The Pennsylvania State University

The Graduate School

AFFECTIVE JUDGEMENTS, ENVIRONMENTAL DETERMINANTS, AND PHYSICAL ACTIVITY IN EMERGING AND YOUNG ADULTS

A Thesis in

Kinesiology

by

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

August 2021

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Abstract

Affective judgements represent a promising target for promoting physical activity among adults. This study examined whether (1) relations between affective judgments and physical activity are robust after adjusting for social, built, and natural environmental determinants and (2) relations vary as a function of specific environmental features. Adults aged 18-29 years (N = 173) self-reported demographic information, affective judgments about physical activity, and characteristics of their social and built environments, and wore an ActiGraph wGT3X-BT accelerometer for 7 days. Time of year was used to estimate the photoperiod. Affective judgments were not associated with physical activity after adjusting for environmental influences. Support for exercise from friends was positively associated with measures of physical activity volume and moderate-to-vigorous physical activity duration. More favorable perceptions of the built environment were positively associated with moderate-to-vigorous intensity physical activity and negatively associated with duration of light-intensity physical activity. A longer photoperiod was associated with more light-intensity physical activity. These results reflect the importance of environmental determinants of physical activity among emerging and young adults. Findings can inform multilevel physical activity interventions for young and emerging adults that identify as insufficiently active as results demonstrate that affective judgments are not a validated target for promoting activity within this population. Interventions geared towards this population should prioritize other targets, such as environmental variables.

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Acknowledgements

First and foremost, I would like to thank Dr. David Conroy for affording me the opportunity to work on this project. I would also like to express my gratitude to Dr. Conroy for the continual support he has offered throughout this project. I would not have been able to complete this project without his considerable guidance.

I would also like to thank Dr. Danielle Symons-Downs and Dr. Constantino Lagoa for volunteering to serve on my committee. I appreciate you both taking the time out of your busy schedule to assist in this endeavor. I would also like to extend considerable gratitude to Mrs. Deborah Brunke-Reese for her substantial efforts and resolve during the data collection process. I provide additional thanks to each of the undergraduate research assistants in the Motivation Laboratory that provided administrative support during the data collection process.

I also owe Drs. Meg Meloy, Jennie Noll, Michael Hecht, David Gansler, Deirdre Logan, Rachael Coakley, and Neil Schechter for previous research opportunities at Penn State University, Suffolk University, and Boston Children's Hospital. The opportunities that you afforded me and the guidance you provided me has allowed me to further my education in graduate school. I would not have been in this position if it was not for your support.

Lastly, I would like to thank my parents, Robert and Lori Turrisi, for their indefatigable support of my personal and professional endeavors. Your continued support and guidance are greatly appreciated.

Research reported in this thesis was supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under Award Number 1R01HL142732-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Introduction

Over 75% of U.S. adults aged 18-29 years fail to meet current aerobic physical activity guidelines, putting themselves at risk for poor health outcomes (Blewett, Rivera Drew, King, & Williams, 2019; Irwin, 2004; Leslie, Fotheringham, Owen, & Bauman, 2001). Insufficiently active individuals within this age group have higher annual direct healthcare expenses than individuals meeting physical activity guidelines (Pratt, Macera, & Wang, 2000; Wang, Pratt, Macera, Zheng, & Heath, 2004). Physical activity is particularly important within this age group because physical activity behavioral patterns during this time may reduce the risk of midlife chronic disease (Racette, Deusinger, Strube, Highstein, & Deusinger, 2008). Physical activity volume and intensity decrease from adolescence to early adulthood (Caspersen, Pereira, & Curran, 2000; Corder et al., 2019; Gordon-Larsen, Nelson, & Popkin, 2004; Kwan, Cairney, Faulkner, & Pullenayegum, 2012; Nelson, Neumark-Stzainer, Hannan, Sirard, & Story, 2006). Thus, physical activity promotion efforts targeted towards individuals transitioning into adulthood may be particularly important in reducing midlife chronic disease risk.

Affective judgements, defined as the expectations corresponding to "the overall pleasure/displeasure, enjoyment, and feeling states expected from performing an activity" (Nasuti & Rhodes, 2013, p. 358), represent a promising target for physical activity promotion. Considerable evidence links affective judgments with physical activity but it is not clear whether those relations are robust across diverse environments or if those relations vary as a function of specific environmental features (Rhodes, Gray, & Husband, 2019; Williams, Rhodes, & Conner, 2019). The purpose of the present study

was two-fold: (a) to estimate associations between affective judgments and device-based measures of physical activity (adjusted for environmental features), and (b) to explore whether associations between affective judgments and physical activity vary as a function of those environmental features.

Affective Judgments towards Physical Activity

Affective processes have emerged alongside cognitive beliefs as intrapersonal determinants of physical activity (Ekkekakis, Zenko, Ladwig, & Hartman, 2018; Williams & Evans, 2014). Affective experiences during physical activity shape affective judgments that "mediate relations between past affective experiences with physical activity and future physical activity performance" (Rhodes, 2017, p. 177). They are reflected in a person's enjoyment of and intrinsic motivation for physical activity (Kendzierski & DeCarlo, 1991; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997).

Several prominent theories have incorporated aspects of affective judgments in their explanations for individual differences in physical activity. The multi-process action control model proposes that affective judgments, such as enjoyment, have a role in people both forming intentions to be physically active and in initiating physical activity behaviors (Rhodes, 2017). Self-determination theory proposes that affective judgments (i.e., intrinsic motivation) are directly involved in both the initiation and maintenance of physical activity behavior without any additional cognitive mediation (Deci & Ryan, 1985; Hagger & Chatzisarantis, 2007).

Whether affective judgments are defined as enjoyment or intrinsic motivation, they consistently exhibit positive associations with physical activity in both observational and experimental research. A meta-analysis of 112 independent samples (82

observational, 20 experimental) reported a significant medium-sized relationship between affective judgments and physical activity (r = 0.42, 95% CI: 0.37-0.46) (Rhodes, Fiala, & Conner, 2009). A separate meta-analysis that included 32 independent samples with experimental manipulations of affective judgments demonstrated that positive changes to affective judgments had a positive medium-to-large sized effect on physical activity (g = 0.43, 95% CI = 0.26-0.60) (Rhodes et al., 2019).

Environmental Influences on Physical Activity

The majority of the evidence base linking affective judgments with physical activity has focused on intrapersonal factors that motivate physical activity. Few studies have adjusted for the influence of the heterogeneous social-ecological contexts within which physical activity unfolds in daily life (Rhodes, Saelens, & Sauvage-Mar, 2018). Three social-ecological determinants in particular may influence how affective judgments are associated with physical activity: the social, built, and natural environments (McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis, Owen, & Fisher, 2008; Spence & Lee, 2003).

The *social environment* refers to the intangible human-developed environment involving the people and organizations that they have interacted or currently interact with (Barnett & Casper, 2001). Social relationships provide support and establish norms that inhibit or promote healthy behaviors (Berkman & Kawachi, 2000; Heaney & Israel, 2008). The support of parents and friends have shown consistent positive associations with self-reported measures of physical activity in adolescence and adulthood (Anderssen & Wold, 2013; Li et al., 2016; McNeill, Kreuter, & Subramanian, 2006; Mendonça, Cheng, Mélo, & de Farias Júnior, 2014; Raudsepp & Viira, 2000). There is an absence of

evidence regarding interactions between measures of affective judgment about physical activity and aspects of the social environment. Family and friends' broader concerns about a person's well-being may provide differential encouragement and support for activities the person enjoys, leading to stronger associations between affective judgments and physical activity.

The *built environment* refers to the tangible human-developed environment including aesthetics, access to transportation, land use mix, neighborhood walkability, proximity to recreational facilities, and traffic safety. These aspects of the built environment can facilitate or inhibit physical activity (Rhodes, Zhang, & Zhang, 2020; Sallis, Adams, & Ding, 2011; Sallis et al., 2020). Despite the physical features of the built environment being identical for individuals living in the same area, perceptions about the built environment can vary from person to person. Perceived aesthetic quality, pedestrian safety, and residential density have all been shown to be associated with physical activity (Bracy et al., 2014; Hoehner, Brennan Ramirez, Elliott, Handy, & Brownson, 2005; Lightfoot & Blanchard, 2011; Su et al., 2014). Like affective judgments, these perceptions are cognitive-evaluative entities that can influence physical activity. It is not presently clear if these perceptions can override affective judgments or change how affective judgments are associated with physical activity.

The *natural environment* consists of all living and non-living things that exist organically, and tend to be more difficult to alter than aspects of the social and built environments (van den Bosch, 2017). Differences in day length (duration of illumination) are associated with differences in physical activity volume and intensity-specific activity duration. People are more active during summer and spring (when days are longer and

temperatures are warmer) than winter (when days are shorter and temperatures are colder) (Chan, Ryan, & Tudor-Locke, 2006; Tucker & Gilliland, 2007; Turrisi et al., 2021). These associations have been observed for moderate-to-vigorous intensity physical activity duration and physical activity volume (Turrisi et al., 2021). There is currently no literature that addresses interactions between physical activity-related affective judgments and the natural environment. One example of an interaction between affective judgments, the natural environment and physical activity is participation in outdoor physical activity. Individuals participating in outdoor physical activities have reported greater enjoyment and intention to repeat the activity than those participating in indoor activities (Thompson Coon et al., 2011).

The Present Study

This study investigated how affective judgments and key environmental features are associated with physical activity in emerging adults. An observational study was conducted with baseline assessments of affective judgments and environmental contexts followed by a one-week ambulatory monitoring period during which participants wore an accelerometer. The hypotheses for the study were that (1) affective judgments would be positively associated with physical activity after adjusting for environmental influences, and (2) more favorable environments (i.e., more social support, perceptions of a more accessible built environment, and monitoring during summer or spring relative to winter) would be positively associated with physical activity. Analyses were extended to explore whether environmental features moderated associations between affective judgments and physical activity (e.g., stronger associations between affective judgments and physical activity when people perceive more social support, a more accessible built environment,

and during summer or spring relative to winter). All analyses controlled for sex, an established demographic covariate of physical activity during this developmental transition (Caspersen et al., 2000; Corder et al., 2019; Gordon-Larsen et al., 2004; Kwan et al., 2012; Nelson et al., 2006).

Methods

Participants and Procedures

Participants were community-dwelling emerging and young adults who self-identified as being insufficiently active and expressed interest in a parent study utilizing a smartphone application to increase physical activity levels. Criteria for inclusion included English fluency, being between the ages of 18-29, owning an Apple (≥ iOS 10) or Android (≥ Android OS 7) smartphone (a requirement for the parent study), and reporting less than 90 min/week of moderate-to-vigorous physical activity. Participants with a visual impairment that would interfere with smartphone use were excluded because of parent study requirements. Recruitment was accomplished via fliers posted in the community and online. All participants provided written informed consent, and the study protocol was approved by the Institutional Review Board of Penn State University (study#00009455).

Prior to enrolling in the study, individuals completed a brief telephone screening to establish eligibility (i.e., no medical contraindications to physical activity and self-reporting less than 90 minutes of past-week moderate-to-vigorous intensity physical activity). Interested eligible participants were scheduled for a study training session in the

lab. At the training session, participants reviewed and signed an informed consent document, completed a battery of questionnaires, and were trained how to wear an activity monitor (ActiGraph wGT3X-BT) and instructed to wear the activity monitor for seven days. Participants were also provided with a wear log and instructed to record any period of time that the device was removed. At the end of the seven-day monitoring period, participants returned the activity monitor and wear log to the lab and received $25 as compensation for their participation. All data were collected between April 2019 and January 2020 (i.e., prior to the COVID-19 pandemic).

Measures

Device-measured physical activity. Participants wore an ActiGraph wGT3X-BT accelerometer around their waist for seven consecutive days to measure physical activity (ActiGraph LLC, 2017). The epoch length used for accelerometer-based data collection was set to 60 seconds. Accelerometer data was extracted using ActiLife (ActiGraph LLC, 2013). Wear time was computed using established criteria and compared to logs containing self-reported wear (Troiano, 2007). For quality assurance, days with wear times of 10 hours or greater were considered valid, and participants were included in analyses if they had at least four valid days of accelerometer data (Migueles et al., 2017; Trost, McIver, & Pate, 2005). Outcome measures included measures of volume (daily step counts, total vector magnitude counts) and intensity-specific durations, expressed as mean values per valid day. The Freedson cut points were used to classify light- and moderate-to-vigorous intensity physical activity (Bassett, Troiano, McClain, & Wolff, 2015).

