Predicting family and child physical activity across six-months of a family-based intervention: An application of theory of planned behavior, planning and habit

Ryan E. Rhodes, Alison Quinlan, Patti-Jean Naylor, Darren E. R. Warburton, & Chris M. Blanchard

2021

The final publication is available at:

https://doi.org/10.1080/02640414.2021.1877460

Running Head: Predictors of Family Physical Activity

Predicting Family and Child Physical Activity across Six-Months of a Family-Based Intervention: An Application of Theory of Planned Behavior, Planning and Habit

Ryan E. Rhodes[1], Alison Quinlan[1], Patti-Jean Naylor[1], Darren E.R. Warburton[2], Chris M. Blanchard[3]

Affiliations: [1]University of Victoria, Victoria, Canada, [2]University of British Columbia, Vancouver, Canada, [3]Dalhousie University, Halifax, Canada

Address correspondence to: Ryan E. Rhodes, Ph.D., Behavioural Medicine Laboratory, School of Exercise Science, Physical and Health Education, PO Box 3010 STN CSC, University of Victoria, Victoria, B.C., V8W 3N4 CANADA, Tel: (250) 721-8384, Fax: (250) 721-7767, EM: rhodes@uvic.ca

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.
Financial Disclosure: The authors have no financial relationships relevant to this article to disclose.
Conflicts of Interest: The authors have no conflicts of interest relevant to this article to disclose.
Funding Source: The trial was funded by the Canadian Institutes for Health Research (#119536)
Author Contributions: RER wrote the paper and conducted analyses, AQ, PJN, CMB, and DERW, all contributed to the trial design and the editing of the final paper.
Registered Trial: clinicaltrials.gov # NCT01882192

Abstract

Background: Family-based physical activity (PA) interventions have proven effective in modifying physical activity; yet, the mechanisms underlying behavioral performance are currently unclear. In this study, we follow-up upon prior trial data that showed changes to child moderate-to-vigorous PA (MVPA) as a result of a family education+planning intervention compared to an education only condition. We examined parents' perceived family PA frequency, family PA social cognitions, and family PA habit over the 26 weeks between the two conditions. **Methods**: One hundred and two parents (of children aged 6 to 12 yrs), were recruited through advertisements and randomized to either a planning + education condition (n = 52) or an education only condition (n = 50) designed to improve child MVPA. Self-reported family PA, social cognition (measured by theory of planned behavior, planning intention, habit) were completed by the contact parent at baseline, six-week, 13-week, and 26-week time-periods. **Results:** The education+planning intervention increased planning intention ($p < .01$) and family PA ($p = .06$) compared to the education only group. The effect of condition on the putative mediators did not explain these changes (all 95% CIs crossed 0), and family PA was associated with child MVPA only at 13 weeks ($p < .01$). Intervention assignment had a small indirect effect on family PA (favoring the education+planning group) via Habit. Perceived behavioral control and habit were consistent predictors of family PA ($p < .05$), but not PA intention or planning intention ($p > .05$). **Conclusions:** The planning+education intervention showed improved family PA and planning intention, yet the null mediation results suggest that other variables from the family system (e.g., child motivation, other parent's motivation and plans) are likely needed to fully understand the intervention effects. The promotion of perceived behavioral control and habit to assist in family PA is recommended for future research in this population. **Registered Trial**: clinicaltrials.gov # NCT01882192

Keywords: Planning, Exercise, Habit, Theory of Planned Behavior

Introduction

Engaging in regular physical activity (PA) during childhood is associated with better physical and mental health profiles [1,2], yet few are active enough to optimize these health outcomes [3]. A child's behavior is inter-connected within the structure and function of the family system [4] and thus parents represent critical enablers of child PA [5]. Family-based PA interventions that focus on promoting child PA by involving parents and their children as stakeholders have generally been successful at increasing child PA (SMD = 0.29), yet the range of effectiveness considerably hetergeneous (95% CI 0.14 to 0.45) [6].

