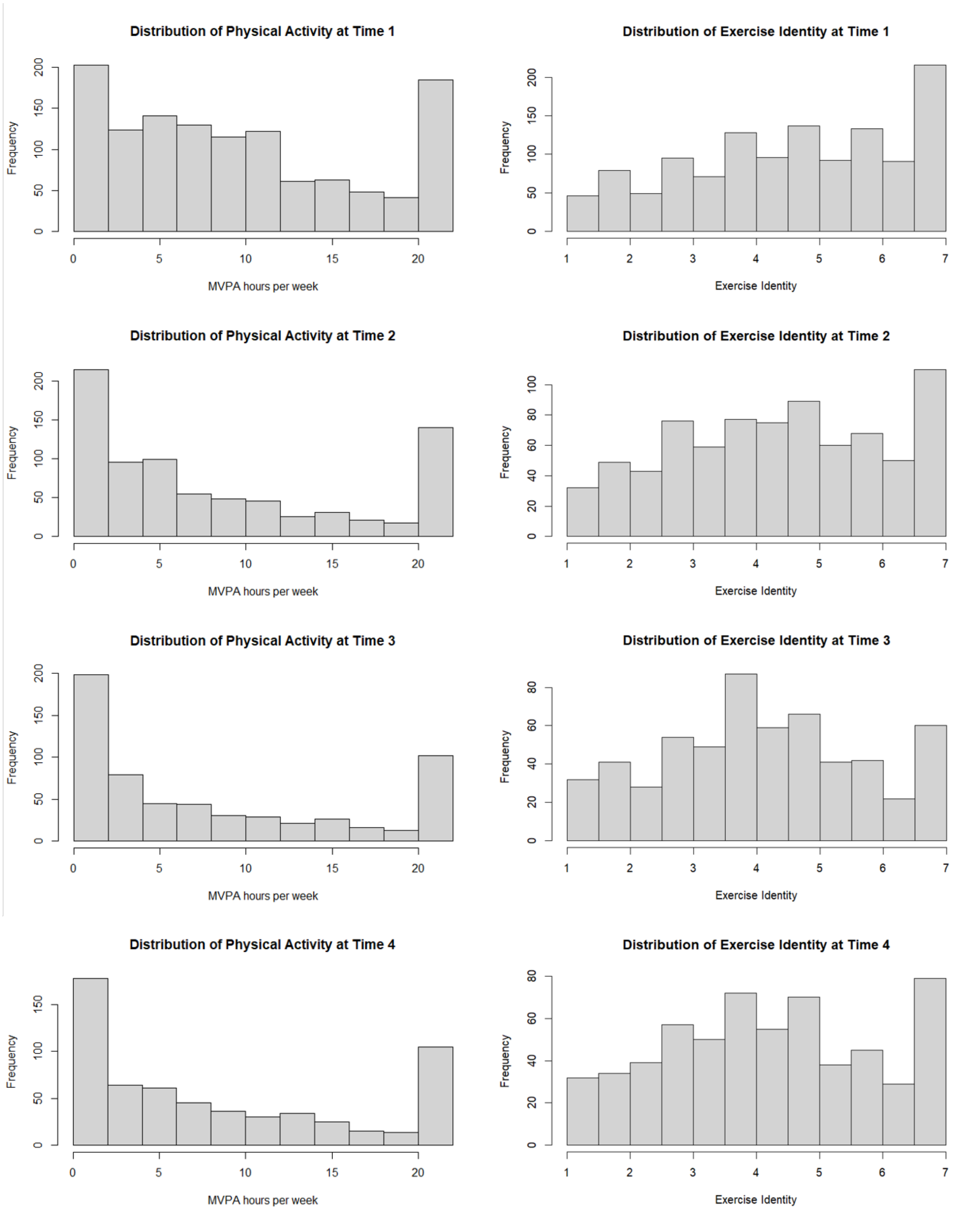



**Figure 1** *Cross-lagged Panel Model examining the relationships between exercise identity and physical activity behavior yearly over four years. Note.* * indicates $p < .05$; dashed lines denote non-significant paths; T = Time. Beta-coefficients represent standardized values.




**Supplementary Materials Figure 1.** *Distributions of Physical Activity and Exercise Identity*

**Supplementary Materials Table 1**

*Correlations*

| Variable | Mean (SD) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1. EI 1 | 4.62 (1.68) | | | | | | | |
| 2. EI 2 | 4.39 (1.68) | .69* | | | | | | |
| 3. EI 3 | 4.13 (1.61) | .64* | .72* | | | | | |
| 4. EI 4 | 4.25 (1.67) | .62* | .65* | .69* | | | | |
| 5. PA 1 | 9.65 (6.90) | .49* | .33* | .31* | .34* | | | |
| 6. PA 2 | 8.52 (7.56) | .29* | .40* | .36* | .33* | .34* | | |
| 7. PA 3 | 8.07 (7.75) | .25* | .26* | .36* | .28* | .25* | .29* | |
| 8. PA 4 | 8.63 (1.79) | .27* | .31* | .30* | .43* | .31* | .37* | .43* |

*Note.* Physical activity (weekly moderate-vigorous physical activity hours); EI: Exercise identity
* indicates $p < .05$.

**Supplementary Materials Table 2**

*Descriptive statistics for exercise identity and physical activity behavior.*

| | PA 1 | PA 2 | PA 3 | PA 4 | EI 1 | EI 2 | EI 3 | EI 4 |
|---|---|---|---|---|---|---|---|---|
| Mean | 9.65 | 8.52 | 8.07 | 8.63 | 4.62 | 4.39 | 4.13 | 4.25 |
| Standard Deviation | 6.90 | 7.56 | 7.75 | 7.61 | 1.68 | 1.68 | 1.61 | 1.67 |
| Kurtosis | 1.912 | 2.077 | 1.852 | 1.798 | 2.034 | 2.017 | 2.241 | 2.078 |
| Skewness | 0.358 | 0.623 | 0.602 | 0.507 | -0.296 | -0.114 | 0.026 | -0.014 |
| Minimum | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| Maximum | 21 | 21 | 21 | 21 | 7 | 7 | 7 | 7 |
| Sample Size | 1,233 | 794 | 604 | 604 | 1,233 | 788 | 581 | 600 |

*Note.* PA: Physical activity (weekly moderate-vigorous physical activity hours); EI: Exercise identity