Predicting Personal Physical Activity of Parents during Participation in a Family Intervention Targeting their Children

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Abstract

The purpose of this study was to examine the effect of two family interventions targeting inactive children on their parents' MVPA. Correlates of MVPA across the trial in the form of theory of planned behavior (TPB) and multi-process action control (M-PAC) were examined as exploratory outcomes. Parents (of children aged 6 to 12 yr) were randomized to either a planning+education (n = 52) or an education only condition (n = 50) designed to improve child MVPA. Parental MVPA (accelerometry, self-report) was assessed at baseline, six-week, 13-week, and 26-week time-periods. Parental MVPA increased from baseline to 26 weeks ($p < .05$), but there were no group differences. The TPB was unable to predict MVPA and application of M-PAC showed this was because nearly all participants possessed the intention to be active. Successful- compared to unsuccessful-intenders had stronger habit in four of the six tests employed ($p < .05$). Parent MVPA may benefit during a family-based intervention but the putative mediators of this increase are unclear.

Key Words: Exercise, theory of planned behavior, habit, action control, randomized trial

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The health benefits of regular physical activity are well-established (Lee et al., 2012; Rhodes, Bredin, Janssen, Warburton, & Bauman, 2017), yet many adults fail to meet the 150 weekly minutes of moderate or greater intensity (MVPA) recommended in public health guidelines (Hallal et al., 2012). One group that is particularly at risk for physical inactivity is parents with dependent children in the family home (Bellows-Riecken & Rhodes, 2008; Condello et al., 2017). For example, declines in PA following the onset of motherhood was identified as one of the most reliable factors associated with changes in PA when compared to 25 other demographic, psychological, social, and environmental correlates (Rhodes & Quinlan, 2015). Thus, promotion strategies to increase and maintain PA during parenthood is essential.

Interestingly, while child-related support and care duties are generally considered the primary barrier to PA among parents (Bellows-Riecken & Rhodes, 2008), many children are also inactive and under their public health target of 60 minutes of MVPA per day (Hallal et al., 2012). As a result, family-based PA promotion initiatives that focus on parental support to enable child MVPA are considered essential to child MVPA intervention (Craggs, Corder, van Sluijs, & Griffin, 2011; Pratt, Cotto, & Goodway, 2017; Trost & Loprinzi, 2011). Taken together, these findings suggest that the family unit, whether one considers parents or their children, is a critical focus of intervention (Rhodes & Quinlan, 2014).

Family interventions focusing on parental support of child PA in the family home have seen considerable research in terms of both observational (Hutchens & Lee, 2018; Mitchell et al., 2012; Xu, Wen, & Rissel, 2015; Yao & Rhodes, 2015) and intervention (Brown et al., 2016; van Sluijs, Kriemler, & McMinn, 2011) methodologies. Less attention has been paid to whether family interventions facilitate parents' MVPA, however, and results have been mixed in terms of intervention "spillover" to parental MVPA practices. Some studies have supported an overall intergenerational effect of family interventions on parental PA (e.g. Flynn, Bassett, Fouts,

Thompson, & Coe, 2017; Morgan et al., 2011; Morgan et al., 2018) while others have shown no parental benefit (e.g., Bronikowski et al., 2016; Ransdell, Robertson, Ornes, & Moyer-Mileur, 2005; Rhodes, Beauchamp, et al., 2018; Wieland et al., 2018).

The disparity in results may be a consequence of both common and opposing parental objectives for their own and their child's MVPA. For example, qualitative enquiry (Brown, Schiff, & van Sluijs, 2015) and descriptive survey (Rhodes & Lim, 2018) underscore the benefits of family PA – particularly those activities performed together- such as improved social functioning, overall family health and learning opportunities for parents to instruct their children. Still, these studies also note realistic barriers such as different PA interests, different perceived intensities and skill-levels between the generations, and different preferences for when to practice the activity. The mixed literature in this domain supports the sustained evaluation of whether family interventions targeting children can act as a catalyst for parental PA.

Regardless of whether there are any effects on parental MVPA as a result of their participation in a child-focused family intervention, there is also a need to understand what factors predict parental MVPA in order to better target future family interventions to their needs. Research predicting the MVPA of parents with young children in the home has seen limited research attention. A few studies using constructs from Bandura's (2004) social cognitive theory (Deflandre, Antonini, & Lorant, 2004; Hinton & Olson, 2001; Pereira et al., 2007) have shown that self-efficacy (i.e., confidence to overcome barriers) predicted PA frequency of mothers. Applications of Ajzen's (1991) theory of planned behavior showed that perceived behavioral control and subjective norm predicted parental PA through intentions (Hamilton & White, 2012; McIntyre & Rhodes, 2009; Rhodes, Blanchard, Benoit, Levy-Milne, et al., 2014).

Still, these studies featured population samples within passive observational designs and may not be reflective of the types of participants who enter family interventions. For example, the theory

of planned behavior has been criticized that its intention construct may not represent participants within interventions because the intention to engage in PA is often the pre-requisite for volunteering for the intervention in the first place (Rhodes & Rebar, 2017). It would therefore be prudent to explore this model within the context of parents volunteering in a family intervention. Furthermore, models that augment traditional social cognitive theories with constructs that purport to determine the intention-behavior gap may be better suited to understanding PA (Rhodes & Yao, 2015; Sheeran & Webb, 2016; Zhang, Zhang, Schwarzer, & Hagger, in press). To our knowledge, the only study that has explored this premise with a parent sample found that planning mediated the relationship between intention and PA (Hamilton, Cox, & White, 2012). Thus, continued exploration of action control models (i.e., models that focus on the translation of intentions into behavior) in this population is needed.

Therefore, the purpose of this study was to explore the potential spillover effect of family interventions by examining the effect of two family interventions targeting inactive children on their parents' personal MVPA. The study included comparing an education group (receiving information about the benefits of MVPA) to an education +planning group (receiving additional information on planning for PA for their child) over 26 weeks. The original randomized controlled trial focused on children aged six to 12 (Rhodes, Naylor, Blanchard, Quinlan, & Warburton, 2019), and showed the planning+education group has higher MVPA at six-weeks, and 13 weeks compared to the education group after baseline, though both conditions returned to similar values at 26 weeks. We hypothesized, similar to the child outcomes, that the planning+education condition would show higher parental MVPA over time due to the additional planning skills learned being applied to their own PA.

A secondary aim of the study was to examine the predictors of parental MVPA across time and any theoretical mediators of the intervention if warranted after the primary analysis. We used

the theory of planned behavior (TPB; Ajzen, 1991) and multi-process action control (M-PAC; Rhodes, 2017) to predict MVPA. Both models have shown predictive capability when explaining PA (McEachan, Conner, Taylor, & Lawton, 2011; Rhodes & Grant, 2018). Briefly, theory of planned behavior suggests that intentions are the primary cause of behavioral action and intention is determined by attitude (evaluation of the behavior; inclusive of both affective/experiential and instrumental evaluations), subjective norm (perceived social pressure) and perceived behavioral control over enacting the behavior. M-PAC conceives intention as a decisional construct (Rhodes & Rebar, 2017) (i.e., intend/do not intend) and has antecedent constructs of perceived behavioral control, instrumental and affective attitude similar to the TPB *(*called *reflective processes)*. In M-PAC, however, the translation of intention into behavior is partly determined by the enactment of *regulation processes* (e.g., planning, self-monitoring), as people begin to use volitional behavioral regulation tactics to help translate positive intentions into action. Finally, continuance of action control is thought to rely upon the development of *reflexive processes* such as habit (i.e., behavior performed from stimulus-response bonds) as one begins to perform the behavior more regularly. Based on prior research (McEachan et al., 2016; Rhodes & Grant, 2018), we expected that MVPA may be predicted by intention and perceived behavioral control using the TPB formulation, while the differences between unsuccessful and successful intenders in meeting MVPA guidelines would be predicted by behavioral regulation and habit using an M-PAC formulation.