Enjoyment. The 18-item Physical Activity Enjoyment Scale (PACES) assessed the extent to which an individual enjoys performing physical activity over the previous four weeks. Items were rated on a five-point scale with the following options: 1 (*strongly disagree*), 2 (*disagree somewhat*), 3 (*neither agree nor disagree*), 4 (*agree somewhat*), and 5 (*strongly agree*). Eleven items were reverse-scored prior to averaging so higher scores represented greater levels of enjoyment towards performing physical activity. Enjoyment scores on the PACES have demonstrated acceptable internal consistency and test-retest reliability in young adults (Kendzierski & DeCarlo, 1991).

Intrinsic motivation. The 7-item interest/enjoyment subscale from the 23-item Intrinsic Motivation Inventory (IMI – Interest and Enjoyment) was used to assess intrinsic motivation related to physical activity performed during the previous month. Items were rated on a scale from 1 (*not at all true for me*) to 7 (*very true for me*). Two items were reverse-scored prior to averaging so higher scores represented greater levels of interest and enjoyment towards performing physical activity. Previous research has shown that the interest/enjoyment subscale scores have acceptable construct validity and reliability in young adults (McAuley, Duncan, & Tammen, 1989).

Social environment. The 26-item Social Support and Exercise Survey (SSES) measured support from family and friends towards performing physical activity in the past three months. The scale contains three subscales: Family – Participation (10 items), Family – Rewards and Punishment (3 items), Friends – Participation (10 items). Items were rated based on frequency of perceived support on a scale ranging from 1 (*none of the time*), 2 (*rarely*), 3 (*a few times*), 4 (*often*), and 5 (*very often*). Higher scores represent greater amounts of perceived social support from that source. Scores from each subscale

has demonstrated acceptable test-retest and internal consistency reliabilities in an adult population (Sallis, Grossman, Pinski, Patterson, & Nader, 1987). The Friends – Rewards and Punishment subscale was not scored because it did not emerge as a distinct factor of the original validation study.

Perceptions of the built environment. The 7-item Built Environment Index (BEI) from the 17-item Physical Activity and Neighborhood Environment Scale was used to assess built environmental support for physical activity in the form of access to facilities, aesthetics, infrastructure, land use mix, residential density, and traffic safety (Sallis et al., 2010). Participants rated the area that can be walked to within 15 minutes of their residence. Item 1 asked respondents about the main type of housing in their neighborhood, with options including "detached single-family housing", "townhouses/rowhouses/apartments/condos of 2-3 stories", "mix of single-family residences, townhouses, row houses, apartments, or condos", "apartments or condos of 4-12 stories", "apartments or condos of more than 12 stories", and "don't know" (NA). Items 2-6 were rated as 1 (*strongly disagree*), 2 (*somewhat disagree*), 3 (*somewhat agree*), or 4 (*strongly agree*), and "don't know" (N/A). Responses to each item were dichotomized for scoring purposes (item 1: 0=single family housing, 1=all other housing types; items 2-6: 0=strongly or somewhat disagree, 1=strongly or somewhat agree). Dichotomized scores were summed to create an overall built environment score with higher numbers indicating greater perceived support for physical activity from the built environment. Responses to BEI items have been significantly associated with meeting physical activity guidelines (i.e., the more supportive the reported built-environmental attributes, the greater the likelihood of sufficient physical activity).(Sallis et al., 2010)

Natural environment. Photoperiod duration was quantified as the distance between the first day of ambulatory monitoring and the equinox. The summer (June 21) and winter (December 21) solstices have the maximum and minimum photoperiods, respectively, in the Northern Hemisphere. Distance was measured in radians based on a cosine curve peaking on the summer solstice. Positive and negative values indicate longer and shorter photoperiods, respectively (values of zero coincide with the spring or autumnal equinox). The maximum value for photoperiod (in radians) was 1.0 (summer solstice) whereas the minimum value was -1.0 (winter solstice).

Statistical Analysis

All statistical analyses were performed using R Studio (R Studio Team, 2020). Descriptive statistics were calculated for all demographic, motivational and physical activity variables, whereas measures of reliability were calculated using the *psych* package (Revelle, 2020). Bivariate correlation analyses between continuous variables were performed using the *Hmisc* package (Harrell Jr. & Dupont, 2021). Standardized regression coefficients for multiple linear regression models were calculated using the *lm.beta* package. The syntax for data processing and analyses can be found in Appendix A.

The level to achieve statistical significance was set to $\alpha = .05$. Listwise deletion was performed if individuals were missing $\geq 20\%$ of responses for each psychological measures or subscales. All continuous independent variables were centered. A composite measure of affective judgment was calculated by calculating and averaging z-scores for each participant's enjoyment and intrinsic motivation scores. The primary hypotheses and secondary hypothesis utilized multiple linear regression with separate models for each

type of device-measured physical activity (i.e., mean daily activity counts, mean daily step counts, mean daily minutes of light-intensity physical activity, mean daily minutes of moderate-to-vigorous physical activity) and each affective judgment measure (i.e., enjoyment, intrinsic motivation, composite affective judgment). All models included variables relating to the perceived built, social, and natural environments and sex. Sensitivity analyses were performed using a sample selected on alternative wear-time criteria (≥5 days with ≥8 hours/day) (Carlson et al., 2012; Thabane et al., 2013).

Results

Descriptive Statistics

One hundred and seventy-three participants met inclusion criteria and wore an ActiGraph wGT3X-BT accelerometer around their waist for seven consecutive days to measure physical activity. Twenty-six individuals were excluded from the main analysis sample for not meeting wear time criteria (i.e., ≥4 days, ≥10 hours/day), whereas 11 individuals were excluded from the sensitivity analysis sample for not meeting wear criteria (i.e., ≥5 days, ≥8 hours/day). An additional 10 individuals were removed from the main analysis sample whereas 11 individuals were removed from the sensitivity analysis sample for not having sufficient data for included psychosocial measures (i.e., ≥80% for included measures and subscales). Descriptive statistics for the main analysis sample and sensitivity analysis sample are presented in Table 1. On average, participants in the main analysis sample (N = 137) were 22.82 years old (*SD* = 2.78), wore the accelerometer for 10.55 hours each day (*SD* = 1.23), and had a BMI of 26.63 (*SD* = 6.66).

Table 1. Sample demographic and anthropometric characteristics

	Main Analysis Sample (n = 137)	Sensitivity Analysis Sample (n = 151)
Characteristic	N (%)	N (%)
Sex		
Male	41 (29.9)	48 (31.8)
Female	96 (70.1)	103 (68.2)
Age (years)		
18-21	52 (38.0)	61 (40.4)
22-25	55 (40.1)	57 (37.8)
26-29	30 (21.9)	33 (21.9)
Ethnicity		
Not Hispanic/Latino	123 (89.8)	135 (89.4)
Hispanic/Latino	14 (10.2)	16 (10.6)
Racial Identity		
American Indian/Alaskan Native	0 (0.0)	0 (0.0)
Asian	27 (19.7)	29 (19.2)
Black/African American	20 (14.6)	20 (13.2)
Native Hawaiian/Other Pacific Islander	0 (0.0)	0 (0.0)
Two or More Races	7 (5.1)	8 (5.3)
White	82 (59.9)	93 (61.6)
Education		
Completed grade school or less	0 (0.0)	0 (0.0)
Some high school	0 (0.0)	0 (0.0)
Completed high school/received GED	18 (13.1)	19 (12.6)
Trade/technical school certificate	3 (2.2)	3 (2.0)
Some college/associate's degree	50 (36.5)	56 (37.1)
Completed college	44 (32.1)	48 (31.8)
Graduate or professional degree	22 (16.1)	25 (16.6)
Work Status		
Employed full-time	15 (10.9)	18 (11.9)
Employed part-time	10 (7.3)	13 (8.6)
Student	109 (79.6)	117 (77.5)
Unemployed	3 (2.2)	3 (2.0)
BMI (kg/m^2)		
Underweight (< 18.5 kg/m^2)	6 (4.4)	6 (4.0)
Normal weight (18.5 – 24.9 kg/m^2)	62 (45.3)	68 (45.0)
Overweight (25.0 – 29.9 kg/m^2)	35 (25.5)	43 (28.5)
Obese (> 30.0 kg/m^2)	33 (24.1)	33 (21.9)
Federal Guidelines for Physical Activity		
Did not meet guidelines	69 (50.4)	71 (47.0)
Met guidelines	68 (49.6)	80 (53.0)

Physical activity data and scores from psychosocial measurements for the main analysis sample are summarized in Table 2. Physical activity data and psychosocial measurements for the sensitivity analysis sample can be found in Appendix B (there were no significant differences between these samples). Participants in the main analysis sample averaged 4746.31 steps/day (*SD* = 1946.70), 145.67 minutes/day of light-intensity physical activity (*SD* = 49.10), 26.82 minutes/day of moderate-to-vigorous physical activity (*SD* = 18.02), and 297,185.30 total activity counts/day (*SD* = 109,151.90).

Neither measure of affective judgment demonstrated a significant bivariate association with any measure of physical activity. Average daily step count ($r = .21$, $p = .01$) and moderate-to-vigorous physical activity duration ($r = .19$, $p = .004$) were positively associated with support from friends. Overall perceptions of the built environment were positively associated with moderate-to-vigorous physical activity duration ($r = .25$, $p = .004$), but negatively associated with light-intensity physical activity duration ($r = -.23$, $p = .007$). Photoperiod was positively associated with light-intensity physical activity duration ($r = .20$, $p = .02$) and negatively associated with moderate-to-vigorous physical activity duration ($r = -.17$, $p = .04$). Average daily activity counts were positively associated with support from friends ($r = .20$, $p = .01$).

Table 2. Descriptive statistics and bivariate correlations for study variables

Measure	M	SD	α	1	2	3	4	5	6	7	8	9	10	11
Physical Activity														
1. TAC/day	297185.30	109151.90	--	--										
2. Steps/day	4746.31	1946.70	--	**.83**	--									
3. MVPA (min/day)	26.82	18.02	--	**.81**	**.87**	--								
4. LPA (min/day)	145.67	49.10	--	**.60**	**.34**	.14	--							
Affective Judgment														
5. Enjoyment	64.70	9.40	.88	.03	.10	.05	.08	--						
6. Intrinsic Motivation	4.30	1.07	.90	.10	.13	.09	.10	**.73**	--					
Social Environment														
7. Family – Participation	21.05	11.63	.93	.10	.14	.10	.03	-.07	-.01	--				
8. Family – Rewards and Punishment	4.91	4.43	.94	.00	.01	.04	-.09	-.13	-.06	**.67**	--			
9. Friends - Participation	20.10	9.12	.90	**.21**	**.21**	**.19**	.06	.07	.13	**.53**	**.45**	--		
Perceptions of the Built Environment														
10. PANES – BEI	4.45	4.45	.57	.05	.14	**.25**	**-.23**	.07	.05	.03	.11	.03	--	
Natural Environment														
11. Photoperiod	0.05	0.72	--	.00	-.09	**-.17**	**.20**	**-.21**	-.13	.13	.11	.04	**-.22**	--

Note: Bolded values denote statistical significance ($p < .05$).

TAC = total activity counts. MVPA = moderate-to-vigorous intensity physical activity. LPA = light intensity physical activity. PANES – BEI = Physical Activity Neighborhood Survey – Built Environment Index.

Multiple Regression Models

The primary hypotheses for the study were that (1) affective judgments would be positively associated with physical activity after adjusting for environmental influences (i.e., Hypothesis 1), and (2) more favorable environments would be positively associated with physical activity (i.e., Hypothesis 2). Table 3 presents coefficients from multiple linear regression models to test these hypotheses with measures of physical activity volume. Models of total daily activity counts were not statistically significant whether they included enjoyment (F[7, 129] = 1.22, p = .30, R^2 = .06), intrinsic motivation (F[7, 129] = 1.28, p = .26, R^2 = .06) or composite affective judgments (F[7, 129] = 1.23, p = .29, R^2 = .06). Similarly, models of daily step counts were not statistically significant for enjoyment (F[7, 129] = 2.03, p = .06, R^2 = .10) or composite affective judgments (F[7, 129] = 2.08, p = .06, R^2 = .10). The model of daily step counts with intrinsic motivation was statistically significant (F[7, 129] = 2.13, p =.04, R^2 = .10) but none of the coefficients for predictor variables were statistically significant in that model. Thus, Hypothesis 1 was rejected for total physical activity volume.

Table 4 summarizes coefficients from multiple regression models of intensity-specific activity duration. Models of daily moderate-to-vigorous physical activity duration were statistically significant whether they included enjoyment (F[7, 129] = 2.56, p = .02, R^2 = .12), intrinsic motivation (F[7, 129] = 2.60, p = .02, R^2 = .12), or composite affective judgments (F[7, 129] = 2.56, p = .02, R^2 = .12). Moderate-to-vigorous physical activity duration was not significantly associated with affective judgments in any of these models but it was associated with friends' support of physical activity in the models with enjoyment and composite affective judgments (but not in the model with intrinsic

motivation; $p = .06$). Duration of moderate-to-vigorous physical activity was positively associated with perceptions of the built environment in all three models. Neither photoperiod nor sex was found to be significantly associated with duration to moderate-to-vigorous physical activity duration in any of the three models. Thus, Hypothesis 1 was rejected for moderate-to-vigorous intensity physical activity duration. Hypothesis 2 was partially supported based on positive associated between moderate-to-vigorous intensity physical activity duration and both the social and perceived built environments.