Understanding and intervening upon child PA within the family has frequently applied social cognitive approaches [7], such as the theory of planned behavior (TPB)[8]. This approach positions intention as the proximal determinant of action, and intention is subsequently co-determined by attitudes (expectations about behavioral outcomes), subjective norm (perceptions of social pressure to perform a behavior), and perceived behavioral control (perceptions of capability and autonomy to enact a behavior). Thus far, educational interventions targeting the attitudes of parents with information about the health benefits of child PA to increase parental support for their children's PA have not been effective [6]. Further, parents often have very high intentions to assist their children in PA, but this goes unrealized in almost half these cases [9,10]. This "intention-behavior gap" is duly recognized in PA research [11] and unsurprising because positive intentions would have presumably influenced the initial decision to even participate in a PA intervention [12]. Instead, interventions that empower parents with skills on "how" to enact physical activity, rather than reasons "why", have been effective [6]. This mimics more recent advances in theory beyond basic social cognitive intention formation approaches e.g., [13], where the binding of intention to behavior is considered a consequence of sound planning and self-regulation tactics [14,15], potentially followed by determinants such as the development of habits [16,17].

While review of the behavior change techniques in family-based interventions can assist in an understanding of the mechanisms underlying behavior change, mediation analysis is also useful [18]. PA performed in a trial is often not a sole function of the intervention itself, so it is helpful to understand predictors of PA independent of intervention assignment [19]. There is ample observational research to demonstrate that parental support (e.g., encouragement, logistical support, co- physical activity) is linked to child PA [20,21], yet there is extremely limited, and mixed

evidence about family-based predictors and mediators of child PA in interventions. For example, Brown et al. [22] showed that family-related variables were not predictive of child PA in three of four intervention studies reviewed. This finding was supported by a more recent trial which also found no link between change in child PA and parental support or parental access to home and local PA facilities [23]. By contrast, Morgan et al. [24] showed that family co-participation in PA mediated the family intervention and child PA association. Co-PA is an important outcome in most family PA interventions [25] so this is a promising finding. Still, the relationship between parental involvement variables and child PA in family interventions is poorly understood and there is no information about the underlying predictive mechanisms such as parental motivation, planning, or family PA habits.

Therefore, the purpose of this study was to examine parent's perceived family PA frequency (co-physical activity), family PA social cognitions, and family PA habit over the course of a family planning intervention. The primary outcome of the original randomized controlled trial was children's (aged 6-12 years) MVPA and the results showed that children in a a planning+education group had higher MVPA, measured using accelerometry, at six-weeks, and 13 weeks compared to an education-only group, though both conditions returned to similar values at 26 weeks [26]. We hypothesized (H1), similar to the child MVPA outcomes, that the education+planning condition would show higher parent-reported family PA and planning intention because this was the key focus of the intervention. We also explored whether family PA habit increased in the planning+education group compared to the education group, because self-regulation and behavior change are theorized as key antecedents of habit development [16,17].

As a null hypothesis (H2), we expected that the education+planning intervention would not affect social cognitive variables of the TPB; [8] compared to the education only condition. This hypothesis was formed based on the post-intentional/action control theoretical focus of the planning+education intervention [27], which suggests that intention and its antecedents are already a pre-requisite of entry into the trial and follow-through of intentions is based on self-regulatory tactics (e.g., planning) and habit (learned cue-based responses). Thus, affective attitude (expectations that family PA will be enjoyable), instrumental attitude (expectations that family PA will be useful), subjective norm (perceptions of social pressure to perform family PA from others), perceived behavioral control (perceptions of capability and autonomy to enact family

PA), and intention (commitment to enact family PA) were not expected to differ by experimental group across the intervention.

An additional aim of the study was to examine the predictors of family PA across time and any theoretical mediators of the intervention. We used an augmented TPB [8] to predict PA (see Figure 1). Briefly, child MVPA was expected to be predicted by family PA because family PA is conceived as one of the forms in which a child is active [24]. In turn (H3), we hypothesized that planning intention[28] would predict family PA, and this sequencing (planning intention to family PA to child MVPA) would collectively mediate the relationship between the intervention conditions and child MVPA. This follows prior theoretical models that propose regular PA is -determined by self-regulation tactics [14]. We further explored whether the intervention also had an indirect effect upon family PA via habit, because habit has also been theorized as a co-determinant with self-regulation in predicting PA[16,17].

Finally, we hypothesized (H4) that perceived behavioral control over family PA, and family PA intention would predict family PA independent of the intervention conditions. This theorizing is based on past research that has shown the importance of motivation (intention) and perceptions of capability and opportunity (perceived behavioral control) in predicting family PA [29,30]. We hypothesized that affective attitude, subjective norm, and perceived behavioral control would predict family PA intention based on past research with the TPB [31], but these variables would be unrelated to the intervention condition because the main behavior change techniques were focused on post-intentional planning.