Methods

We followed the consolidated standards of reporting trials statement for this study (Schulz, Altman, Moher, & CONSORT Group, 2010).

Design

A two-arm parallel design randomized trial was conducted. Participants were randomized using an online program, Research Randomizer^{TM} (Urbaniak & Plous, 2015) that allowed for

allocation of participants to one of two groups after baseline assessment: 1) family PA planning + information/education; or 2) PA information/education only. Participants were allocated to these conditions using a 1:1 ratio and subsequently assessed at six-weeks, 13-weeks, and 26-weeks. Participants were aware of the condition they were in, but blind to the other condition. Initial recruiters were blinded to treatment allocation as this was concealed by a trial coordinator (who performed the randomization). Rolling recruitment began in June 2012 and completed in April 2017.

Participants

Participants were recruited through advertisements, booths at local markets, recreation centers, and through materials passed out at local schools. Families were also recruited through referrals, whereby the recruiting family received a $25 CAN grocery store gift card if they referred another family who enrolled in the study.

Inclusion criteria**.** Participants were children, aged 6 to 12 years, from single or dual parent families. Children were included in the study if they did not meet PA guidelines of at least 60 minutes of MVPA per day (Tremblay et al., 2011), assessed in an initial self-report screening and via baseline acceleromentry. While all members of the family were invited to participate in the intervention, only one child and one parent was designated as the target for measurement a priori (parent with lowest MVPA value at baseline).The parent results are the focus of this report.

Study setting**.** Participants were recruited in Greater Victoria, British Columbia, Canada.

Intervention

More details of the intervention can be found in previous publications (Quinlan, Rhodes, Blanchard, Naylor, & Warburton, 2015; Rhodes et al., 2019). Intervention materials were delivered face-to-face by a research assistant after the one week baseline assessment. Both conditions received the Canadian PA Guidelines (Tremblay et al., 2011) hand-out which outlined both child

MVPA guidelines and adult MVPA guidelines of 150 min per week. Intensity was discussed as to what constituted MVPA and examples were provided.

From that point forward, the intervention focused on PA in the family with a particular focus on achieving child MVPA guidelines. The PA information/education only condition received a booklet outlining the benefits of PA for the whole family (Janssen & LeBlanc, 2010) and common barriers and solutions to get children active (Rhodes, Naylor, & McKay, 2010)

For the planning condition, in addition to the information/education material provided, families also received a dry erase calendar and a workbook on planning family PA that included brainstorming exercises using implementation intentions and action planning as well as coping planning and traditional goal setting (Locke & Latham, 1990; Prestwich, Lawton, & Conner, 2003; Sniehotta, Scholz, & Schwarzer, 2005, 2006; Strecher et al., 1995). The expectation was for ongoing use of the calendars (or a related planning format) and to use the workbooks to assist during their weekly planning process. Check-in sessions were conducted with all families at six-weeks and 13-weeks, and coincided with the measurement waves.

Outcomes

The primary outcome of the study was minutes per week of MVPA measured via accelerometry. The primary endpoint was the full 26 weeks of the trial, with secondary endpoints at the six-week and 13-week assessments. The ActiGraph GT3X accelerometer enabled for single axis was used to assess the participants. Participants wore the accelerometer on an elastic belt above the right hip for seven consecutive days for at least 10 hours a day only removing for sleep, water activities or showering. Logbooks were used to confirm the accelerometer data matched participant activity reports.

The ActiLife software version 6.11.9 (2015) was used to analyze the data. The accelerometers were initialized to collect pre-filtered data at a sample rate of 60 Hz for the adults

and were downloaded into 10 second epochs and then reintegrated into 60 second epochs to align with the methods used in Troiano (2008). A minimum of four days with at least 600 minutes per day including at least one weekend day of valid wear time were included in analysis based on recommended best practice (Trost, McIver, & Pate, 2005; Ward, Evenson, Vaughn, Rodgers, & Troiano, 2005). For determining valid wear time, the Troiano (2008) algorithm was used which defines non-wear time as a period of at least 60 consecutive minutes of zero counts, with an allowance for one to two minutes of counts between 0 and 100. These periods of non-wear-time were subtracted from total wear-time. The Troiano (2008) cut points were used, which classifies MVPA as 2020 counts per minute (CPM) and above. These cut points have been frequently used to determine adult PA levels (Migueles et al., 2017). In alignment with recommended Canadian PA guidelines (Tremblay et al., 2011), sustained bout MVPA was determined. Bouts were defined as having 10 or more consecutive minutes above the MVPA threshold with an allowance for interruptions of one or two minutes below the threshold. Total bout minutes were calculated across the week and used for all analyses. Data were modelled so that all participants had a complete seven-day dataset. This was conducted by taking the average of the valid days and inputting those averages for the missing days (Esliger, Copeland, Barnes, & Tremblay, 2005) Fifty-seven percent of the sample had seven complete days of wear-time (21% had 6 days, 14% had 5 days, 8% had 4 days).

As a secondary indicator of MVPA we used a modified Godin Leisure-Time Questionnaire (Godin, Jobin, & Bouillon, 1986; Godin & Shephard, 1985). Both weekly frequency and duration of PA were provided with an open-ended assessment and the multiplicative (frequency x duration) sum of moderate and vigorous intensity minutes were used as the estimate of weekly MVPA (Courneya, Jones, Rhodes, & Blanchard, 2004).

Predictors

The instrumentation used to assess the constructs of the TPB included common items for assessment of this theory (Ajzen, 2002; Conner & Norman, 2015). Questions were framed in terms of expectations of getting 150 minutes of MVPA in a separate section that asked participants to consider their own personal PA and not necessarily PA with their family. Baseline and time 2 asked for expectations of getting MVPA over the next six weeks and time 3 asked for expectations of MVPA over the next 3 months in order to correspond with the assessment times of the trial. *Affective attitude* (unenjoyable-enjoyable, boring-exciting) and *instrumental attitude* (unwise-wise, harmful-beneficial) were measured with three semantic differential items on seven-point scales. *Subjective norm* was measured with three items comprising both the injunctive (most people who are important to me would want me to…, most people whose opinions I value would expect me to…) and descriptive (most people who are important to me will…) components of the concept with seven-point response anchors from strongly disagree to strongly agree. *Perceived behavioral control* was measured with two items through the response options of seven-point scales between strongly disagree and strongly agree. Assessment of perceived behavioral control included both of its components of capability (confident I can…) and autonomy (under my control, up to me…), with a phrase to hold motivation constant (i.e., if I really wanted to) in order to reduce any confounded assessment of motivation (Williams & Rhodes, 2014, 2016). Finally, intention strength (Rhodes & Rebar, 2017) was measured with two items (I intend…, I am committed…) using seven-point Likert response anchors from strongly disagree to strongly agree. Measures of affective attitude (time 1 α = 0.68; time 2 α = 0.86, time 3 α = 0.80, time 4 α = 0.87), instrumental attitude (time 1 α = 0.83; time 2 α = 0.81, time 3 α = 0.87, time 4 α = 0.63), subjective norm (time 1 α = 0.65; time 2 α = 0.71, time 3 α = 0.67, time 4 α = 0.75), perceived behavioral control (time 1 α = 0.68; time 2 α = 0.79, time 3 α = 0.88, time 4 α = 0.66) and intention (time 1 α = 0.68; time 2 α = 0.79, time 3 α = 0.77, time 4 α = 0.76) showed adequate internal consistency.