Models of light-intensity activity duration were statistically significant whether they included enjoyment ($F[7, 129] = 2.33$, $p = .03$, $R^2 = .11$), intrinsic motivation ($F[7, 129] = 2.38$, $p = .03$, $R^2 = .11$), or composite affective judgments ($F[7, 129] = 2.40$, $p = .02$, $R^2 = .12$). Light-intensity physical activity duration was not significantly associated with any of the affective judgments. It was negatively associated with perceptions of the built environment, positively associated with photoperiod, and not significantly associated with the social environment. Thus, Hypothesis 1 was rejected for light intensity-specific physical activity duration but Hypothesis 2 was partially supported based on positive associations between light-intensity physical activity and both the perceived built environment and natural environment.

Table 3. Coefficients for multiple linear regression of measures of physical activity volume on affective judgments, environmental determinants, and sex

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgment Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Total Activity Counts Model									
Intercept	**296603.20 (17261.45)**	**0.00**	**<.001**	**295759.40 (17283.80)**	**0.00**	**<.001**	**296477.00 (17258.30)**	**0.00**	**<.001**
Affective Judgment	-77.62 (1032.21)	-0.01	0.94	5743.20 (8984.80)	0.06	0.52	3168.50 (10392.40)	0.03	0.76
Family - Participation	759.48 (1167.07)	0.08	0.52	758.80 (1165.00)	0.08	0.52	764.90 (1166.40)	0.08	0.51
Family - Rewards & Punishment	-4163.03 (2929.35)	-0.17	0.16	-3919.50 (2919.60)	-0.16	0.18	-4017.00 (2929.10)	-0.16	0.17
Friends - Participation	**2902.73 (1236.05)**	**0.24**	**<.05**	**2746.90 (1240.90)**	**0.23**	**<.05**	**2822.80 (1241.50)**	**0.24**	**<.05**
Perceived Built Environment	3963.69 (6000.82)	0.06	0.51	3753.40 (5993.80)	0.06	0.53	3854.60 (6000.90)	0.06	0.52
Photoperiod	2745.34 (13580.78)	0.02	0.84	3928.40 (13426.20)	0.03	0.77	3589.80 (13525.40)	0.02	0.79
Sex (Female)	830.71 (20776.93)	0.00	0.97	2034.90 (20827.90)	0.01	0.92	1010.80 (20774.40)	0.00	0.96
Step Counts Model									
Intercept	**4496.89 (301.73)**	**0.00**	**<.001**	**4470.49 (301.81)**	**0.00**	**<.001**	**4486.26 (301.35)**	**0.00**	**<.001**
Affective Judgment	8.88 (18.04)	0.04	0.62	149.64 (156.89)	0.08	0.34	141.36 (181.46)	0.07	0.44
Family - Participation	23.67 (20.40)	0.14	0.25	23.38 (20.34)	0.14	0.25	23.60 (20.37)	0.14	0.25
Family - Rewards & Punishment	-76.51 (51.20)	-0.17	0.14	-74.17 (50.98)	-0.17	0.15	-74.53 (51.15)	-0.17	0.15
Friends - Participation	**43.02 (21.61)**	**0.20**	**<.05**	40.87 (21.67)	0.19	0.06	41.62 (21.68)	0.19	0.06
Perceived Built Environment	150.01 (104.89)	0.13	0.16	147.17 (104.66)	0.12	0.16	148.13 (104.78)	0.12	0.16
Photoperiod	-167.20 (237.39)	-0.06	0.48	-162.37 (234.45)	-0.06	0.49	-158.95 (236.17)	-0.06	0.50
Sex (Female)	355.94 (363.18)	0.08	0.33	393.62 (363.70)	0.09	0.28	371.11 (362.74)	0.09	0.31

Table 4. Coefficients for multiple linear regression of intensity-specific activity duration on affective judgments, environmental determinants, and sex

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgment Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Moderate-to-Vigorous Activity Model									
Intercept	**25.13 (2.76)**	**0.00**	**<.001**	**25.04 (2.76)**	**0.00**	**<.001**	**25.13 (2.76)**	**0.00**	**<.001**
Affective Judgment	-0.03 (0.16)	-0.02	0.85	0.69 (1.44)	0.04	0.63	0.26 (1.66)	0.01	0.88
Family - Participation	0.09 (0.19)	0.06	0.64	0.09 (0.19)	0.06	0.64	0.09 (0.19)	0.06	0.64
Family - Rewards & Punishment	-0.40 (0.47)	-0.10	0.39	-0.36 (0.47)	-0.09	0.44	-0.38 (0.47)	-0.09	0.42
Friends - Participation	**0.40 (0.20)**	**0.20**	**<.05**	0.38 (0.20)	0.18	0.06	**0.39 (0.20)**	**0.20**	**<.05**
Perceived Built Environment	**2.36 (0.96)**	**0.21**	**<.05**	**2.33 (0.96)**	**0.21**	**<.05**	**2.35 (0.96)**	**0.21**	**<.05**
Photoperiod	-3.25 (2.17)	-0.13	0.14	-3.05 (2.15)	-0.12	0.16	-3.12 (2.16)	-0.13	0.15
Sex (Female)	2.40 (3.32)	0.06	0.47	2.53 (3.33)	0.06	0.45	2.40 (3.32)	0.06	0.47
Light Intensity Activity Model									
Intercept	**143.66 (7.54)**	**0.00**	**<.001**	**142.60 (7.55)**	**0.00**	**<.001**	**143.11 (7.53)**	**0.00**	**<.001**
Affective Judgment	0.57 (0.45)	0.11	0.21	5.44 (3.93)	0.12	0.17	6.48 (4.53)	0.12	0.16
Family - Participation	0.35 (0.51)	0.08	0.50	0.33 (0.51)	0.08	0.52	0.34 (0.51)	0.08	0.51
Family - Rewards & Punishment	-1.85 (1.28)	-0.17	0.15	-1.86 (1.28)	-0.17	0.15	-1.82 (1.28)	-0.16	0.16
Friends - Participation	0.43 (0.54)	0.08	0.43	0.40 (0.54)	0.07	0.47	0.40 (0.54)	0.07	0.47
Perceived Built Environment	**-5.67 (2.62)**	**-0.19**	**<.05**	**-5.72 (2.62)**	**-0.19**	**<.05**	**-5.72 (2.62)**	**-0.19**	**<.05**
Photoperiod	**12.62 (5.93)**	**0.19**	**<.05**	**12.20 (5.87)**	**0.18**	**<.05**	**12.60 (5.90)**	**0.19**	**<.05**
Sex (Female)	2.87 (9.08)	0.03	0.75	4.39 (9.10)	0.04	0.63	3.66 (9.06)	0.03	0.69

Exploratory Moderation Analyses

When two-way interactions between affective judgments and environmental factors were added to the multiple linear regression models of total physical activity volume and intensity-specific durations, none of the models in the main analysis sample achieved statistical significance (all $p < .05$). Results from regression models of total physical activity volume and intensity-specific duration from the main analysis sample can be found in Appendices E and F, respectively. All analyses described above were repeated with the larger sensitivity analysis sample. Results from regression models of total physical activity volume and intensity-specific duration from the sensitivity analysis sample can be found in Appendices G and H, respectively.

Sensitivity Analyses

All variables that achieved significance in bivariate correlation and multiple linear regression analyses in the main analyses sample also achieved significance in the sensitivity analysis sample. Conclusions about the main hypotheses did not change; however, a limited number of additional associations achieved significance in the sensitivity analysis sample due to the increased sample size and statistical power.

Physical activity data and scores from psychosocial measurements for the sensitivity analysis sample are presented in Appendix B. Appendix C presents coefficients from multiple linear regression models with measures of physical activity volume. Appendix D presents coefficients from multiple linear regression models with measures of intensity-specific activity duration. Results from regression models of total physical activity volume and intensity-specific duration with interaction terms of

affective judgment from the sensitivity analysis sample can be found in Appendices G and H, respectively.

Discussion

This study tested associations between physical activity, affective judgments towards physical activity, and the social, built, and natural environments. The hypothesis that affective judgments would be positively associated with physical activity after adjusting for environmental influences was not supported. The hypothesis that more favorable environments would be positively associated with physical activity was partially supported. Support from friends (i.e., more favorable social environment) was positively associated with measures of physical activity volume and moderate-to-vigorous physical activity duration. More favorable perceptions of the built environment were positively associated with moderate-to-vigorous intensity physical activity and negatively associated with duration of light-intensity physical activity. A longer photoperiod (i.e., more favorable natural environment) was associated with more light-intensity physical activity. This study made four important contributions to the literature on physical activity during the transition into adulthood.

First, results indicated that conclusions from a recent meta-analysis may not generalize to samples reporting low levels of physical activity (Rhodes et al., 2009). Point estimates for bivariate correlations between affective judgements and device-based measures of physical activity in the current study were small, whereas estimates from the recent meta-analysis were medium-sized (Rhodes et al., 2009). The meta-analysis consisted of 85 independent samples of individuals aged ≥18 whereas the current study

examined individuals that identified as being insufficiently active (i.e., do not meet federal guidelines for physical activity) between 18-29 years old. It is possible that believing that one is not physically active weakens the association between affective judgments and physical activity. Future research should investigate the possibility that self-schemas (e.g., exercise identity), physical self-perceptions, or other self-related beliefs may moderate the influence of affective judgments on physical activity (Marsh & Cheng, 2012; Sabiston, Whitehead, & Eklund, 2012).

Second, this study raises the possibility that measurement methods for physical activity may impact conclusions about relations with affective judgments. The vast majority of the existing evidence used self-report measures of physical activity. In a seminal meta-analysis, only five of the 82 correlational studies used device-based measures of physical activity (Rhodes et al., 2009). Of those five studies, only two used accelerometers to measure physical activity. In contrast, the present study used accelerometers to measure both physical activity volume and intensity-specific duration when estimating associations with affective judgements towards physical activity. The limitations of self-reported physical activity are well-known (e.g., recall bias, memory errors) (Althubaiti, 2016). Future research on affective judgments should prioritize device-based measures to evaluate the impact of measurement methods on conclusions.

Although it is possible that prior conclusions about relations between affective judgments and physical activity were incorrect, we believe that judgment is premature based on these data because, as noted above, our sample was selected for insufficient physical activity. Excluding the most active people will restrict the range of variance in physical activity and attenuate associations with other variables (e.g., affective

judgments). Although these data may not be well-suited for theory development, they provide an important insight for intervention developers: affective judgments are not a validated target for promoting activity among those who identify as insufficiently active. Thus, interventions geared towards those that identify as insufficiently active should initially prioritize other targets, such as environmental variables.

A third contribution of the study was in identifying different patterns of built and natural environmental determinants for different physical activity intensities. Bivariate correlation analyses demonstrated that a longer photoperiod was positively associated with light-intensity physical activity duration and negatively associated with moderate-to-vigorous intensity physical activity duration. However, it was noteworthy that the positive association between photoperiod and light-intensity physical activity duration achieved significance in regression analyses whereas the negative association between photoperiod and moderate-to-vigorous intensity physical activity duration was not present in regression analyses. This discrepancy may indicate that seasonality and photoperiod influence activity selection, with these selections having potential consequences for intensity-specific duration. The positive association between photoperiod and light-intensity physical activity duration was consistent with previous findings (Turrisi et al., 2021). The present study provided additional insight into the relationship between photoperiod and intensity-specific physical activity duration as this topic had not been explored in young and emerging adults who report being insufficiently active.

Both bivariate and multiple linear regression analyses demonstrated that more favorable perceptions of the built environment were positively associated with moderate-

to-vigorous physical activity duration and negatively associated with light-intensity physical activity duration. The positive association between moderate-to-vigorous physical activity duration and perceptions of the built environment was consistent with prior finding. Perceived infrastructure, safety, proximity to recreational facilities, and aesthetics have all demonstrated positive associations with moderate-to-vigorous physical activity duration (Sallis et al., 2020). The negative association between light-intensity physical activity duration and perceptions of the built environment in this population appears to be a novel finding. Considerable research has investigated associations between perceptions of the built environment and step count, but only one other study has investigated associations between perceptions of the built environment and light-intensity physical activity (Jago, Baranowski, & Baranowski, 2006). That study found that perceptions of the built environment demonstrated a null association with light-intensity physical activity; however, it sampled youth rather than young and emerging adults. Additional research in this area is warranted to replicate these findings in young and emerging adults that identify as being insufficiently active.