Methods

The full detailed methods for this study have been reported elsewhere [26,32,33]. We followed the consolidated standards of reporting trials statement for this study [34].

Design

The trial featured a two-arm parallel design where participants were randomized and allocated using a 1:1 ratio to one of two groups after baseline assessment: 1) family PA planning + information/education; or 2) PA information/education only. Participants were assessed at six-weeks, 13-weeks, and 26-weeks. Participants were aware of the condition they were in, but blind to the other condition, while initial recruiters were blinded to treatment allocation (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 booths at local markets, advertisements, recreation centers, and through passive materials sent to local schools. Families were also recruited through referrals, whereby the recruiting family received a $25 CAN grocery store gift card. Study recruitment, retention, and assessment numbers for children and their parent contact can be found in Rhodes et al. [26,33]. Briefly, One hundred and two participants who met the study inclusion criteria and completed the baseline assessments were randomly assigned to one of the two conditions (n = 52 planning + education; n = 50 education). Of these, 42 participants in the planning + education group and 38 education group participants completed the study to the six-month endpoint (22% attrition), which included a gradual continuous drop-out across the six week (8% attrition), three month (7% attrition) and six month (7% attrition) assessment times. Five parents did not complete the six month measures despite the rest of the family completing the study due to family circumstances (n=3) and not wanting to complete the measures (n=2). Attrition numbers were not significantly different ($p > .05$) across the groups.

Inclusion criteria**.** Participants were children (aged 6-12 years) who did not meet international PA guidelines of at least 60 minutes of MVPA per day [35], based on self-report screening and baseline accelerometry and their least active parent (lowest MVPA at baseline). While all members of the family were invited to participate in the intervention, only the one child and one parent were designated for measurements.

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

Procedures

The study followed procedures established in a prior pilot study [36] and detailed information can be found in prior published reports [26,32]. The lead trial coordinator consulted on the study protocol with all research assistants to ensure the protocol was standardized. 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. A member of the research team overviewed the

instructions for wearing the device and ensured the belts were the appropriate size for participants. 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. As an incentive for families to complete all assessments, an honorarium was provided upon pick-up of the accelerometers starting at $25 at baseline and increasing by $5 at each time point.

Intervention

Details of the intervention can be found in previous publications [26,32,33]. In short, a research assistant delivered intervention materials face-to-face after the baseline accelerometry assessment. Both conditions received the Canadian Physical Activity Guidelines [35] handout, which outlined adult and child MVPA guidelines. PA intensity was discussed and examples were provided.

The PA information/education only condition received a booklet outlining the benefits of PA for the whole family and common barriers and solutions to get children active [36]

The planning condition received the same information/education material as well as 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 [37,38]. The expectation was ongoing use of this material 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. The check-in sessions included discussion on whether families have been using the materials, if they have been able to incorporate physical activity, if they have been experiencing any challenges and how they might overcome those challenges.

Outcomes

The primary outcome of the overall trial was child MVPA measured via accelerometry [26]. This variable has been carried over to the present study as the criterion dependent variable in the prediction equations only. An Actigraph GT3X accelerometer was used with single axis enabled to assess the participants, who wore it on an elastic belt above the right hip for seven consecutive days for at least 10 hours a day (only removing for water activities or showering). All participants were asked to complete a logbook, recording the dates worn, if the device was removed, and what their day roughly looked like including any physical activities. Logbooks were used to confirm the accelerometer data matched what was reported by participants. If a discrepancy was noted, such as dates not matching what was recorded on the device with what was recorded on the logbook, this was adjusted to reflect the appropriate dates.

Accelerometers were initialized to collect pre-filtered data at a sample rate of 30 Hz for the children and were downloaded into 10-second epochs to capture the sporadic nature of child PA [39,40]. 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 [40,41]. For determining valid wear time, the Troiano [42] 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. Child MVPA was determined using the Evenson [43] cutpoints based off of recommendations from Trost et al. [44]. Data was modelled so that all participants had a complete seven-day data-set. Data were modelled by taking the average of the valid days and inputting those averages for the missing days within participants [45].