Assessments of the additional constructs featured in M-PAC (Rhodes, 2017) included *behavioral regulation* in the form of planning and self-reported *habit*. The behavioral regulation measure was derived and validated by Sniehotta et al. (2005) and included questions about "keeping track of PA in a diary or log", "setting short term goals", "making detailed plans about concerning "when", "where", "how", and "what" PA", "plans regarding what to do if something interfered with PA", and "reserving time in a your schedule for PA". Assessment of habit used the self-reported automaticity index (Gardner, Abraham, Lally, & De Bruijn, 2012). Responses options for both measures were on a 7-point Likert scale from (1) strongly disagree to (5) strongly agree. Reliabilities were acceptable for planning (time 1 $\alpha = 0.88$; time 2 $\alpha = 0.86$, time 3 $\alpha = 0.86$, time 4 $\alpha = 0.86$) and habit (time 1 $\alpha = 0.96$; time 2 $\alpha = 0.97$, time 3 $\alpha = 0.97$, time 4 $\alpha = 0.95$).

Procedures

The study followed procedures established in a prior pilot study (Rhodes et al., 2010) and detailed information can be found in prior published reports (Quinlan et al., 2015; Rhodes et al., 2019). This study was advertised as a family-based intervention, although child MVPA was considered the critical outcome of interest across the study data collection and during advertisement. After interested parents contacted the researcher and the family was determined to be eligible to participate in the study, the trial coordinator scheduled a baseline assessment at the University of Victoria laboratory. The baseline assessment for parents included a parent-reported questionnaire of demographic factors and the above noted predictor variables and getting setup with an accelerometer for the seven-day assessment protocol. After the completion of the accelerometry assessment, participants were randomized to one of the two conditions. Following randomization, the trial coordinator scheduled a baseline session with the family to deliver the study materials. At six-weeks and 13-weeks, the research staff met with families to drop off accelerometers, conduct a check-in

session and administer online questionnaires of the self-reported parent outcomes. Follow-up assessment was at 26-weeks with the same measures.

Statistical Analysis

Given the nested nature of the data (i.e., repeated assessments at Level-1 nested within the participants at Level-2), the primary outcomes were analyzed using hierarchical linear modeling (HLM) in HLM 6.0. Power analysis was based on the child outcomes and not the hypotheses contained within this study. Specifically, with a standard power estimation (.80) of a trend with 4 repeated assessments, one-between group factor, and an alpha of .05 suggested that a sample size of 96 could detect a small-medium effect size based on our prior pilot study (Rhodes et al., 2010) and recent meta-analysis of the family PA intervention literature (Brown et al., 2016). For each outcome, a model was entered with a random intercept (i.e., the baseline score for a given outcome), a fixed linear trend (i.e., coded 0 = baseline, 6 = 6 weeks, 13 = 13 weeks, 26 = 26 weeks to reflect the weekly change over the 26-week period), and a fixed quadratic trend at Level-1. At Level-2, condition (0 = education; 1 = planning + education) was entered to predict the intercept, linear and quadratic trends.

For the prediction analyses, missingness of the variables was inspected to determine the appropriate imputation procedures (Allison, 2002) and normality of all variables was checked to determine whether any transformations were required. Prediction of both MVPA via accelerometry and self-report (week six, week 13, week 26) used TPB constructs from the prior epoch (baseline, week six, week 13). This approach corresponded perfectly to the questionnaire phrasing. Furthermore, both prospective behavior and prospective behavior regressed upon past behavior were explored as outcomes to assess behavior and behavior change, respectively (Rhodes & Courneya, 2003). Ordinary least squares regression analyses with path analysis were used to predict MVPA during these epochs. The PROCESS macro for SPSS (Hayes, 2013) was used (5000 bootstrapped

samples) to investigate any mediation effects of the theoretical constructs between condition (education, education+planning) and MVPA if warranted from the results of the primary analyses.

For analyses using an M-PAC formulation, intention-behavior profiles were formatted to include intenders as those who scored “slightly agree (5)”, “moderately agree (6)” and “strongly agree (7)”. By contrast, those participants who answered responses that were among the “undecided (4)” and “any category of disagree (1-3)” were considered nonintenders. The approach mirrors the binary decisional intention construct used in M-PAC, as intention is not meant to represent the intensity of commitment but rather the mere direction of intended action (Rhodes & Rebar, 2017). Behavior, measured with both accelerometry and self-report, was coded as unsuccessful <150 min MVPA) and successful (>149 min MVPA) in accordance with Canadian guidelines (Tremblay et al., 2011). The categorization provides four possible quadrants of: 1) nonintenders (low intention, low inactive), 2) nonintenders who were active (low intention, active), 3) unsuccessful intenders (high intention, inactive), and 4) successful intenders (high intention, active). We further investigated any changes in behavior (decreased, stayed the same, increased) in terms of MVPA guidelines. Prediction of the category membership used logistic regression with predictors expressed as odds ratios with corresponding statistical significance and 95% confidence intervals.

Results

Participant Flow

One hundred and eighty-eight parents contacted our research coordinator about participating in the study. Of these, 102 (n = 50 education condition; n = 52 education + planning condition) were deemed eligible and completed the baseline questionnaire package, accelerometry assessment and were randomly assigned to one of the two conditions. However, of these 102 families, 42 participants in the planning + education group and 38 education group participants completed the study to the 26-week endpoint (22% attrition). Five parents did not complete the six month measures

despite the rest of the family completing the study due to family circumstances (n=3) and not wanting to complete the measures (n=2). There was a gradual continuous drop-out across the six week (8% attrition), three month (7% attrition) and six month (7% attrition) assessment times with the most common reasons being lack of interest to continue (41%), changes in family circumstances such as divorce (18%), and a child's refusal to wear the accelerometer (14%). No participants cited harms associated with the study (see Figure 1).

Baseline Characteristics of Respondents

Baseline characteristics of the parents can be found in Table 1. There were no statistically significant differences between the two groups on demographics, health indicators, or family composition. Parents had a mean age of 42 (SD = 5), and the majority (78%) of the volunteering parents were mothers. The sample was mainly white, and approximately two-thirds were university educated, while 72% were working parents. Almost half of the families were single-parent structures (41%) and just under one third (29%) had siblings participating in the trial as well. With regard to health measures, 33% of parents self-reported their health as poor or fair, 40% reported it was good, and 27% reported very good to excellent. Nine percent of the sample reported being a smoker and an equal amount reported having type 2 diabetes, six percent reported having high blood pressure, and high cholesterol and four percent reported having cancer. Baseline MVPA with accelerometry was 74.40 minutes per week (SD= 82.15; 14% of sample meeting international guidelines of 150 min) and 163.33 minutes per week (SD= 161.93; 43% of sample meeting international guidelines of 150 min) when MVPA was measured with self-report.