The subscale used to measure perceptions of the built environment did so in a residential context, although many individuals spend a significant portion of their time in other contexts. Future research should also consider either capturing perceptions of the built environment in areas where an individual spends considerable time (e.g., home, work) and the greater context of the individuals' residence (i.e., municipality) and/or capturing time-in place as a potential moderating variable between perceptions of the built environment and device-based measures of physical activity (Matthews, 2017).

The fourth contribution of this study was based on the differing pattern of results within the context of the social environment. Support from friends in physical activity participation was found to be positively associated with moderate-to-vigorous physical activity duration. These findings are consistent with previous research on intensity-specific physical activity duration and social support including similar populations (De Bourdeaudhuij, Sallis, & Vandelanotte, 2002; Dowda, Ainsworth, Addy, Saunders, & Riner, 2003; Treiber et al., 1991). Support from friends in physical activity participation was also found to be positively associated with total daily activity counts and total daily step counts. Friend-based social support towards exercise and measures of physical activity volume activity have demonstrated similar associations in youth and older adults but remains understudied in young and emerging adults (Mendonça et al., 2014; Smith, Banting, Eime, O'Sullivan, & Uffelen, 2017).

Neither support from parents in physical activity participation nor parental rewards and punishments for participating in physical activity were found to be significantly associated with either measure of physical activity volume or intensity-specific duration. Future research should investigate whether these associations can be replicated longitudinally, as high turnover among friendships occurs during young and emerging adulthood and parental units may present stability during an otherwise unstable time (Arnett, 2000).

Limitations

Four key limitations of this study should be noted. First, environmental variables were assessed as narrow, static influences; future work should consider conducting audits of the built environment, collecting measures of support for physical activity from

parents and friends, capturing a broader range of features from the natural environment, and quantifying exposure differences as a function of mobility. Second, analyses focused on person-level variation and were not sensitive to daily fluctuations in behavior or environmental context. Third, waist worn accelerometers are accurate in capturing activities such as walking and running but systematically undercount activities such as cycling, strength training, and swimming (Kelly et al., 2013). Finally, the research design was observational so strong causal inferences are not possible.

Conclusions

In sum, affective judgments were not significantly associated with device-based measures of physical activity volume or intensity-specific duration in a population that reported low levels of physical activity. Features of the social environment were positively associated with physical activity volume and intensity-specific duration. Features of the built and natural environments demonstrated mixed associations with measures of intensity-specific physical activity duration.

Affective judgments are not a validated target for promoting activity among young and emerging adults that identify as insufficiently active, and interventions geared towards this population should prioritize other targets, such as environmental variables. Specifically, the findings suggest that including friends in promotion efforts to increase physical activity volume and moderate-to-vigorous physical activity in emerging adults may be beneficial. Future efforts to promote moderate-to-vigorous activity should try to improve upon perceptions of the built environment. Interventions seeking to promote light-intensity physical activity may be needed most between the spring and autumnal equinox.