Predictor Variables

The parent referent completed all questions about family-based PA. Family-based PA was defined in the questionnaires as "at least one parent and at least one child together, accumulating at least 30 minutes of activity, 4 times per week or more during your free time". This is an admittedly arbitrary definition that was meant to create a referent in order for parents to respond to questions with a similar context [46].

Family PA was measured by the instrument featured in our prior pilot trial [31,36]. The original template was based on the Godin Leisure-Time Exercise Questionnaire [47], the International Physical Activity Questionnaire [48] and the Behavioral Risk Factor Surveillance System Survey Questionnaire [49]. This includes an open estimate of frequency in a typical week for parent respondents to complete, based on a 30 minutes duration to correspond with our

definition of family PA. Canada's guide for family PA [50] highlights structured (swimming lessons, skating, team sports etc.) and unstructured (family walks, bike rides, child play at parks or in the backyard) PA so separate questions were created for each type. The final outcome measure included total frequency of bouts using an amalgam composite of the two categories.

The instrumentation used to assess the constructs of the TPB included common items for assessment [51,52], yet framed for our family PA definition. Baseline and six weeks assessments asked for expectations of family PA over the next six weeks and 13 week and 26 week assessments asked for expectations 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 two 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 [53]. Finally, intention strength [12] was measured with a single item (I am committed…) using seven-point Likert response anchors from strongly disagree to strongly agree . Measures of affective attitude (time 1 $\alpha = 0.66$; time 2 $\alpha = 0.69$, time 3 $\alpha = 0.73$, time 4 $\alpha = 0.76$), instrumental attitude (time 1 $\alpha = 0.79$; time 2 $\alpha = 0.58$, time 3 $\alpha = 0.74$, time 4 $\alpha = 0.76$), subjective norm (time 1 $\alpha = 0.64$; time 2 $\alpha = 0.64$, time 3 $\alpha = 0.63$, time 4 $\alpha = 0.62$), perceived behavioral control (time 1 $\alpha = 0.70$; time 2 $\alpha = 0.89$, time 3 $\alpha = 0.77$, time 4 $\alpha = 0.57$) showed generally adequate internal consistency.

Assessments of post-intentional constructs included *planning intention* and self-reported *habit*. The planning intention measure was derived from work by Mistry et al. [28], based on prior items validated by Sniehotta et al. [54] and included forecasting questions about whether the parent will "keep track of family PA in a diary or log", "set short term family PA goals", "make detailed plans about concerning "when", "where", "how", and "what" family PA", "will make plans

276 regarding what to do if something interfered with family PA", and "reserve time in your schedule
277 for family PA". Assessment of habit used the self-reported automaticity index [55], adjusted to the
278 definition of family PA. Response options for both measures were on a 7-point Likert scale from
279 (1) strongly disagree to (5) strongly agree. Reliabilities were acceptable for planning intention
280 (time 1 $\alpha = 0.86$; time 2 $\alpha = 0.90$, time 3 $\alpha = 0.85$, time 4 $\alpha = 0.89$) and habit (time 1 $\alpha = 0.95$;
281 time 2 $\alpha = 0.95$, time 3 $\alpha = 0.96$, time 4 $\alpha = 0.95$).

282 **Statistical Analysis**

283 Normality of all variables was checked to determine whether any transformations were
284 required. We followed a procedure where skewness and kurtosis was first checked, followed by
285 conversion to z-scores if skewness was over 2.0 and/or kurtosis was over 3.0 [56]. Z-scores > 3.29
286 were considered outliers, and subsequently shrunk to the next highest score in the distribution [57].
287 Missingness of the variables was then inspected to determine the appropriate imputation
288 procedures [58].

289 To address H1 and H2, a series of 2 (group: education, education+planning) by 4 (time:
290 baseline, 6 weeks, 13 weeks, 26) repeated measures analyses of variance were conducted on
291 family PA, all theory of planned behavior constructs, intention to plan, and habit. Power analysis
292 (.80 with an alpha of .05) of a trend with 4 repeated assessments, one-between group factor, an
293 estimated small-medium effect size based on our prior pilot study [36] and a meta-analysis of the
294 family physical activity intervention literature [6], suggested that a sample size of 96 could detect
295 the primary hypothesis [59]. Given the a priori primary end-point of 26 weeks for this study [32],
296 family PA and planning intention were also investigated with analysis of covariance by condition
297 at each time point, controlling for baseline.