Handling Missing Data and Normality Assumptions

Prior to conducting the HLM analyses, preliminary analyses showed that self-reported MVPA and accelerometer-measured MVPA were kurtotic (i.e., values ≥ 2.94) at various time points in both conditions. Therefore, the data for all four time points were square root transformed

(Tabachnick & Fidell, 1996). Subjective norm was slightly kurtotic (value = 2.24) in the intervention condition at 6 weeks. As square root and log transformations did not normalize the variable, the analysis proceeded without transformation as all remaining time points were normally distributed and the variable's skewness was -1.35. For the prediction analyses, we found these data missing completely at random at six weeks [Little's test (105) = 127.56; p = .08], and 13 weeks [Little's test (88) = 82.16; p = .67], and 26 weeks [Little's test (33) = 35.75; p = .34 MVPA assessed only] when comparing to baseline measures and demographics. A more specific analysis of dummy coding a "missingness" variable at each measurement time and testing for the association with various baseline variables showed no associations among variables ($p > 05$). This suggests a more conservative missing at random estimation of these data is accurate and an imputation approach was conducted using the expectation-maximization algorithm (Allison, 2002, 2012).

Primary Outcome: MVPA

Descriptive statistics can be found in Table 2. Further, results from the HLM analyses in Table 3 showed that there was a significant linear trend for self-reported MVPA (beta = .35, p = .02) and accelerometer-measured MVPA (beta = .34, p = .00), whereas the quadratic trend was only significant for accelerometer-measured MVPA (beta = -.01, p =.01). Both trends favored increased MVPA across time. However, condition did not significantly predict the linear or quadratic trends (i.e., the change in self-reported and accelerometer derived MVPA was similar over time for both conditions).

Secondary Outcomes: Predictor Variables

Results from the HLM analyses showed that the linear and quadratic trends were non-significant for affective and instrumental attitude, habit, perceived behavioral control and subjective norm. The linear trend was significant for intention (beta = -.46, p = .01) and planning (beta = -.16) as well as the quadratic trends (intention beta = .11, p = .04; planning beta = .004, p = .00) (see

Table 2 for descriptives). Both effects showed a decline across time. None of the condition x linear trend or condition x quadratic trends were significant (i.e., the change in each predictor variable was similar over time for both conditions).

Prediction of MVPA

Given the results did not show an association between condition and MVPA or its proposed predictor constructs in the prior analyses, the sample of 102 parents was collapsed to simplify the prediction analyses. Descriptive statistics and bivariate correlations among the TPB and M-PAC constructs with MVPA can be found in Supplementary Tables 1-3. For the TPB, participants scored high on all constructs (all means > 5.5) and particularly high on instrumental attitude, subjective norm and intention (all > 6) across the trial. Attitude, subjective norm and perceived behavioral control were associated with intention (rs ranged from .20 to .50). Only perceived behavioral control at baseline (r = .20) was associated with MVPA measured via accelerometry. Perceived behavioral control was associated with self-reported MVPA across the trial (rs .21 to .33) as well as affective attitude at baseline and six weeks (rs .28 to .29) and intention at six weeks (r = .29).

The addition of the planning and habit variables for M-PAC, showed greater variance in responses among participants with means <5 (with the exception of planning at baseline). Habit at baseline and six weeks was associated with MVPA measured via acceleromentry (rs .20 to .33). Habit was also associated with self-reported MVPA across the trial (rs .36 to .51). Finally, MVPA measures derived from accelerometry and self-report were associated with each other across the trial (rs .20 to .32).

Figure 2a details the path model for the TPB predicting MVPA from baseline to six weeks, Figure 2b shows the TPB at six weeks predicting MVPA at 13 weeks, and Figure 2c details the TPB at 13 weeks predicting MVPA at 26 weeks. Intention and perceived behavioral control did not predict MVPA assessed via accelerometry at any time-point (p > .05; all 95% CIs crossed through

0). Similarly, intention did not predict self-reported MVPA at any time point ($p > .05$; all 95% CIs crossed through 0). Perceived behavioral control did not predict self-reported MVPA at six weeks or 13 weeks, but did have a significant effect at 26 weeks ($\beta = .39$; $p < .01$; 95% CI $\beta = .11$ to $\beta = .54$). Null findings ($p > .05$; all 95% CIs crossed through 0) were present when predicting the residual variance of behavior after controlling for past behavior in all six tests.

Prediction of intention fared much better than MVPA and ranged from 30% (baseline) to 39% (six weeks) explained variance. Affective attitude (baseline: $\beta = .32$; $p < .01$, 95% CI $\beta = .10$ to $\beta = .46$; six weeks: $\beta = .28$; $p < .01$, 95% CI $\beta = .14$ to $\beta = .47$; 13 weeks: $\beta = .25$; $p < .01$, 95% CI $\beta = .07$ to $\beta = .42$) and perceived behavioral control (baseline: $\beta = .26$; $p < .01$, 95% CI $\beta = .10$ to $\beta = .45$; six weeks: $\beta = .43$; $p < .01$, 95% CI $\beta = .28$ to $\beta = .61$; 13 weeks: $\beta = .44$; $p < .01$, 95% CI $\beta = .27$ to $\beta = .62$) were reliable predictors of intention across all three prediction periods. Subjective norm also predicted intention at baseline ($\beta = .24$; $p < .01$, 95% CI $\beta = .05$ to $\beta = .41$) but not at six weeks or three months ($p > .05$; all 95% CIs crossed through 0). Instrumental attitude did not predict intention at any time period.

The intention-behavior profiles created for M-PAC can be found in Table 4. Because of the very small sample sizes for nonintenders and nonintenders who were active, these participants were eliminated from further analyses. Similarly, the sample sizes of MVPA declines (accelerometry n = 5 to 8; self-report n = 4 to 11) and increases (accelerometry n = 5 to 12; self-report n = 13 to 15) around 150 min guidelines were deemed to create cell sizes too small for any formal prediction analyses.

Prediction of those who translated their intentions into behavior compared to those who did not using M-PAC constructs is presented in Table 5. There were no significant predictors of the intention-behavior profiles using accelerometry at baseline to six weeks and 13 weeks to 26 weeks (all 95% CIs crossed 1.0). By contrast, habit was a predictor of successful intenders compared to

unsuccessful intenders using accelerometry in the six weeks to 13 week epoch (OR = 1.99, $p < .01$; 95% CI 1.31 to 3.04). Habit was also the significant predictor of intention and self-reported MVPA profiles at all time periods (baseline to six weeks: OR = 1.60, $p < .05$; 95% CI 1.18 to 2.17; six weeks to 13 weeks: OR = 2.08, $p < .01$; 95% CI 1.33 to 3.26; 13 weeks to 26 weeks: OR = 1.88, $p < .01$; 95% CI 1.20 to 2.93). Explanation of the intention-behavior profiles ranged from five percent to 27% using accelerometry and from 23% to 37% using self-report (Nagelkerke R^2 estimation).

Discussion

The purpose of this study was to examine the "spillover" effect of two family interventions targeting inactive children on their parents' personal MVPA. The interventions included comparing an education group (receiving information about the benefits of MVPA) to an education +planning group (receiving additional information on planning for PA for their child) over 26 weeks. We hypothesized that the planning+education condition may show higher parental MVPA over time due to the application of additional planning skills learned. We saw no support for this hypothesis; however, both conditions did increase MVPA over the 26 week intervention. This increase was not mimicked in our putative mediators of MVPA measured using TPB and M-PAC. Indeed, intention strength and planning decreased across the trial.