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Appendix A. R Syntax Used for Analyses

```
#### ---- Set Working Directory ----

# setwd()

#### ---- Loading Libraries ----

library(gdata) # data cleaning
library(Hmisc) # correlation
library(janitor) # data cleaning
library(lm.beta) # standardized beta coefficients from MLR
library(lubridate) # formatting dates
library(plyr) # data cleaning
library(psych) # descriptives
library(tidyverse) # data cleaning

#### ---- Looping Through Directory To Create One Dataset for Actigraph Data ----

filenames = list.files(pattern="*.csv")
filenames

numfiles <- length(filenames)

all <- lapply(filenames,function(i){
  i <- paste(".\\",i,sep="")
  read.csv(i, header=FALSE)
})

filenames <- gsub("-",".",filenames)

names(all) <- gsub(".csv","",filenames)

actigraph <- do.call(rbind, all)
```

```
actigraph <- actigraph %>%
  row_to_names(row_number = 1) #create variable names from first row

actigraph <- rownames_to_column(actigraph) #create id from row names

#### ---- Manipulate Actigraph Data ----

# renaming variables

actigraph <- actigraph %>%
  rename(
    id_runin = rowname,
    dayofweek = `Day of Week`,
    dayofweek_number = `Day of Week Num`,
    freedson_bouts_occuring = `Number of Freedson (1998) Bouts occurring in this day`,
    freedson_bouts_starting = `Number of Freedson (1998) Bouts starting in this day`,
    freedson_bouts_ending = `Number of Freedson (1998) Bouts ending in this day`,
    freedson_total_time = `Total time of Freedson (1998) Bouts occurring in this day`,
    freedson_total_activitycounts= `Total activity counts of Freedson (1998) Bouts occurring in this day`,
    sedentary_bouts_occuring = `Number of Sedentary Bouts occurring in this day`,
    sedentary_bouts_starting = `Number of Sedentary Bouts starting in this day`,
    sedentary_bouts_ending = `Number of Sedentary Bouts ending in this day`,
    sedentary_bouts_totaltime = `Total time of Sedentary Bouts occurring in this day`,
    sedentary_breaks_occuring = `Number of Sedentary Breaks occurring in this day`,
    sedentary_breaks_starting = `Number of Sedentary Breaks starting in this day`,
    sedentary_breaks_ending = `Number of Sedentary Breaks ending in this day`,
    sedentary_breaks_totaltime = `Total time of Sedentary Breaks occurring in this day`,
    minutes_sedentary = Sedentary,
    minutes_light_pa = Light,
    minutes_moderate_pa = Moderate,
    minutes_vigorous_pa = Vigorous,
    minutes_veryvigorous_pa = `Very Vigorous`,
    minutes_mvpa = `Total MVPA`,
```

```
    percent_mvpa = `% in MVPA`,
    axis1_counts = `Axis 1 Counts`,
    axis2_counts = `Axis 2 Counts`,
    axis3_counts = `Axis 3 Counts`,
    axis1_averagecounts = `Axis 1 Average Counts`,
    axis2_averagecounts = `Axis 2 Average Counts`,
    axis3_averagecounts = `Axis 3 Average Counts`,
    axis1_maxcounts = `Axis 1 Max Counts`,
    axis2_maxcounts = `Axis 2 Max Counts`,
    axis3_maxcounts = `Axis 3 Max Counts`,
    axis1_cpm = `Axis 1 CPM`,
    axis2_cpm = `Axis 2 CPM`,
    axis3_cpm = `Axis 3 CPM`,
    vcm_totalcounts = `Vector Magnitude Counts`,
    vcm_averagecounts = `Vector Magnitude Average Counts`,
    vcm_maxcounts = `Vector Magnitude Max Counts`,
    vcm_cpm = `Vector Magnitude CPM`,
    steps_counts = `Steps Counts`,
    steps_perminute = `Steps Per Minute`,
    steps_maxcounts = `Steps Max Counts`,
    lux_averagecounts = `Lux Average Counts`,
    lux_maxcounts = `Lux Max Counts`,
    epochs = `Number of Epochs`,
    wear_time = Time,
    calendar_days = `Calendar Days`)

rm(All, all, myfiles, test)

actigraph <- actigraph %>%
  mutate_all(na_if,"") # make all blank cells

actigraph <- actigraph %>%
  drop_na(dayofweek_number) # partially drop summary columns
```

```
actigraph <- actigraph %>%
  filter(dayofweek_number != "Day of Week Num") # complete drop summary columns

actigraph$id_runin <- str_extract(actigraph$id_runin, "^.*(?=(_))")

str(actigraph)

factors <- c('id_runin' ,'dayofweek', 'dayofweek_number')
actigraph[,factors] <- lapply(actigraph[,factors] , factor)

str(actigraph)

numerics <- c('freedson_bouts_occuring' ,'freedson_bouts_starting', 'freedson_bouts_ending',
              'freedson_total_time', 'freedson_total_activitycounts', 'sedentary_bouts_occuring',
              'sedentary_bouts_starting', 'sedentary_bouts_ending', 'sedentary_bouts_totaltime',
              'sedentary_breaks_occuring', 'sedentary_breaks_starting', 'sedentary_breaks_ending',
              'sedentary_breaks_totaltime', 'minutes_sedentary', 'minutes_light_pa',
              'minutes_moderate_pa', 'minutes_vigorous_pa', 'minutes_veryvigorous_pa', 'minutes_mvpa',
              'percent_mvpa', 'axis1_counts', 'axis2_counts', 'axis3_counts', 'axis1_averagecounts',
              'axis2_averagecounts', 'axis3_averagecounts', 'axis1_maxcounts', 'axis2_maxcounts',
              'axis3_maxcounts', 'axis1_cpm', 'axis2_cpm', 'axis3_cpm', 'vcm_totalcounts',
              'vcm_averagecounts', 'vcm_maxcounts', 'vcm_cpm', 'steps_counts', 'steps_maxcounts',
              'steps_perminute', 'lux_averagecounts', 'lux_maxcounts', 'epochs', 'wear_time',
              'calendar_days')

as.numeric.factor <- function(x) {as.numeric(levels(x))[x]} # need to create new function for step below

actigraph[,numerics] <- lapply(actigraph[,numerics] , as.numeric.factor)

str(actigraph)

actigraph$dayofweek_number <- drop.levels(actigraph$dayofweek_number)

actigraph$dayofweek <- drop.levels(actigraph$dayofweek)
```

```
### ---- Load in Qualtrics Data (i.e., self-report behavioral measures and subscales)  ----

# qualtrics <- read.csv()

### ---- Manipulate Qualtrics Data ----

qualtrics <- qualtrics %>%
  select(StartDate, Run.in.ID, age, sex, ethnicity, racial.identity, education, work.status,
         stadiometer_1, stadiometer_2, scale_1, scale_2, panes1, panes2, panes3, panes4, panes5, panes6, panes7, sses_familysupport_1,
sses_familysupport_2, sses_familysupport_3, sses_familysupport_4, sses_familysupport_5, sses_familysupport_6, sses_familysupport_7,
sses_familysupport_8, sses_familysupport_9, sses_familysupport_10, sses_familysupport_11, sses_familysupport_12, sses_familysupport_13,
sses_friendsupport_1, sses_friendsupport_2, sses_friendsupport_3, sses_friendsupport_4, sses_friendsupport_5, sses_friendsupport_6,
sses_friendsupport_7, sses_friendsupport_8, sses_friendsupport_9, sses_friendsupport_10, sses_friendsupport_11, sses_friendsupport_12,
sses_friendsupport_13, paces_1, paces_2, paces_3, paces_4, paces_5, paces_6, paces_7, paces_8, paces_9, paces_10, paces_11, paces_12,
paces_13, paces_14, paces_15, paces_16, paces_17, paces_18, imi_intenj_1, imi_intenj_2,
         imi_intenj_3, imi_intenj_4, imi_intenj_5, imi_intenj_6, imi_intenj_7)

qualtrics <- qualtrics %>%
  rename(date = StartDate,
         id_runin = Run.in.ID,
         race = racial.identity,
         work_status = work.status)

str(qualtrics$date)
qualtrics$date <- as.Date(qualtrics$date, format = "%m/%d/%Y")
str(qualtrics$date)

str(qualtrics)

factors <- c('id_runin' ,'sex', 'ethnicity', 'race', 'education', 'work_status')
qualtrics[,factors] <- lapply(qualtrics[,factors] , factor)

summary(qualtrics$sex)
```

```
levels(qualtrics$sex)
qualtrics$sex <- factor(qualtrics$sex, levels = c(1, 2), labels = c("male", "female"))
summary(qualtrics$sex)

summary(qualtrics$ethnicity)
levels(qualtrics$ethnicity)
qualtrics$ethnicity <- factor(qualtrics$ethnicity, levels = c(1, 2), labels = c("not hispanic/latino", "hispanic/latino"))
summary(qualtrics$ethnicity)

summary(qualtrics$race)
levels(qualtrics$race)
qualtrics$race <- factor(qualtrics$race, levels = c(2, 4, 5, 6), labels = c("asian", "two or more races", "black/african american", "white"))
summary(qualtrics$race)

summary(qualtrics$education)
levels(qualtrics$education)
qualtrics$education <- factor(qualtrics$education, levels = c(3, 4, 5, 6, 7), labels = c("high school/GED", "trade school/technical school", "some college/associate's degree", "college degree", "graduate or professional degree"))
summary(qualtrics$education)

summary(qualtrics$work_status)
levels(qualtrics$work_status)
qualtrics$work_status <- factor(qualtrics$work_status, levels = c(1, 2, 3, 5, 6), labels = c("employed full-time", "employed part-time", "student", "unemployed and looking", "unemployed and not looking"))
summary(qualtrics$work_status)

str(qualtrics)

### ---- Scoring Measures in Qualtrics Data ----

# BMI

qualtrics$bmi_1 <- (qualtrics$scale_1 * 703)/(qualtrics$stadiometer_1^2)
qualtrics$bmi_2 <- (qualtrics$scale_2 * 703)/(qualtrics$stadiometer_2^2)
```

```
qualtrics$bmi <- (qualtrics$bmi_1 + qualtrics$bmi_2)/2

qualtrics$bmi_cats <- as.factor(ifelse(qualtrics$bmi >= 30, "obese",
                                ifelse(qualtrics$bmi >=25 & qualtrics$bmi < 30 , "overweight",
                                    ifelse(qualtrics$bmi >=18.5 & qualtrics$bmi < 25, "normal", ifelse(qualtrics$bmi < 18.5,  "underweight", NA)))))

# Built Environment Index - Physical Activity Enjoyment Scale

grep("panes", colnames(qualtrics)) # Identify column numbers for panes

qualtrics[, 13:19] %>%
  select(everything()) %>%
  summarise_each(funs(sum(is.na(.)))) # missing data check

qualtrics$panes1 <- ifelse(qualtrics$panes1 == 1, 0, ifelse(qualtrics$panes1 == 9, NA, 1)) # Dichotomize item 1 as 0 = single family housing and 1
= all other responses (excluding don't know).
qualtrics$panes2 <- ifelse(qualtrics$panes2 == 1 | qualtrics$panes2 == 2, 0, ifelse(qualtrics$panes2 == 5, NA, 1)) # Dichotomize items 2 though 7
as 0 = strongly or somewhat disagree and 1 = strongly or somewhat agree.
qualtrics$panes3 <- ifelse(qualtrics$panes3 == 1 | qualtrics$panes3 == 2, 0, ifelse(qualtrics$panes3 == 5, NA, 1))
qualtrics$panes4 <- ifelse(qualtrics$panes4 == 1 | qualtrics$panes4 == 2, 0, ifelse(qualtrics$panes4 == 5, NA, 1))
qualtrics$panes5 <- ifelse(qualtrics$panes5 == 1 | qualtrics$panes5 == 2, 0, ifelse(qualtrics$panes5 == 5, NA, 1))
qualtrics$panes6 <- ifelse(qualtrics$panes6 == 1 | qualtrics$panes6 == 2, 0, ifelse(qualtrics$panes6 == 5, NA, 1))

qualtrics$bei <- qualtrics$panes1 + qualtrics$panes2 + qualtrics$panes3 + qualtrics$panes4 + qualtrics$panes5 + qualtrics$panes6

summary(qualtrics$bei)

# Physical Activity Enjoyment Scale

grep("paces", colnames(qualtrics)) # identify column numbers

qualtrics[, 46:63] %>%
  select(everything()) %>%
```

```
  summarise_each(funs(sum(is.na(.)))) # missing data check

qualtrics[, c(47, 48, 51, 53, 57, 60, 63)] = 6 - qualtrics[, c(47, 48, 51, 53, 57, 60, 63)] # reverse coding

qualtrics$paces <- rowSums(qualtrics[, 46:63], na.rm = T)

# Interest/Enjoyment Subscale - Intrinsic Motivation Inventory

grep("imi", colnames(qualtrics)) # identify column numbers

qualtrics[, 64:70] %>%
  select(everything()) %>%
  summarise_each(funs(sum(is.na(.)))) # missing data check

qualtrics[, c(66, 67)] = 8 - qualtrics[, c(66, 67)] # reverse coding

qualtrics$imi <- rowSums(qualtrics[, 64:70], na.rm = T)/7

describe(qualtrics$imi)
describe(qualtrics$paces)
summary(qualtrics$paces)
summary(qualtrics$imi)

# Social Support and Exercise Survey

grep("sses_family", colnames(qualtrics)) # Identify column numbers
grep("sses_friends", colnames(qualtrics)) # Identify column numbers

qualtrics[, 20:45] %>%
  select(everything()) %>%
  summarise_each(funs(sum(is.na(.)))) # missing data check

qualtrics$family_participation <- rowSums(qualtrics[, c(20:25, 29:32)], na.rm = T)
qualtrics$family_rewardsandpunishment <- rowSums(qualtrics[, 26:28], na.rm = T)
```

```
qualtrics$friends_participation <- rowSums(qualtrics[, c(33:38, 42:45)], na.rm = T)

qualtrics$age_cats <- ifelse(qualtrics$age >= 18 & qualtrics$age < 22, "18-21", ifelse(qualtrics$age >= 22 & qualtrics$age < 26, "22-25",
ifelse(qualtrics$age >= 26 & qualtrics$age <= 29, "26-29", NA)))

### ---- Selecting Actigraph Variables For Analyses ----

actigraph <- actigraph %>%
  select(id_runin, dayofweek, dayofweek_number, minutes_light_pa, minutes_mvpa, vcm_totalcounts, vcm_averagecounts, steps_counts,
steps_perminute, wear_time, calendar_days)

actigraph$valid_day_10hours <- ifelse(actigraph$wear_time >= 600, 1, 0)

actigraph$valid_day_8hours <- ifelse(actigraph$wear_time >= 480, 1, 0)

actigraph <- actigraph %>%
  group_by(id_runin) %>% mutate(numberofvaliddays_10hours = sum(valid_day_10hours))

actigraph <- actigraph %>%
  group_by(id_runin) %>% mutate(numberofvaliddays_8hours = sum(valid_day_8hours))

actigraph_means <- ddply(actigraph, "id_runin", summarize,
                         minutes_lpa_sum = sum(minutes_light_pa, na.rm=TRUE),
                         minutes_mvpa_sum = sum(minutes_mvpa, na.rm=TRUE),
                         minutes_lpa_mean = mean(minutes_light_pa, na.rm=TRUE),
                         minutes_mvpa_mean = mean(minutes_mvpa, na.rm=TRUE),
                         vcm_counts_total = mean(vcm_totalcounts, na.rm=TRUE),
                         vcm_counts_sum = sum(vcm_averagecounts, na.rm = TRUE),
                         step_counts_mean = mean(steps_counts, na.rm=TRUE),
                         step_counts_sum = sum(steps_counts, na.rm = TRUE),
                         wear_time_mean = mean(wear_time, na.rm=TRUE),
                         wear_time_sum = sum(wear_time, na.rm = TRUE),
                         numberofvaliddays_10hours = sum(valid_day_10hours, na.rm = TRUE),
                         numberofvaliddays_8hours = sum(valid_day_8hours, na.rm = TRUE))
```

```
actigraph_means$eligible_4x10 <- ifelse(actigraph_means$numberofvaliddays_10hours >= 4, 1, 0)

actigraph_means$eligible_5x8 <- ifelse(actigraph_means$numberofvaliddays_8hours >= 5, 1, 0)

actigraph_means$total_pa_sum <- actigraph_means$minutes_lpa_sum + actigraph_means$minutes_mvpa_sum

actigraph_means$total_pa_mean <- actigraph_means$minutes_lpa_mean + actigraph_means$minutes_mvpa_mean

actigraph_means$meets_guidelines <- ifelse(actigraph_means$minutes_mvpa_sum >= 150, 1, 0)

### ---- Load Photoperiod and Qualification Datasets ----

# photoperiod <- read.csv()

str(photoperiod$date)
photoperiod$date <- as.Date(photoperiod$date, format = "%m/%d/%Y")
str(photoperiod$date)

#### ---- Merging Datasets ----

merge_one <- merge(actigraph_means, qualtrics, by = "id_runin")
merge_two <- merge(merge_one, photoperiod, by = "date")

master <- merge_two

#### ---- Table 1 (Descriptive Statistics) ----

master$age_cats <- as.factor(master$age_cats)

master$meets_guidelines <- as.factor(master$meets_guidelines)

eligible <- master %>%
```

```
  filter(eligible_4x10 == 1)

eligible <-  eligible[!is.na(eligible$bei),]

summary(eligible$sex)
summary(eligible$sex)/nrow(eligible)

summary(eligible$age_cats)
summary(eligible$age_cats)/nrow(eligible)

summary(eligible$ethnicity)
summary(eligible$ethnicity)/nrow(eligible)

summary(eligible$race)
summary(eligible$race)/nrow(eligible)

summary(eligible$education)
summary(eligible$education)/nrow(eligible)

summary(eligible$work_status)
summary(eligible$work_status)/nrow(eligible)

summary(eligible$bmi_cats)
summary(eligible$bmi_cats)/nrow(eligible)

summary(eligible$meets_guidelines)
summary(eligible$meets_guidelines)/nrow(eligible)

mean(eligible$age)
sd(eligible$age)

mean(eligible$bmi, na.rm = T)
sd(eligible$bmi, na.rm = T)
```

```
sensitivity <- master %>%
  filter(eligible_5x8 == 1)

sensitivity <-  sensitivity[!is.na(sensitivity$bei),]

summary(sensitivity$sex)
summary(sensitivity$sex)/nrow(sensitivity)

summary(sensitivity$age_cats)
summary(sensitivity$age_cats)/nrow(sensitivity)

summary(sensitivity$ethnicity)
summary(sensitivity$ethnicity)/nrow(sensitivity)

summary(sensitivity$race)
summary(sensitivity$race)/nrow(sensitivity)

summary(sensitivity$education)
summary(sensitivity$education)/nrow(sensitivity)

summary(sensitivity$work_status)
summary(sensitivity$work_status)/nrow(sensitivity)

summary(sensitivity$bmi_cats)
summary(sensitivity$bmi_cats)/nrow(sensitivity)

summary(sensitivity$meets_guidelines)
summary(sensitivity$meets_guidelines)/nrow(sensitivity)

mean(sensitivity$age)
sd(sensitivity$age)

mean(sensitivity$bmi, na.rm = T)
sd(sensitivity$bmi, na.rm = T)
```

```
#### ---- Table 2 (Main Analysis | Correlation) ----

table_2 <- eligible %>%
  select(step_counts_mean, minutes_lpa_mean, minutes_mvpa_mean, vcm_counts_total, paces, imi, family_participation,
family_rewardsandpunishment, friends_participation, bei, photoperiod)

describe(table_2)

for_corr <- rcorr(as.matrix(table_2))
for_corr

#### ---- Appendix B (Sensitivity Analysis | Correlation) ----

sensitivity_correlation <- sensitivity %>%
  select(step_counts_mean, minutes_lpa_mean, minutes_mvpa_mean, vcm_counts_total, paces, imi, family_participation,
family_rewardsandpunishment, friends_participation, bei, photoperiod)

describe(sensitivity_correlation)

for_corr <- rcorr(as.matrix(sensitivity_correlation))
for_corr

#### ---- Table 2 (Main Analysis | Internal Consistency) ----

grep("paces", colnames(eligible)) # identify column numbers

psych::alpha(eligible[,63:80]) # paces

grep("imi", colnames(eligible)) # identify column numbers

psych::alpha(eligible[,81:87]) # imi - interest and enjoyment

grep("sses_family", colnames(eligible)) # Identify column numbers
```

```
psych::alpha(eligible[,c(37:42, 46:49)]) # family - participation
psych::alpha(eligible[,43:45]) # family - r&p

grep("sses_friends", colnames(eligible))

psych::alpha(eligible[,c(50:55, 59:62)]) # friends - participation

grep("panes", colnames(eligible))

psych::alpha(eligible[,30:36]) # panes

#### ---- Appendix B (Sensitivity Analysis | Internal Consistency) ----

grep("paces", colnames(sensitivity)) # identify column numbers

psych::alpha(sensitivity[,63:80]) # paces

grep("imi", colnames(sensitivity)) # identify column numbers

psych::alpha(sensitivity[,81:87]) # imi - interest and enjoyment

grep("sses_family", colnames(sensitivity)) # Identify column numbers

psych::alpha(sensitivity[,c(37:42, 46:49)]) # family - participation
psych::alpha(sensitivity[,43:45]) # family - r&p

grep("sses_friends", colnames(sensitivity))

psych::alpha(sensitivity[,c(50:55, 59:62)]) # friends - participation

grep("panes", colnames(sensitivity))

psych::alpha(sensitivity[,30:36]) # panes
```

```
#### ---- Table 3 (Main Analysis | Regression) ----

eligible$paces_scaled <- scale(eligible$paces, center = T, scale = T)
eligible$imi_scaled <- scale(eligible$imi, center = T, scale = T)
eligible$composite_AJ <- (eligible$paces_scaled + eligible$imi_scaled)/2

eligible$paces_centered <- scale(eligible$paces, center = T, scale = F)
eligible$imi_centered <- scale(eligible$imi, center = T, scale = F)
eligible$family_participation_centered <- scale(eligible$family_participation, center = T, scale = F)
eligible$family_rewardsandpunishment_centered <- scale(eligible$family_rewardsandpunishment, center = T, scale = F)
eligible$friends_participation_centered <- scale(eligible$friends_participation, center = T, scale = F)
eligible$bei_centered <- scale(eligible$bei, center = T, scale = F)
eligible$photoperiod_centered <- scale(eligible$photoperiod, center = T, scale = F)

model_counts_paces <- lm(vcm_counts_total ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_counts_paces)
lm.beta(model_counts_paces)

model_steps_paces <- lm(step_counts_mean ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_steps_paces)
lm.beta(model_steps_paces)

model_lpa_paces <- lm(minutes_lpa_mean ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_lpa_paces)
lm.beta(model_lpa_paces)

model_mvpa_paces <- lm(minutes_mvpa_mean ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_mvpa_paces)
```

```
lm.beta(model_mvpa_paces)

model_counts_imi <- lm(vcm_counts_total ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_counts_imi)
lm.beta(model_counts_imi)

model_steps_imi <- lm(step_counts_mean ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_steps_imi)
lm.beta(model_steps_imi)

model_lpa_imi <- lm(minutes_lpa_mean ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_lpa_imi)
lm.beta(model_lpa_imi)

model_mvpa_imi <- lm(minutes_mvpa_mean ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_mvpa_imi)
lm.beta(model_mvpa_imi)

model_counts_composite <- lm(vcm_counts_total ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_counts_composite)
lm.beta(model_counts_composite)

model_steps_composite <- lm(step_counts_mean ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_steps_composite)
lm.beta(model_steps_composite)

model_lpa_composite <- lm(minutes_lpa_mean ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
```

```
summary(model_lpa_composite)
lm.beta(model_lpa_composite)

model_mvpa_composite <- lm(minutes_mvpa_mean ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered
+ friends_participation_centered + bei_centered+ photoperiod_centered + sex, eligible)
summary(model_mvpa_composite)
lm.beta(model_mvpa_composite)

#### ---- Appendix C (Sensitivty Analysis | Regression) ----

sensitivity$paces_scaled <- scale(sensitivity$paces, center = T, scale = T)
sensitivity$imi_scaled <- scale(sensitivity$imi, center = T, scale = T)
sensitivity$composite_AJ <- (sensitivity$paces_scaled + sensitivity$imi_scaled)/2

sensitivity$paces_centered <- scale(sensitivity$paces, center = T, scale = F)
sensitivity$imi_centered <- scale(sensitivity$imi, center = T, scale = F)
sensitivity$family_participation_centered <- scale(sensitivity$family_participation, center = T, scale = F)
sensitivity$family_rewardsandpunishment_centered <- scale(sensitivity$family_rewardsandpunishment, center = T, scale = F)
sensitivity$friends_participation_centered <- scale(sensitivity$friends_participation, center = T, scale = F)
sensitivity$bei_centered <- scale(sensitivity$bei, center = T, scale = F)
sensitivity$photoperiod_centered <- scale(sensitivity$photoperiod, center = T, scale = F)

model_counts_paces <- lm(vcm_counts_total ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_counts_paces)
lm.beta(model_counts_paces)

model_steps_paces <- lm(step_counts_mean ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_steps_paces)
lm.beta(model_steps_paces)

model_counts_imi <- lm(vcm_counts_total ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
```

```
summary(model_counts_imi)
lm.beta(model_counts_imi)

model_steps_imi <- lm(step_counts_mean ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_steps_imi)
lm.beta(model_steps_imi)

model_counts_composite <- lm(vcm_counts_total ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_counts_composite)
lm.beta(model_counts_composite)

model_steps_composite <- lm(step_counts_mean ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_steps_composite)
lm.beta(model_steps_composite)

#### ---- Appendix D (Sensitivty Analysis | Regression) ----

model_mvpa_paces <- lm(minutes_mvpa_mean ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_mvpa_paces)
lm.beta(model_mvpa_paces)

model_lpa_paces <- lm(minutes_lpa_mean ~ paces_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_lpa_paces)
lm.beta(model_lpa_paces)

model_mvpa_imi <- lm(minutes_mvpa_mean ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_mvpa_imi)
lm.beta(model_mvpa_imi)
```

```
model_lpa_imi <- lm(minutes_lpa_mean ~ imi_centered + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_lpa_imi)
lm.beta(model_lpa_imi)

model_mvpa_composite <- lm(minutes_mvpa_mean ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered
+ friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_mvpa_composite)
lm.beta(model_mvpa_composite)

model_lpa_composite <- lm(minutes_lpa_mean ~ composite_AJ + family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex, sensitivity)
summary(model_lpa_composite)
lm.beta(model_lpa_composite)


#### ---- Appendix E (Main Analysis | Volume, Interaction Terms) ----

interaction_model_counts_paces <- lm(vcm_counts_total ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), eligible)
summary(interaction_model_counts_paces)
lm.beta(interaction_model_counts_paces)

interaction_model_steps_paces <- lm(step_counts_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), eligible)
summary(interaction_model_steps_paces)
lm.beta(interaction_model_steps_paces)
```

```
interaction_model_counts_imi <- lm(vcm_counts_total ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered+ sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), eligible)
summary(interaction_model_counts_imi)
lm.beta(interaction_model_counts_imi)

interaction_model_steps_imi <- lm(step_counts_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered+ sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), eligible)
summary(interaction_model_steps_imi)
lm.beta(interaction_model_steps_imi)

interaction_model_counts_composite_AJ  <- lm(vcm_counts_total ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), eligible)
summary(interaction_model_counts_composite_AJ)
lm.beta(interaction_model_counts_composite_AJ)

interaction_model_steps_composite_AJ  <- lm(step_counts_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), eligible)
summary(interaction_model_steps_composite_AJ)
lm.beta(interaction_model_steps_composite_AJ)

#### ---- Appendix F (Sensitivity Analysis | Volume Interaction Terms) ----

interaction_model_counts_paces <- lm(vcm_counts_total ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), sensitivity)
```

```
summary(interaction_model_counts_paces)
lm.beta(interaction_model_counts_paces)

interaction_model_steps_paces <- lm(step_counts_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), sensitivity)
summary(interaction_model_steps_paces)
lm.beta(interaction_model_steps_paces)

interaction_model_counts_imi <- lm(vcm_counts_total ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered+ sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), sensitivity)
summary(interaction_model_counts_imi)
lm.beta(interaction_model_counts_imi)

interaction_model_steps_imi <- lm(step_counts_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered+ sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), sensitivity)
summary(interaction_model_steps_imi)
lm.beta(interaction_model_steps_imi)

interaction_model_counts_composite_AJ  <- lm(vcm_counts_total ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), sensitivity)
summary(interaction_model_counts_composite_AJ)
lm.beta(interaction_model_counts_composite_AJ)

interaction_model_steps_composite_AJ  <- lm(step_counts_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
```

```
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), sensitivity)
summary(interaction_model_steps_composite_AJ)
lm.beta(interaction_model_steps_composite_AJ)

#### ---- Appendix G (Main Analysis | Intensity, Interaction Terms) ----

interaction_model_mvpa_paces <- lm(minutes_mvpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), eligible)
summary(interaction_model_mvpa_paces)
lm.beta(interaction_model_mvpa_paces)

interaction_model_lpa_paces <- lm(minutes_lpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), eligible)
summary(interaction_model_lpa_paces)
lm.beta(interaction_model_lpa_paces)

interaction_model_mvpa_imi <- lm(minutes_mvpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), eligible)
summary(interaction_model_mvpa_imi)
lm.beta(interaction_model_mvpa_imi)

interaction_model_lpa_imi <- lm(minutes_lpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), eligible)
summary(interaction_model_lpa_imi)
lm.beta(interaction_model_lpa_imi)
```

```
interaction_model_mvpa_composite_AJ  <- lm(minutes_mvpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered
+ friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), eligible)
summary(interaction_model_mvpa_composite_AJ)
lm.beta(interaction_model_mvpa_composite_AJ)


interaction_model_lpa_composite_AJ  <- lm(minutes_lpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), eligible)
summary(interaction_model_lpa_composite_AJ)
lm.beta(interaction_model_lpa_composite_AJ)

#### ---- Appendix H (Sensitivity Analysis | Intensity, Interaction Terms) ----

interaction_model_mvpa_paces <- lm(minutes_mvpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), sensitivity)
summary(interaction_model_mvpa_paces)
lm.beta(interaction_model_mvpa_paces)

interaction_model_lpa_paces <- lm(minutes_lpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*paces_centered) +
(family_rewardsandpunishment_centered*paces_centered) + (friends_participation_centered*paces_centered) + (bei_centered*paces_centered) +
(photoperiod_centered*paces_centered) + (sex*paces_centered), sensitivity)
summary(interaction_model_lpa_paces)
lm.beta(interaction_model_lpa_paces)

interaction_model_mvpa_imi <- lm(minutes_mvpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*imi_centered) +
```

```
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), sensitivity)
summary(interaction_model_mvpa_imi)
lm.beta(interaction_model_mvpa_imi)

interaction_model_lpa_imi <- lm(minutes_lpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*imi_centered) +
(family_rewardsandpunishment_centered*imi_centered) + (friends_participation_centered*imi_centered) + (bei_centered*imi_centered) +
(photoperiod_centered*imi_centered) + (sex*imi_centered), sensitivity)
summary(interaction_model_lpa_imi)
lm.beta(interaction_model_lpa_imi)

interaction_model_mvpa_composite_AJ  <- lm(minutes_mvpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered
+ friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), sensitivity)
summary(interaction_model_mvpa_composite_AJ)
lm.beta(interaction_model_mvpa_composite_AJ)


interaction_model_lpa_composite_AJ  <- lm(minutes_lpa_mean ~ family_participation_centered + family_rewardsandpunishment_centered +
friends_participation_centered + bei_centered+ photoperiod_centered + sex +  (family_participation_centered*composite_AJ) +
(family_rewardsandpunishment_centered*composite_AJ) + (friends_participation_centered*composite_AJ) + (bei_centered*composite_AJ) +
(photoperiod_centered*composite_AJ) + (sex*composite_AJ), sensitivity)
summary(interaction_model_lpa_composite_AJ)
lm.beta(interaction_model_lpa_composite_AJ)
```