298 To address the second aim of the study, prediction of child MVPA via accelerometry and
299 family PA with self-report (week six, week 13, week 26) used augmented TPB constructs from
300 the prior epoch (baseline, week six, week 13). This approach corresponded perfectly to the
301 questionnaire phrasing. Furthermore, both prospective behavior and prospective behavior
302 regressed upon past behavior were explored as outcomes to assess behavior and behavior change,
303 respectively [60]. Ordinary least squares regression analyses with path analysis were used to
304 predict child MVPA and family PA during these epochs. The PROCESS macro for SPSS [61] was

used (5000 bootstrapped samples) to investigate any mediation effects of the theoretical constructs between condition (education, education+planning) and PA and indirect effects across the path model. The path analyses (see Figure 1) included direct effects estimates in two regression equations that include five independent variables (dependent variables: intention, family PA), followed by two regression equations that included two independent variables (dependent variable: planning intention, child MVPA). Using a medium effect size ($f^2 = .15$), our power analysis suggested that the sample was sufficiently powered for seven independent variables (alpha = .05; power = .80), supporting sample size parameters for the path models.

Results

Baseline Characteristics of Respondents

Baseline characteristics of the children are already detailed in Rhodes et al. [26,33]. Children had an average age of 9 yr, with an equal representation of boys and girls (52% female), and mainly white. Child accelerometry assessment at baseline indicated 49.12 (SD = 17.91) min of daily MVPA and BMI scores were all above the 50th but lower than the 85th percentile for age and sex [62]. Parents had a mean age of 42 (SD = 5.00), and the majority (78%) were mothers. A majority of parents had a college education (64%), moderate to high incomes (56% >$74,000 CAN) and were employed (72%). Almost half of the parents were single-parents (41%) and just under one third (29%) of families had siblings participating in the trial. In terms of parental health, 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. Baseline accelerometry showed that MVPA among the parent contacts was 74.40 minutes per week (SD= 82.15; 14% of sample meeting international guidelines of 150 min).

Handling Missing Data and Normality Assumptions

Prior to conducting the main analyses, preliminary analyses showed that perceived behavioral control (time 1 and 2), intention (time 1, 2, and 4), Family PA (time 3 and 4) were kurtotic (i.e., values ≥ 3) at various time points in both conditions. Therefore, outliers (no more than 3 on any variable) were reduced to the next highest value [57], which reduced all kurtosis below 2.00. Similar to prior results with this data-set [26,33], we found these data missing

completely at random across the three time periods [Little's test p = >.34 for all times]. A more specific analysis of dummy coding a "missingness" variable at each measurement time and testing for the association with various baseline variables also 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 [58,63].

Family Physical Activity and Predictor Variables

The repeated measures analysis of variance results can be found in Table 1 and mean and SD values by intervention condition across all variables is detailed in Table 2. Family PA had a significant effect for time ($p < .01$; $\eta^2 = .07$), with both groups reporting an increase in frequency over the intervention, but not a significant time by condition interaction ($p = .19$; $\eta^2 = .07$). Follow-up analysis of covariance tests by time-point, however, showed that changes in family PA were higher from baseline in the planning+education group for six weeks ($F_{1,99} = 3.68$; $p = .06$; $\eta^2 = .04$) and the 26 week primary end-point ($F_{1,99} = 3.79$; $p = .06$; $\eta^2 = .04$), but not at 13 weeks ($F_{1,99} = 0.44$; $p = .51$; $\eta^2 = .00$). Planning intention had a significant time effect ($p < .01$; $\eta^2 = .77$) and time x condition interaction ($p = .02$; $\eta^2 = .09$). Specifically, planning intention dropped across the trial, yet the planning+education condition showed less decrease across time than the education condition (see Table 2). Follow-up analysis of covariance tests showed that planning intention was higher in the planning+education group for six weeks ($F_{1,99} = 7.18$; $p < .01$; $\eta^2 = .07$), and 13 weeks ($F_{1,99} = 8.18$; $p < .01$; $\eta^2 = .08$), but not the 26 week end-point ($F_{1,99} = 0.88$; $p = .35$; $\eta^2 = .01$). No other variables showed evidence of an interaction effect by condition across time ($p > .10$). However, habit ($p < .01$; $\eta^2 = .21$), instrumental attitude ($p < .01$; $\eta^2 = .21$), subjective norm ($p = .01$; $\eta^2 = .04$), perceived behavioral control ($p < .01$; $\eta^2 = .27$), and intention ($p < .01$; $\eta^2 = .48$) all showed significant time effects across the trial. Habit gradually increased across time, while instrumental attitude, subjective norm, perceived behavioral control, and intention generally decreased across the trial from their initially high baseline scores.