These findings prove interesting because the results show support for the premise of a spill-over effect of parents participating in a family intervention for their children similar to some other research on this topic (e.g. Flynn et al., 2017; Morgan et al., 2011; Morgan et al., 2018), yet the additional intensity in the planning+education group was not more effective than the education condition. It may be that mere volunteerism was the catalyst for change but this is difficult to conclude in the absence of a no contact control condition and any coinciding mediators that showed similar increases across time. The decrease in intention and planning across time is also contrary to the increase in MVPA, suggesting these variables were not sensitive to the behavioral changes.

These decreases are likely due to a response shift from a more fulsome experience with MVPA as performance of the behavior began after the initial anticipation of the intervention (Campbell, 1957). Still, from a practical standpoint, the results support the existence of spill-over, making family interventions a useful PA promotion intervention for parents. Future family intervention research may improve upon this effect by targeting intervention components for parental MVPA.

Building from this recommendation, the secondary aim of the study was to examine the predictors of parental MVPA in order to inform future interventions. We used the TPB (Ajzen, 1991) and M-PAC (Rhodes, 2017) to predict MVPA. TPB suggests that intention is formed via affective and instrumental attitudes, subjective norm, and perceived behavioral control (Ajzen, 1991; Fishbein & Ajzen, 2010); however, meta-analysis has shown that affective attitude and perceived behavioral control are the most reliable predictors (McEachan et al., 2016). Our results replicated this finding. Affective attitude and perceived behavioral control were consistent predictors of intention across the trial in the medium effect size range (Cohen, 1992), while subjective norm and instrumental attitude were not. The critical importance of perceived behavioral control among parents with dependent children in the home has been well established in prior PA research (Deflandre et al., 2004; Hinton & Olson, 2001; McIntyre & Rhodes, 2009; Pereira et al., 2007; Rhodes, Blanchard, Benoit, Levy-Milne, et al., 2014). Thus, targeting underlying control beliefs (Hamilton & White, 2011; Rhodes, Blanchard, Benoit, Naylor, et al., 2014) is likely an essential aspect of any intervention upon intention with this demographic. Little research has been done on promoting PA affective attitude (Rhodes, Gray, & Husband, 2018), but a focus on the mental health aspects of MVPA to assist with the stress of the parenting experience has been identified as the critical behavioral belief to target (McIntyre & Rhodes, 2009; Rhodes, Blanchard, Benoit, Naylor, et al., 2014).

TPB suggests that behavior is the product of intention and perceived behavioral control, to the extent it represents a proxy of actual control (Ajzen, 1991; Fishbein & Ajzen, 2010). Contrary to this expectation, we found that intention could not predict MVPA across the trial (measured via accelerometry or self-report) and perceived behavioral control predicted MVPA in only one of six tests. The finding is discrepant with meta-analysis results, which generally show that intention can reliably predict PA in the medium effect size range (McEachan et al., 2011). We believe these differences relate to the sample in our study and represent what is typically referred to as the intention-behavior gap (Sheeran & Webb, 2016). Specifically, all of our participants were volunteering to engage in a family PA trial and thus had, by nature of this process, an intention to be active in some capacity (Rhodes & Rebar, 2017). Thus, there was little variance in intention that could explain MVPA compared to observational samples in the community that include a wider range of people with disparate intentions. This is evidenced by the baseline mean of intention in our sample of 6.21 out of seven (SD = 0.68). It would seem that intention scores were sensitive enough to vary with its purported social cognitive predictors (e.g., affective attitude, perceived behavioral control), but not sensitive enough to predict MVPA.

With the limited range of intention in the sample, the focus on understanding action control (i.e., the translation of intention into behavior) with the constructs of M-PAC (Rhodes, 2017) appeared warranted. Creation of the intention-behavior profiles for this approach showed that nearly the entire sample was comprised of intenders and thus could be separated into those who succeeded in their MVPA intentions and those who did not. The intention behavior gap ranged from 28% to 34% for self-reported MVPA and from 62% to 79% for MVPA via accelerometry. These estimates are within the range of a meta-analysis on the PA intention behavior gap (Rhodes & de Bruijn, 2013), but show there is clearly a smaller gap when people self-report versus direct assessment of MVPA. To our knowledge, this is the first reported intention-behavior gap analysis using

accelerometry and it is interesting to note that the gap may be even larger than prior estimates if one assumes that accelerometry is the more accurate measure of MVPA.

Prediction of MVPA using M-PAC showed that those parents who reported higher levels of habit were more likely to follow through with their intentions of self-reported MVPA compared to those who reported lower habit. The effect was in the small to medium-sized range (Chen, Cohen, & Chen, 2010). To our knowledge, this is the first application of the habit construct within a sample of parents with dependent children, showing the potential utility of the construct for this population. This predictive effect, however, was replicated in only one of the three tests of MVPA measured via accelerometry across the trial. Like the TPB, M-PAC was generally unable to account for directly assessed MVPA. This may be a result of incidental lifestyle behavior. Both theoretical approaches build from the conception that behavior is initially planned, and Rhodes (2017) delimits that incidental behavior is not a good fit for the application of M-PAC because its entire premise is based on closing the intention-behavior gap. Thus the noted discrepancy in this study may be in part from the behavioral assessment technique because total PA (incidental and planned) is captured in accelerometry compared to retrospectively self-aware behavior that is assessed in self-report (Troiano, McClain, Brychta, & Chen, 2014). By contrast, self-reported behavior and habit associations may be merely advantaged via common methods bias. It should be noted that the correlation between accelrometry and self-reported MVPA was significant yet modest throughout the trial (rs .20 to .34) and habit did have a significant ($p < .05$) bivariate correlation with accelrometry in two of three tests. Thus, there is some overall evidence that habit was linked to both measures of MVPA.

Regardless of assessment technique, the lack of MVPA prediction from behavioral regulation (planning, self-monitoring) across the trial is noteworthy. This construct is generally seen as the hallmark of almost all action control theories (Rhodes & Yao, 2015), so our results are

discordant with prior research (Kwasnicka, Presseau, White, & Sniehotta, 2013; Rhodes, Grant, & De Bruijn, in press; Zhang et al., in press). Still, the finding complements our null results for the primary objective of this study, as an intervention focused on planning would conceivably have little effect on behavior if it was not a correlate of behavior within the sample. From a M-PAC perspective, Rhodes (2017) suggests that an established/maintained pattern of action control will be strongly determined by reflexive factors such as habit, and behavioral regulation will be more important during the adoption of the behavior as individuals attempt to regulate the new behavior into their lifestyle. This is in line with dual-process theories that suggest the default condition in behavioral performance is that of reflexive processes because they are the most efficient (Evans & Stanovich, 2013; Strack & Deutsch, 2004). Habit is seen as a critical mechanism for increasing action control efficiency (Rhodes & Rebar, 2018). Thus, it may be that parents' action control was largely dependent on existing habits and not through volitional attempts to change behavior given that only a small number of participants were altering their MVPA each epoch. Regardless, the current findings support interventions focused on building MVPA habits. This literature is sparse at the moment but a focus on building consistency in participants' PA practice with critical cues to action that precede the behavior is recommended in an attempt to build the learned cue-behavior associations responsible for habits (Gardner & Rebar, 2019).