Appendix B. Descriptive statistics and bivariate correlations for the sensitivity analysis sample

Measure	M	SD	α	1	2	3	4	5	6	7	8	9	10	11
Physical Activity														
1. TAC/day	301731.78	103956.28	--	--										
2. Steps/day	4886.90	1899.23	--	**.81**	--									
3. MVPA (min/day)	27.99	18.14	--	**.78**	**.87**	--								
4. LPA (min/day)	144.84	47.39	--	**.55**	**.25**	.04	--							
Affective Judgment														
5. Enjoyment	64.03	10.25	.90	.04	.04	.02	.13	--						
6. Intrinsic Motivation	4.26	1.09	.90	.07	.06	.04	.12	**.77**	--					
Social Environment														
7. Family – Participation	21.22	11.74	.93	.06	.07	.05	-.01	-.04	-.01	--				
8. Family – Rewards and Punishment	4.90	4.38	.94	-.02	-.02	.00	-.09	-.11	-.08	**.67**	--			
9. Friends - Participation	20.05	8.80	.89	**.20**	**.18**	**.19**	.04	.11	.14	**.48**	**.41**	--		
Perceptions of the Built Environment														
10. PANES – BEI	4.47	1.64	.57	.10	**.18***	**.28**	**-.22**	.05	.05	.02	.09	.06	--	
Natural Environment														
11. Photoperiod	0.01	0.72	--	.00	-.12	**-.20**	**-.22**	-.12	-.08	.07	.09	.04	**-.23**	--

Note: Bolded values denote statistical significance ($p < .05$). The asterisk (*) denotes coefficients that achieved significance in the sensitivity analysis sample but not the main analysis sample. TAC = total activity counts. MVPA = moderate-to-vigorous intensity physical activity. LPA = light intensity physical activity. PANES – BEI = Physical Activity Neighborhood Survey – Built Environment Index.