Despite the novel findings in our study and the strong methods employed, there are noteworthy limitations. The sample of families was mainly white, middle income, and educated. While many of these features do represent Victoria (Statistics Canada, 2017), the generalizability to other regions worldwide is unknown. Second, the parents were not delimited by MVPA (e.g., < 150 min) as an inclusion criteria and thus some of the parents (14% using baseline accelerometry; 43% using baseline self-report) were physically active above public health guidelines at baseline. This ceiling effect may have been partly responsible for the null findings in objective one and highly

motivated sample noted in objective two. Third, while our measurement of the predictor variables had generally acceptable reliability, there were some circumstances where measures had internal consistencies just below rule of thumb (i.e., .70) which may compromise the findings, and the measurement of habit via self-report is an ongoing controversy although no alternative has yet been validated (Rebar, Gardner, Rhodes, & Verplanken, in press). Finally, the predictor models for TPB and M-PAC did not include some of the specific variables noted in their extended approaches. Specifically, a separation of subjective norm (injunctive norm and descriptive norm) and perceived behavioral control (autonomy, capability) may be useful for future applications of the reasoned action approach (Fishbein & Ajzen, 2010) and the separation of perceived behavioral control (capability, opportunity) and addition of identity may be useful for future tests of M-PAC (Rhodes, 2017).

Overall, our results showed that the two family interventions focused on increasing child PA were associated with increased parental MVPA, but there was no difference between these intervention groups and no effect on the putative mediators from the TPB or M-PAC to explain the increases. The findings demonstrate there may be a "spillover" effect within the family intervention context that is used by parents as a springboard to improve their own PA but its mechanism was not identified. The TPB was unable to predict MVPA across the study. Application of M-PAC showed this was likely because nearly all participants possessed the intention to be physically active. The predictor of successful- compared to unsuccessful-intenders was the presence of a stronger habit, but not the use of behavioral regulation tactics such as planning. Thus, the promotion of habit to assist in action control (i.e., translation of intentions into behavior) is recommended for future research in this population.

Ethics approval and consent to participate: The study was approved by the University of Victoria Human Research Ethics Board and informed consent was provided from all participants.

Figure Captions

Figure 1: Participant Flow

Figure 2: Prediction of MVPA using the theory of planned behavior (A) baseline to six weeks; (B) six weeks to 13 weeks; and (C) 13 weeks to 26 weeks. Note: slotted lines = $p > .05$; full lines = $p < .05$. Upper coefficient represents accelerometry MVPA as dependent variable and the lower coefficient represents self-reported MVPA as the dependent variable.

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Table 1
Parent Demographic and Health Profile

Characteristic	Education Condition (n = 50)	Education + Planning Condition (n = 52)	p-Level
Target Parent Demographic Profile			
Age Mean (SD)	42.96 (5.71)	42.17 (5.68)	.50
% Female	83.0	75.5	.36
% Visible Minority	17.0	7.7	.16
% Completed University	60.4	67.9	.43
% Married/Common-law	70.8	69.2	.86
% >$74,000 CAN Family Income	56.1	56.3	.99
% Currently Employed	70.8	73.6	.76
Family Profile			
% of single-mother families in the trial	37.7	35.6	.72
% of single-father families in the trial	8.7	6.8	.63
% of families with siblings in the trial	28.9	28.8	.98
Target Parent Health Profile			
Self-reported health Mean (SD)	2.49 (1.04)	3.19 (0.89)	.11
% Smoker	8.3	9.4	.85
% with diabetes	8.9	8.3	.93
% with cancer	4.3	4.0	.95
% with high blood pressure	6.5	6.1	.94
% with high cholesterol	11.4	2.0	.09
Target Child Profile			
Age	9.10 (1.90)	8.77 (2.25)	.43
% Female	54.0	50.0	.67

Table 2
Descriptives statistics across physical activity, theory of planned behavior, and multi-process action control constructs by experimental group.

	Planning + Education				Education			
	Mean (Standard Deviation)				Mean (Standard Deviation)			
	Baseline	6 weeks	12 weeks	24 weeks	Baseline	6 weeks	12 weeks	24 weeks
Affective Attitude	5.72 (.99)	5.67(1.08)	5.88(.76)	5.85(.91)	5.52(1.00)	5.58(.89)	5.69(1.01)	5.60(.88)
Habit	3.99 (1.92)	3.82(1.88)	3.94(1.73)	4.38(1.68)	3.12(1.41)	3.22(1.49)	3.69(1.66)	3.91(1.41)
Instrument Attitude	6.63 (.58)	6.63 (.47)	6.69 (.46)	6.50 (.58)	6.67 (.47)	6.57 (.48)	6.69 (.47)	6.70 (.43)
Intention Strength	6.15 (.67)	5.45 (.97)	5.48 (1.03)	5.93 (1.18)	6.26 (.69)	5.91 (.72)	5.88 (.77)	5.91 (.98)
PBC	5.91 (.66)	5.50 (.87)	5.67 (.89)	5.93 (.87)	5.88 (.68)	5.47 (1.01)	5.79 (.91)	5.63 (1.06)
Planning	5.58 (1.12)	4.73 (1.32)	4.44 (1.24)	4.43 (1.44)	5.79 (.96)	4.63 (1.45)	4.75 (1.38)	4.46 (1.36)
Subjective Norm	5.89 (.88)	5.81 (.88)	5.79 (.74)	5.83 (.82)	6.19 (.64)	5.85 (.88)	6.07 (.66)	5.93 (.73)
Self-reported MVPA	191.9(160.2)	180.6(163.3)	187.1(152.8)	257.2(220.8)	133.6(159.9)	158.6(135.6)	180.9(122.2)	205.8(159.9)
MVPA Accelerometer	92.77(94.05)	112.9(117.1)	100.2(91.8)	90.1(83.3)	54.9(62.5)	83.5 (102.6)	107.4(93.9)	104.6(106.1)

Note: MVPA is expressed in weekly minutes when the activity was completed for at least a 10 minute bout.

Table 3
Results from hierarchical linear model analyses

	AA	IA	Habit	Intention	PBC	SN	BR	MVPA (SR)[1]	MVPA (Accel)[1]
	B (p value)	B (p value)	B (p value)	B (p value)	B (p value)	B (p value)	B (p value)	B (p value)	B (p value)
Intercept	5.51 (.00)	6.65 (.00)	3.09 (.00)	6.26 (.00)	5.83(.00)	6.15 (.00)	5.73 (.00)	9.47 (.00)	5.71 (.00)
Condition	.19 (.32)	-.02 (.85)	.91(.01)	-.11 (.41)	.06 (.68)	-.27 (.07)	-.16 (.45)	2.65 (.04)	2.41 (.02)
Linear	.01 (.70)	-.01 (.50)	.04 (.35)	-.46 (.01)	-.02 (.30)	-.03 (.08)	-.16 (.00)	.35 (.02)	.34 (.00)
Condition	-.01 (.71)	.02 (.23)	-.02 (.71)	-.48 (.10)	-.02 (.48)	.03 (.32)	.02 (.68)	-.26 (.16)	-.21 (.23)
Quadratic	-.0002 (.81)	.001 (.38)	-.0002 (.86)	.11 (.04)	.001 (.41)	.001 (.18)	.004 (.00)	-.01 (.16)	-.01 (.01)
Condition	.001 (.67)	-.001 (.10)	.0001(.94)	.18 (.06)	.001 (.29)	-.001 (.44)	-.001 (.68)	.01 (.33)	.004 (.51)

Note. * $p < .05$; ** $p < .01$; B = beta; Condition is coded [0 = education; 1 = planning + education]; AA = affective attitude; IA = instrumental attitude; PBC = perceived behavioral control; SN = subjective norm; BR = behavioral regulation; MVPA = moderate to vigorous physical activity; SR = self report; Accel = accelerometer;
[1] Self-reported MVPA and accelerometer measured MVPA were square root transformed prior to analysis

Table 4
Intention-MVPA profiles across baseline to 26 weeks

	Nonintenders (n)	Nonintenders who were active (n)	Unsuccessful intenders (n)	Successful intenders (n)
Baseline intention to six week MVPA				
MVPA Accelerometry	1	0	80	21
MVPA Self-report	1	0	47	54
Six week intention to 13 week MVPA				
MVPA Accelerometry	5	1	74	22
MVPA Self-report	6	0	34	62
13 week intention to 26 week MVPA				
MVPA Accelerometry	7	0	75	20
MVPA Self-report	4	4	32	62

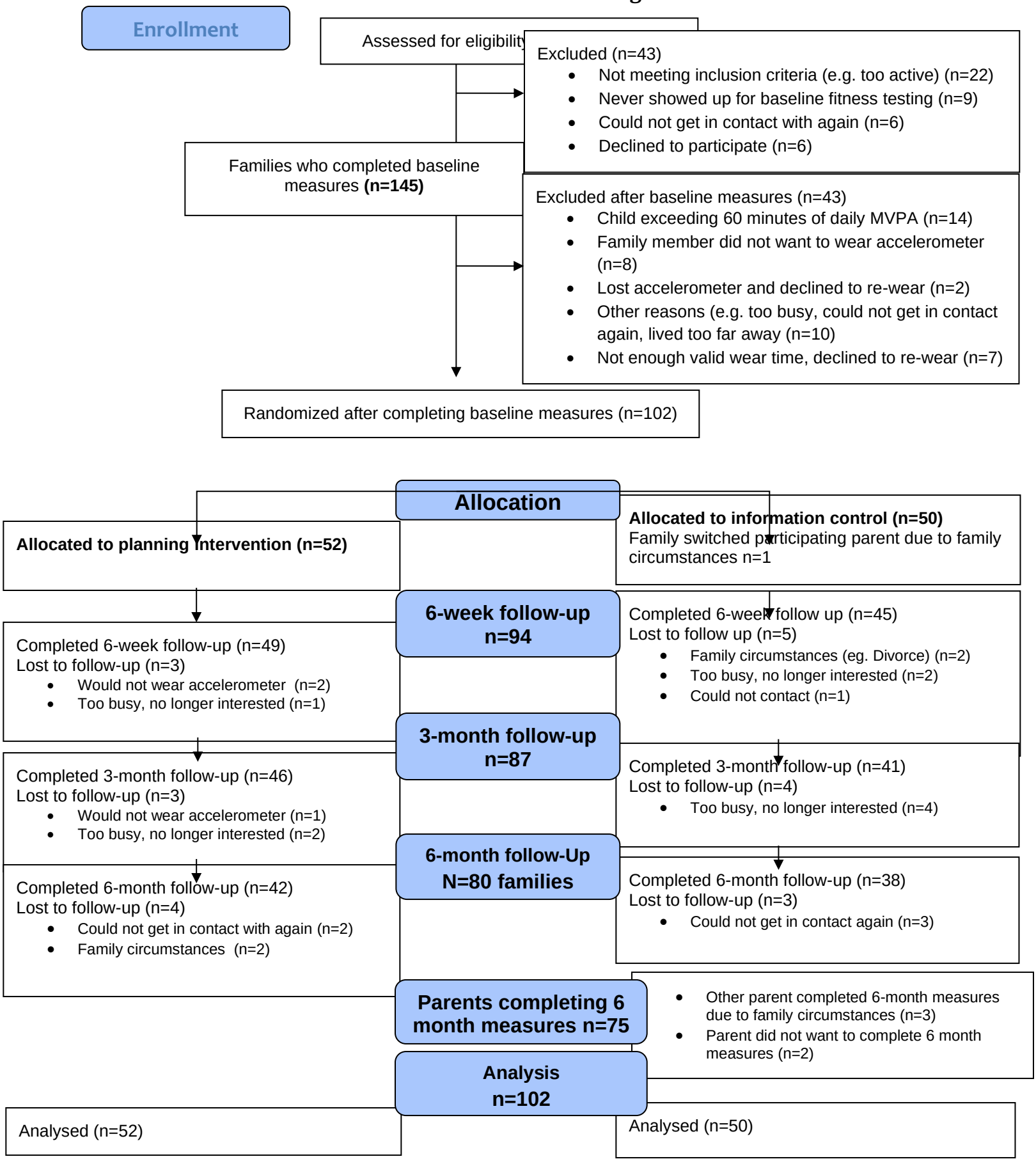
Table 4.
Prediction of Intention-Behavior Profiles Meeting the Physical Activity Guidelines for Accelerometry and Self-Reported Behavior using Multi-Process Action Control Variables

	Intention-Behavior Profiles		χ^2	R^2	OR	95% CI
	Unsuccessful Intenders	Successful Intenders				
Accelerometry Baseline to Six Weeks			3.34	0.05		
Affective Attitude	5.60 (1.02)	5.83 (0.75)			1.32	0.72 to 2.40
Instrumental Attitude	6.66 (0.53)	6.63 (0.52)			1.15	0.39 to 3.40
Perceived Control	5.87 (0.65)	6.05 (0.69)			1.55	0.65 to 3.70
Planning	5.73 (0.99)	5.64 (1.14)			0.78	0.46 to 1.32
Habit	3.50 (1.69)	3.92 (1.63)			1.08	0.79 to 1.48
Accelerometry Six Weeks to 13 Weeks			18.58*	0.27		
Affective Attitude	5.57 (0.94)	5.92 (0.67)			1.08	0.51 to 2.31
Instrumental Attitude	6.60 (0.36)	6.70 (0.39)			1.77	0.48 to 6.08
Perceived Control	5.59 (0.76)	5.70 (0.59)			0.92	0.40 to 2.11
Planning	4.84 (1.16)	4.62 (1.28)			0.79	0.46 to 1.34
Habit	3.30 (1.41)	5.79 (1.47)			1.99*	1.31 to 3.04
Accelerometry 13 Weeks to 26 Weeks			4.53	0.07		
Affective Attitude	5.67 (0.88)	5.80 (0.59)			1.24	0.57 to 2.66
Instrumental Attitude	6.70 (0.35)	6.66 (0.42)			0.87	0.21 to 3.53
Perceived Control	5.85 (0.55)	5.76 (0.74)			0.69	0.28 to 1.69
Planning	4.75 (0.94)	4.39 (1.13)			0.69	0.41 to 1.16
Habit	3.82 (1.38)	4.25 (1.51)			1.23	0.80 to 1.91
Self-Report Baseline to Six Weeks			21.73*	0.26		
Affective Attitude	5.39 (1.09)	5.86 (0.80)			1.65[a]	0.98 to 2.81
Instrumental Attitude	6.74 (0.41)	6.66 (0.48)			0.94	0.38 to 2.32
Perceived Control	5.80 (0.66)	6.00 (0.64)			1.49	0.69 to 3.24
Planning	5.97 (0.81)	5.77 (1.05)			0.77	0.47 to 1.27