Appendix C. Sensitivity analysis coefficients for multiple linear regression of measures of physical activity volume on affective judgments, environmental determinants, and sex

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgment Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Total Activity Counts Model									
Intercept	**303355.35 (15052.19)**	**0.00**	**<.001**	**303110.30 (15071.20)**	**0.00**	**<.001**	**303336.50 (15053.50)**	**0.00**	**<.001**
Affective Judgment	-70.17 (845.74)	-0.01	0.93	2405.60 (7934.20)	0.03	0.76	1083.90 (9233.00)	0.01	0.91
Family - Participation	492.11 (1030.25)	0.06	0.63	489.50 (1030.00)	0.06	0.64	491.10 (1030.20)	0.06	0.63
Family - Rewards & Punishment	-3877.98 (2689.12)	-0.16	0.15	-3745.40 (2684.40)	-0.16	0.17	-3803.50 (2690.20)	-0.16	0.16
Friends - Participation	**2714.54 (1118.21)**	**0.23**	**<.05**	**2637.40 (1122.50)**	**0.22**	**<.05**	**2675.70 (1122.70)**	**0.23**	**<.05**
Perceived Built Environment	6381.83 (5349.17)	0.10	0.23	6293.10 (5350.90)	0.10	0.24	6342.90 (5351.10)	0.10	0.24
Photoperiod	3214.01 (12126.81)	0.02	0.79	3544.30 (12081.20)	0.02	0.77	3443.30 (12108.40)	0.02	0.78
Sex (Female)	-2380.19 (18313.67)	-0.01	0.90	-2020.90 (18349.60)	-0.01	0.91	-2352.60 (18316.20)	-0.01	0.90
Step Counts Model									
Intercept	**4690.19 (270.05)**	**0.00**	**<.001**	**4689.43 (270.49)**	**0.00**	**<.001**	**4691.20 (270.11)**	**0.00**	**<.001**
Affective Judgment	-2.64 (15.17)	-0.01	0.86	13.83 (142.40)	0.01	0.92	-6.77 (165.67)	0.00	0.97
Family - Participation	14.59 (18.48)	0.09	0.43	14.57 (18.49)	0.09	0.43	14.59 (18.49)	0.09	0.43
Family - Rewards & Punishment	-76.14 (48.25)	-0.18	0.12	-74.40 (48.18)	-0.17	0.12	-75.27 (48.27)	-0.17	0.12
Friends - Participation	**43.78 (20.06)**	**0.20**	**<.05**	**42.86 (20.15)**	**0.20**	**<.05***	**43.37 (20.14)**	**0.20**	**<.05***
Perceived Built Environment	183.33 (95.97)	0.16	0.06	182.40 (96.04)	0.16	0.06	182.99 (96.01)	0.16	0.06
Photoperiod	-217.80 (217.57)	-0.08	0.32	-212.59 (216.83)	-0.08	0.33	-214.67 (217.26)	-0.08	0.32
Sex (Female)	288.38 (328.56)	0.08	0.38	289.49 (329.33)	0.07	0.38	286.89 (328.65)	0.07	0.38

Note: Bolded values denote statistical significance ($p < .05$). The asterisk (*) denotes coefficients that achieved significance in the sensitivity analysis sample but not the main analysis sample.

Appendix D. Sensitivity analysis coefficients for multiple linear regression of intensity-specific activity duration on affective judgments, environmental determinants, and sex

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgment Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Moderate-to-Vigorous Activity Model									
Intercept	**27.56 (2.52)**	**0.00**	**<.001**	**27.62 (2.52)**	**0.00**	**<.001**	**27.61 (2.52)**	**0.00**	**<.001**
Affective Judgment	-0.09 (0.14)	-0.05	0.54	-0.32 (1.33)	-0.02	0.81	-0.70 (1.54)	-0.04	0.65
Family - Participation	0.05 (0.17)	0.03	0.78	0.05 (0.17)	0.03	0.78	0.05 (0.17)	0.03	0.78
Family - Rewards & Punishment	-0.49 (0.45)	-0.12	0.28	-0.46 (0.45)	-0.11	0.30	-0.48 (0.45)	-0.12	0.29
Friends - Participation	**0.45 (0.19)**	**0.22**	**<.05**	**0.44 (0.19)**	**0.21**	**<.05***	**0.45 (0.19)**	**0.22**	**<.05**
Perceived Built Environment	**2.64 (0.89)**	**0.24**	**<.001**	**2.63 (0.90)**	**0.34**	**<.001**	**2.64 (0.90)**	**0.24**	**<.001**
Photoperiod	-3.73 (2.03)	-0.15	0.07	-3.63 (2.02)	-0.14	0.07	-3.68 (2.03)	-0.15	0.07
Sex (Female)	0.64 (3.06)	0.02	0.84	0.55 (3.07)	0.01	0.86	0.56 (3.06)	0.01	0.85
Light Intensity Activity Model									
Intercept	**141.26 (6.65)**	**0.00**	**<.001**	**140.45 (6.67)**	**0.00**	**<.001**	**140.81 (6.64)**	**0.00**	**<.001**
Affective Judgment	0.65 (0.37)	0.14	0.08	5.69 (3.51)	0.13	0.11	7.31 (4.07)	0.15	0.07
Family - Participation	0.12 (0.45)	0.03	0.80	0.11 (0.46)	0.03	0.80	0.11 (0.45)	0.03	0.80
Family - Rewards & Punishment	-1.36 (1.19)	-0.13	0.25	-1.40 (1.19)	-0.13	0.24	-1.34 (1.19)	-0.12	0.26
Friends - Participation	0.36 (0.49)	0.07	0.47	0.35 (0.50)	0.06	0.49	0.33 (0.50)	0.06	0.50
Perceived Built Environment	**-5.14 (2.36)**	**-0.18**	**<.05**	**-5.19 (2.37)**	**-0.18**	**<.05**	**-5.19 (2.36)**	**-0.18**	**<.05**
Photoperiod	**13.46 (5.35)**	**0.21**	**<.05**	**13.03 (5.34)**	**0.20**	**<.05**	**13.34 (5.34)**	**0.20**	**<.05**
Sex (Female)	5.24 (8.09)	0.05	0.52	6.44 (8.12)	0.06	0.43	5.91 (8.08)	**0.06**	0.47

Note: Bolded values denote statistical significance ($p < .05$). The asterisk (*) denotes coefficients that achieved significance in the sensitivity analysis sample but not the main analysis sample.

Appendix E. Coefficients for multiple linear regression of measures of physical activity volume on environmental determinants and sex and their interactions with affective judgments

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgment Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Total Activity Counts Model									
Intercept	**290625.18 (17961.49)**	**0.00**	**<.001**	**292448.40 (17886.20)**	**0.00**	**<.001**	**290855.30 (17985.60)**	**0.00**	**<.001**
Family - Participation	542.37 (1253.72)	0.06	0.67	754.00 (1241.60)	0.08	0.54	613.70 (1252.30)	0.07	0.63
Family - Rewards & Punishment	-3957.68 (3126.53)	-0.16	0.21	-4098.30 (3067.00)	-0.17	0.18	-4110.20 (3101.00)	-0.17	0.19
Friends - Participation	**2852.00 (1319.02)**	**0.24**	**<.05**	**2928.80 (1303.40)**	**0.24**	**<.05**	**2937.30 (1320.20)**	**0.25**	**<.05**
Perceived Built Environment	5719.68 (6206.44)	0.09	0.36	5794.70 (6103.60)	0.09	0.34	5383.00 (6138.90)	0.08	0.38
Photoperiod	5660.63 (13848.38)	0.04	0.68	6880.70 (13840.90)	0.05	0.62	6723.60 (13888.60)	0.04	0.63
Sex (Female)	4524.80 (21558.94)	0.02	0.83	2083.90 (21578.80)	0.01	0.92	4704.20 (21626.30)	0.02	0.83
Family – Participation * Affective Judgement (AJ)	-129.95 (131.75)	-0.13	0.33	198.50 (1220.20)	0.02	0.87	-705.80 (1422.00)	-0.06	0.62
Family - Rewards & Punishment * AJ	-216.16 (282.67)	-0.10	0.45	-2334.80 (2291.00)	-0.11	0.31	-2530.80 (2669.10)	-0.11	0.34
Friends – Participation * AJ	173.12 (126.11)	0.18	0.17	1455.60 (1056.60)	0.14	0.17	1683.10 (1209.40)	0.16	0.17
Perceived Built Environment * AJ	421.80 (571.13)	0.07	0.46	12295.50 (7049.30)	0.17	0.08	9502.00 (7221.60)	0.13	0.19
Photoperiod * AJ	266.89 (1576.87)	0.02	0.87	9780.00 (13639.50)	0.07	0.47	7905.40 (15994.90)	0.05	0.62
Sex (Female) * AJ	44.12 (2602.62)	0.00	0.99	-18976.10 (22747.30)	-0.16	0.41	-13376.50 (26673.10)	-0.10	0.62
Step Counts Model									
Intercept	**4365.57 (312.14)**	**0.00**	**<.001**	**4374.27 (309.75)**	**0.00**	**<.001**	**4350.78 (312.34)**	**0.00**	**<.001**
Family - Participation	18.55 (21.79)	0.11	0.40	30.20 (21.50)	0.18	0.16	24.12 (21.75)	0.14	0.27
Family - Rewards & Punishment	-68.66 (54.33)	-0.16	0.21	-97.90 (53.11)	-0.22	0.07	-85.79 (53.85)	-0.20	0.11
Friends - Participation	**46.86 (22.92)**	**0.22**	**<.05**	**44.69 (22.57)**	**0.21**	**<.05**	**45.59 (22.93)**	**0.21**	**<.05**
Perceived Built Environment	166.24 (107.86)	0.14	0.13	178.65 (105.70)	0.15	0.09	162.28 (106.61)	0.14	0.13
Photoperiod	-113.26 (240.66)	-0.04	0.64	-105.69 (239.69)	-0.04	0.66	-103.01 (241.19)	-0.04	0.67
Sex (Female)	476.71 (374.66)	0.11	0.21	450.69 (373.69)	0.11	0.23	539.66 (406.95)	0.12	0.18
Family – Participation * AJ	-4.17 (2.29)	-0.24	0.07	-5.98 (21.13)	-0.03	0.78	-27.72 (24.70)	-0.14	0.26

Family - Rewards & Punishment * AJ	1.36 (4.91)	0.04	0.78	-21.24 (39.68)	-0.06	0.59	-7.69 (46.35)	-0.02	0.87
Friends – Participation * AJ	2.81 (2.19)	0.16	0.20	15.39 (18.30)	0.08	0.40	22.57 (21.00)	0.12	0.29
Perceived Built Environment * AJ	6.84 (9.93)	0.06	0.49	**277.84 (122.08)**	**0.22**	**<.05**	180.87 (125.41)	0.14	0.15
Photoperiod * AJ	-0.78 (27.40)	0.00	0.98	178.96 (236.20)	0.07	0.45	129.63 (277.77)	0.04	0.64
Sex (Female) * AJ	-24.49 (45.23)	-0.10	0.59	-700.47 (393.93)	-0.33	0.08	-584.27 (463.22)	-0.24	0.21

Note: Bolded values denote statistical significance ($p < .05$).

Appendix F. Coefficients for multiple linear regression of measures of intensity-specific activity duration on environmental determinants and sex and their interactions with affective judgments