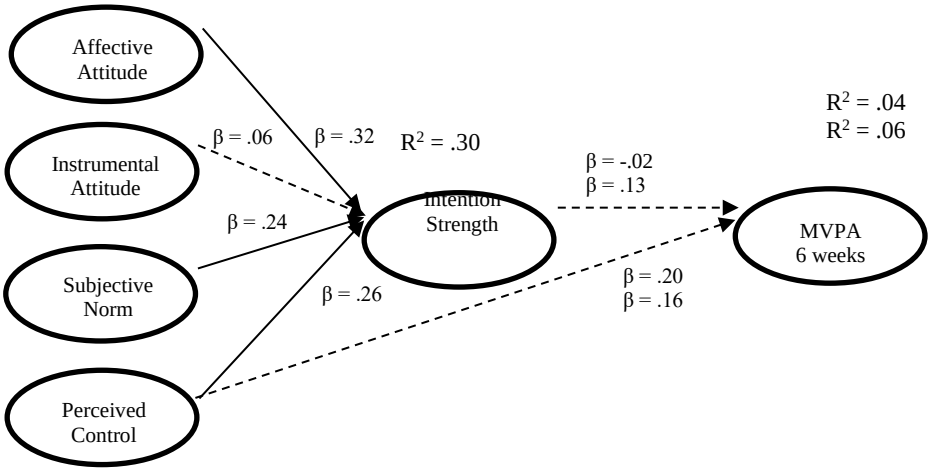
Habit	2.88 (1.39)	4.20 (1.68)			1.60*	1.18 to 2.17
Self-Report Six Weeks to 13 Weeks			30.22*	0.37		
Affective Attitude	5.37 (1.05)	5.80 (0.77)			1.58	0.83 to 3.01
Instrumental Attitude	6.62 (0.39)	6.62 (0.36)			0.73	0.17 to 3.14
Perceived Control	5.43 (0.70)	5.71 (0.72)			1.75	0.81 to 3.76
Planning	5.02 (1.13)	4.67 (1.21)			0.65	0.40 to 1.05
Habit	2.65 (1.16)	4.19 (1.46)			2.08*	1.33 to 3.26
Self-Report 13 Weeks to 26 Weeks			16.96*	0.23		
Affective Attitude	5.60 (0.89)	5.78 (0.76)			0.79	0.40 to 1.57
Instrumental Attitude	6.76 (0.34)	6.65 (0.38)			0.50	0.12 to 2.06
Perceived Control	5.67 (0.58)	5.93 (0.58)			1.79	0.78 to 4.13
Planning	4.55 (1.03)	4.75 (0.96)			1.40	0.80 to 2.44
Habit	3.25 (1.37)	4.29 (1.29)			1.88*	1.20 to 2.93

Note: *=p<0.05; a = p <.10. R^2 = Nagelkerke R^2. Unsuccessful intenders (baseline to six weeks Accelerometry n = 80, Self-Report n = 47; six weeks to 13 weeks Accelerometry n = 74, Self-Report n = 34; 13 weeks to 26 weeks Accelerometry n = 75; Self-Report n = 32), Successful intenders (baseline to six weeks Accelerometry n = 21, Self-Report n = 54; six weeks to 13 weeks Accelerometry n = 22; Self-Report n = 62; 13 weeks to 26 weeks Accelerometry n = 20; Self-Report n = 62).

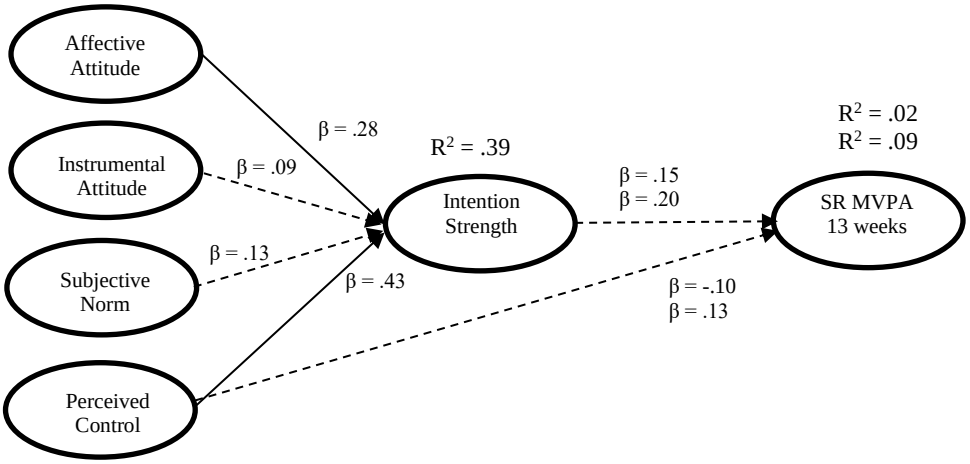
CONSORT 2010 Flow Diagram



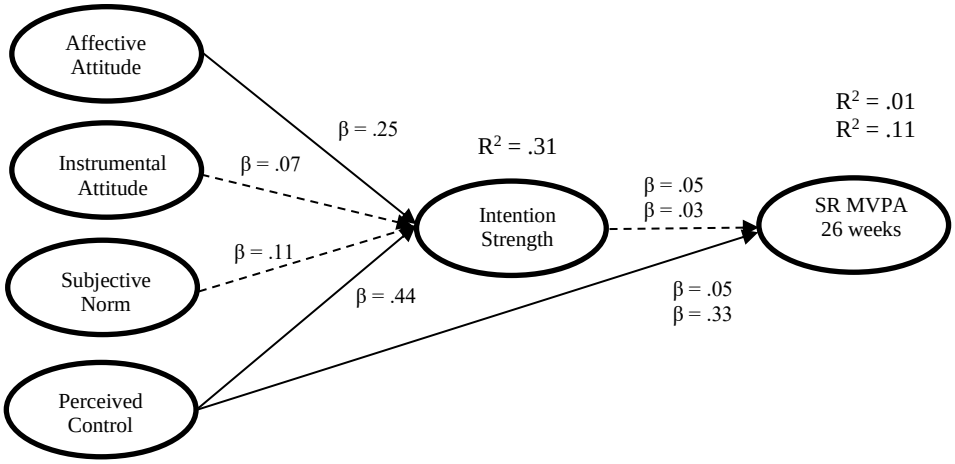
A)


Affective Attitude
Instrumental Attitude
Subjective Norm
Perceived Control
β = .06
β = .32
β = .24
β = .26
R² = .30
Intention Strength
β = -.02
β = .13
R² = .04
R² = .06
MVPA 6 weeks
β = .20
β = .16

B)


Affective Attitude
Instrumental Attitude
Subjective Norm
Perceived Control
β = .28
β = .09
β = .13
β = .43
R² = .39
Intention Strength
β = .15
β = .20
R² = .02
R² = .09
SR MVPA 13 weeks
β = -.10
β = .13

C)


Affective Attitude
Instrumental Attitude
Subjective Norm
Perceived Control
β = .25
β = .07
β = .11
β = .44
R² = .31
Intention Strength
β = .05
β = .03
R² = .01
R² = .11
SR MVPA 26 weeks
β = .05
β = .33