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgments Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Moderate-to-Vigorous Activity Model									
Intercept	**24.32 (2.85)**	**0.00**	**<.001**	**24.38 (2.85)**	**0.00**	**<.001**	**24.18 (2.86)**	**0.00**	**<.001**
Family - Participation	0.04 (0.20)	0.02	0.86	0.11 (0.20)	0.07	0.59	0.07 (0.20)	0.05	0.72
Family - Rewards & Punishment	-0.32 (0.50)	-0.08	0.52	-0.48 (0.49)	-0.12	0.33	-0.44 (0.49)	-0.11	0.37
Friends - Participation	**0.45 (0.21)**	**0.23**	**<.05**	0.41 (0.21)	0.21	0.05	**0.43 (0.21)**	**0.22**	**<.05**
Perceived Built Environment	**2.45 (0.98)**	**0.22**	**<.05**	**2.65 (0.97)**	**0.24**	**<.05**	**2.50 (0.97)**	**0.23**	**<.05**
Photoperiod	-2.83 (2.20)	-0.11	0.20	-2.47 (2.20)	-0.10	0.27	-2.55 (2.21)	-0.10	0.25
Sex (Female)	3.40 (3.42)	0.09	0.32	2.89 (3.44)	0.07	0.40	3.45 (3.43)	0.09	0.32
Family – Participation * AJ	-0.03 (0.02)	-0.21	0.10	0.00 (0.19)	0.00	0.98	-0.20 (0.23)	-0.11	0.38
Family - Rewards & Punishment * AJ	0.00 (0.04)	-0.01	0.94	-0.37 (0.36)	-0.11	0.31	-0.28 (0.42)	-0.07	0.51
Friends – Participation * AJ	0.03 (0.02)	0.17	0.16	0.18 (0.17)	0.10	0.29	0.25 (0.19)	0.14	0.19
Perceived Built Environment * AJ	0.06 (0.09)	0.06	0.51	2.13 (1.12)	0.18	0.06	1.58 (1.15)	0.13	0.17
Photoperiod * AJ	0.25 (0.25)	0.09	0.32	2.85 (2.17)	0.12	0.19	3.31 (2.54)	0.12	0.19
Sex (Female) * AJ	-0.32 (0.41)	-0.15	0.44	-5.27 (3.62)	-0.27	0.15	-5.42 (4.24)	-0.24	0.20
Light Intensity Activity Model									
Intercept	**142.88 (7.83)**	**0.00**	**<.001**	**143.53 (7.91)**	**0.00**	**<.001**	**143.39 (7.89)**	**0.00**	**<.001**
Family - Participation	0.32 (0.55)	0.08	0.56	0.23 (0.55)	0.05	0.68	0.25 (0.55)	0.06	0.66
Family - Rewards & Punishment	-1.81 (1.36)	-0.16	0.19	-1.42 (1.36)	-0.13	0.30	-1.50 (1.36)	-0.14	0.27
Friends - Participation	0.28 (0.57)	0.05	0.63	0.43 (0.58)	0.08	0.46	0.36 (0.58)	0.07	0.54
Perceived Built Environment	-4.76 (2.71)	-0.16	0.08	**-5.60 (2.70)**	**-0.19**	**<.05**	**-5.35 (2.69)**	**-0.18**	**<.05**
Photoperiod	**13.29 (6.04)**	**0.20**	**<.05**	11.62 (6.12)	0.17	0.06	**12.71 (6.10)**	**0.19**	**<.05**
Sex (Female)	1.64 (9.40)	0.02	0.86	2.55 (9.54)	0.02	0.79	2.11 (9.49)	0.02	0.82
Family – Participation * Affective Judgement (AJ)	0.02 (0.06)	0.05	0.73	0.32 (0.54)	0.07	0.56	0.25 (0.62)	0.05	0.69
Family - Rewards & Punishment * AJ	-0.17 (0.12)	-0.17	0.18	-0.15 (1.01)	-0.02	0.88	-0.75 (1.17)	-0.07	0.52
Friends – Participation * AJ	0.05 (0.05)	0.11	0.39	0.29 (0.47)	0.06	0.53	0.31 (0.53)	0.07	0.56
Perceived Built Environment * AJ	-0.03 (0.25)	-0.01	0.89	-0.32 (3.12)	-0.01	0.92	-0.67 (3.17)	-0.02	0.83
Photoperiod * AJ	-0.27 (0.69)	-0.04	0.70	-2.11 (6.03)	-0.03	0.73	-3.45 (7.02)	-0.05	0.62
Sex (Female) * AJ	1.2 (1.13)	0.20	0.29	6.72 (10.06)	0.13	0.51	10.77 (11.71)	0.18	0.36

Note: Bolded values denote statistical significance ($p < .05$).

Appendix G. Sensitivity analysis coefficients for multiple linear regression of measures of physical activity volume on environmental determinants and sex and their interactions with affective judgments

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgment Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Total Activity Counts Model									
Intercept	**297422.20 (15608.20)**	**0.00**	**<.001**	**301442.50 (15602.20)**	**0.00**	**<.001**	**298767.70 (15681.00)**	**0.00**	**<.001**
Family - Participation	248.20 (1085.50)	0.03	0.82	448.40 (1085.60)	0.05	0.68	299.60 (1089.10)	0.03	0.78
Family - Rewards & Punishment	-3900.60 (2816.90)	-0.16	0.17	-3961.60 (2816.10)	-0.17	0.16	-3990.40 (2821.80)	-0.17	0.16
Friends - Participation	**2687.00 (1181.60)**	**0.23**	**<.05**	**2896.40 (1178.30)**	**0.25**	**<.05**	**2854.20 (1187.00)**	**0.24**	**<.05**
Perceived Built Environment	8485.70 (5546.90)	0.13	0.13	8125.80 (5469.90)	0.13	0.14	7994.10 (5504.30)	0.13	0.15
Photoperiod	5817.00 (12380.80)	0.04	0.64	6294.20 (12526.20)	0.04	0.62	6342.40 (12491.60)	0.04	0.61
Sex (Female)	1539.80 (18935.70)	0.01	0.94	-3719.70 (18977.90)	-0.02	0.84	102.50 (19029.40)	0.00	0.99
Family – Participation * Affective Judgement (AJ)	-103.20 (117.30)	-0.12	0.38	337.00 (1094.60)	0.03	0.76	-472.90 (1309.70)	-0.04	0.92
Family - Rewards & Punishment * AJ	-165.30 (251.10)	-0.07	0.51	-1628.60 (2045.40)	-0.08	0.43	-1823.10 (2482.50)	-0.08	0.72
Friends – Participation * AJ	134.90 (113.90)	0.14	0.24	1095.80 (967.50)	0.11	0.26	1316.80 (1158.90)	0.12	0.46
Perceived Built Environment * AJ	344.20 (496.9)	0.06	0.49	9977.70 (6033.20)	0.15	0.10	8005.30 (6446.00)	0.11	0.26
Photoperiod * AJ	-218.10 (1412.0)	-0.02	0.88	4750.40 (12453.80)	0.04	0.70	1746.90 (15190.00)	0.01	0.22
Sex (Female) * AJ	932.90 (2079.0)	0.08	0.65	-6371.70 (18889.60)	-0.06	0.74	616.80 (22459.00)	0.00	0.91
Step Counts Model									
Intercept	**4587.16 (280.38)**	**0.00**	**<.001**	**4650.69 (278.98)**	**0.00**	**<.001**	**4605.47 (281.33)**	**0.00**	**<.001**
Family - Participation	9.12 (19.50)	0.06	0.64	18.68 (19.41)	0.12	0.34	13.29 (19.54)	0.08	0.5
Family - Rewards & Punishment	-69.67 (50.60)	-0.16	0.17	-92.22 (50.35)	-0.21	0.07	-82.66 (50.63)	-0.19	0.10
Friends - Participation	**48.89 (21.23)**	**0.23**	**<.05**	**49.64 (21.07)**	**0.23**	**<.05**	**50.07 (21.30)**	**0.23**	**<.05**
Perceived Built Environment	**202.34 (99.64)**	**0.18**	**<.05***	**209.46 (97.80)**	**0.18**	**<.05***	**198.03 (98.75)**	**0.17**	**<.05***
Photoperiod	-174.66 (222.40)	-0.07	0.43	-168.53 (223.98)	-0.06	0.45	-172.69 (224.11)	-0.07	0.44
Sex (Female)	382.99 (340.15)	0.09	0.26	286.89 (339.34)	0.07	0.40	363.00 (341.40)	0.09	0.29
Family – Participation * AJ	-2.98 (2.11)	-0.18	0.16	0.80 (19.57)	0.00	0.97	-16.36 (23.50)	-0.08	0.49

Family - Rewards & Punishment * AJ	1.59 (4.51)	0.04	0.73	-5.33 (36.57)	-0.01	0.88	5.46 (44.54)	0.01	0.90
Friends – Participation * AJ	2.53 (2.05)	0.15	0.22	11.12 (17.30)	0.06	0.52	18.98 (20.79)	0.10	0.36
Perceived Built Environment * AJ	5.72 (8.93)	0.06	0.52	**228.63 (107.88)**	0.18	**<.05**	165.34 (115.65)	**0.13**	0.16
Photoperiod * AJ	-4.76 (25.37)	-0.02	0.85	118.93 (222.68)	0.05	0.59	61.08 (272.52)	0.02	0.82
Sex (Female) * AJ	-2.15 (37.35)	-0.01	0.95	-381.46 (337.76)	-0.19	0.26	-262.35 (402.93)	-0.11	0.52

Note: Bolded values denote statistical significance ($p < .05$). The asterisk (*) denotes coefficients that achieved significance in the sensitivity analysis sample but not the main analysis sample.

Appendix H. Sensitivity analysis coefficients for multiple linear regression of measures of intensity-specific activity duration on environmental determinants and sex and their interactions with affective judgments

	Enjoyment Model			Intrinsic Motivation Model			Composite Affective Judgments Model		
	b (SE)	B	p	b (SE)	B	p	b (SE)	B	p
Moderate-to-Vigorous Activity Model[abc]									
Intercept	**26.79 (2.62)**	**0.00**	**<.001**	**27.39 (2.63)**	**0.00**	**<.001**	**26.95 (2.63)**	**0.00**	**<.001**
Family - Participation	-0.01 (0.18)	0.00	0.97	0.05 (0.18)	0.03	0.79	0.02 (0.18)	0.01	0.92
Family - Rewards & Punishment	-0.42 (0.47)	-0.10	0.37	-0.54 (0.47)	-0.13	0.26	-0.51 (0.47)	-0.12	0.29
Friends - Participation	**0.50 (0.20)**	**0.24**	**<.05**	**0.48 (0.20)**	**0.23**	**<.05***	**0.50 (0.20)**	**0.24**	**<.05**
Perceived Built Environment	**2.78 (0.93)**	**0.25**	**<.001**	**2.87 (0.92)**	**0.26**	**<.001**	**2.79 (0.92)**	**0.25**	**<.001**
Photoperiod	-3.31 (2.08)	-0.13	0.11	-3.22 (2.11)	-0.13	0.13	-3.21 (2.10)	-0.13	0.13
Sex (Female)	1.44 (3.17)	0.04	0.65	0.43 (3.19)	0.01	0.89	1.16 (3.20)	0.03	0.72
Family – Participation * AJ	-0.03 (0.02)	-0.18	0.16	0.03 (0.18)	0.02	0.87	-0.14 (0.22)	-0.08	0.52
Family - Rewards & Punishment * AJ	0.01 (0.04)	0.03	0.83	-0.18 (0.34)	-0.05	0.61	-0.07 (0.42)	-0.02	0.86
Friends – Participation * AJ	0.02 (0.02)	0.14	0.25	0.12 (0.16)	0.07	0.48	0.19 (0.19)	0.10	0.34
Perceived Built Environment * AJ	0.04 (0.08)	0.04	0.67	1.45 (1.02)	0.12	0.16	1.07 (1.08)	0.09	0.32
Photoperiod * AJ	0.11 (0.24)	0.04	0.65	1.57 (2.10)	0.07	0.46	1.66 (2.55)	0.06	0.52
Sex (Female) * AJ	-0.05 (0.35)	-0.02	0.90	-1.88 (3.18)	-0.10	0.55	-1.56 (3.77)	-0.07	0.68
Light Intensity Activity Model									
Intercept	**140.37 (6.88)**	**0.00**	**<.001**	141.19 (6.96)	**0.00**	**<.001**	**140.96 (6.95)**	**0.00**	**<.001**
Family - Participation	0.09 (0.48)	0.02	0.85	0.07 (0.48)	0.02	0.88	0.06 (0.48)	0.01	0.90
Family - Rewards & Punishment	-1.45 (1.24)	-0.13	0.24	-1.15 (1.26)	-0.11	0.36	-1.21 (1.25)	-0.11	0.33
Friends - Participation	0.21 (0.52)	0.04	0.68	0.36 (0.53)	0.07	0.5	0.29 (0.53)	0.05	0.58
Perceived Built Environment	-4.25 (2.44)	-0.15	0.08	**-4.90 (2.44)**	**-0.17**	**<.05**	**-4.76 (2.44)**	**-0.17**	**<.05**
Photoperiod	**14.09 (5.46)**	**0.21**	**<.05**	**12.78 (5.59)**	**0.19**	**<.05***	**13.52 (5.53)**	**0.21**	**<.05**
Sex (Female)	4.60 (8.35)	0.05	0.58	4.62 (8.47)	0.05	0.59	4.64 (8.43)	0.05	0.58
Family – Participation * Affective Judgement (AJ)	0.03 (0.05)	0.06	0.62	0.39 (0.49)	0.09	0.42	0.37 (0.58)	0.08	0.52
Family - Rewards & Punishment * AJ	-0.17 (0.11)	-0.18	0.12	-0.43 (0.91)	-0.05	0.64	-1.05 (1.1)	-0.10	0.34
Friends – Participation * AJ	0.03 (0.05)	0.08	0.51	0.25 (0.43)	0.05	0.56	0.24 (0.51)	0.05	0.64
Perceived Built Environment * AJ	0.06 (0.22)	0.02	0.79	1.22 (2.69)	0.04	0.65	0.94 (2.86)	0.03	0.74
Photoperiod * AJ	-0.06 (0.62)	-0.01	0.93	-0.48 (5.56)	-0.01	0.93	-0.77 (6.73)	-0.01	0.91
Sex (Female) * AJ	0.84 (0.92)	0.16	0.36	3.07 (8.43)	0.06	0.72	6.39 (9.95)	0.11	0.52

Note: Bolded values denote statistical significance ($p < .05$). The asterisk (*) denotes coefficients that achieved significance in the sensitivity analysis sample but not the main analysis sample.

a - denotes Enjoyment Model significance with moderate-to-vigorous physical activity duration

b - denotes Intrinsic Motivation Model significance with moderate-to-vigorous physical activity duration

c - denotes Composite Affective Judgments Model significance with moderate-to-vigorous physical activity duration