Prediction of MVPA

Bivariate correlations among the augmented TPB constructs with family PA and child MVPA can be found in Supplementary Tables 1-3. Attitude, subjective norm and perceived behavioral control were associated with family PA intention (rs ranged from .34 to .71), with the exception of instrumental attitude at 13 weeks (r = -.03). Family PA intention was consistently

associated with planning intention (rs ranged from .27 to .59) and habit was associated with most TPB variables, with the exception of instrumental attitude ($p > .05$). Habit was the only variable consistently associated with family PA (rs ranged from .23 to .30), and family PA was only associated with child MVPA at 13 weeks (r = .25).

Figure 1a details the path model for the augmented TPB predicting MVPA from baseline to six weeks, Figure 1b shows the augmented TPB at six weeks predicting MVPA at 13 weeks, and Figure 1c details the augmented TPB at 13 weeks predicting MVPA at 26 weeks. These same models are presented with unstandardized residuals in Supplemental Figure 1 to predict analysis of change over time. Family PA and condition predicted ($p < .05$) child MVPA at 13 weeks in both the standard and residual models (R^2 range .14 to .15), but did not predict child MVPA at six weeks or 26 weeks ($p > .05$). At 13 weeks, analyses in the standard model showed there were indirect effects of perceived behavioral control ($\beta = .07$; 95% CI $\beta = .01$ to $\beta = .22$) and habit ($\beta = .08$; 95% CI $\beta = .01$ to $\beta = .23$) on child MVPA through family PA, but there were no indirect effects of condition, intention, or planning intention (all 95% CIs crossed through 0). No mediation/indirect effects were identified in the residual models.

Prediction of family PA ranged from nine to 16% variance explained across the standard and residual models. PA intention and planning intention did not predict family PA across any time point in the standard or residual models ($p > .05$). Perceived behavioral control, by contrast, predicted ($p < .05$) family PA at six weeks in the standard and residual model and at 13 weeks for the standard model only. Habit predicted ($p < .05$) family PA at 13 weeks and 26 weeks in the standard model but not in the residual models ($p > .05$). Condition assignment, favoring the education+planning group, had an independent effect on family PA at six weeks in the residual model, but no other significant direct effects ($p > .05$). Condition also had a small indirect effect on family PA at 13 weeks ($\beta = .09$; 95% CI $\beta = .02$ to $\beta = .19$) and 26 weeks ($\beta = .09$; 95% CI $\beta = .03$ to $\beta = .18$) through habit for the standard models only.

PA intention predicted planning intention consistently across the standard models ($p < .05$). Affective attitude (13 weeks $\beta = .08$; 95% CI $\beta = .01$ to $\beta = .21$), subjective norm (baseline $\beta = .11$; 95% CI $\beta = .04$ to $\beta = .22$), and perceived behavioral control (baseline $\beta = .10$; 95% CI $\beta = .07$ to $\beta = .23$; 6 weeks $\beta = .14$; 95% CI $\beta = .02$ to $\beta = .32$) had indirect effects upon planning intention through PA intention at various time periods. Change in PA intention also predicted change in planning intention from baseline to six weeks ($p < .01$), but not the change from six

weeks to 13 weeks ($p > .05$). This effect of PA intention change from baseline to six weeks mediated the effects of perceived behavioral control ($\beta = .23$; 95% CI $\beta = .06$ to $\beta = .51$) and subjective norm ($\beta = .08$; 95% CI $\beta = .02$ to $\beta = .21$) changes from baseline to six weeks upon corresponding changes in planning intention. Independent of the effect of PA intention on planning intention, condition assignment had effects on planning intention at six weeks ($p < .05$) for both the standard and residual models and at 13 weeks ($\beta = .20$, $p < .05$) for the standard model only.

Finally, TPB variables explained significant ($p < .01$) variance in intention in both the standard and residual models across all time points (R^2 range from .30 to .60). For the standard models, affective attitude, subjective norm, and perceived behavioral control were consistent significant ($p < .05$) predictors of PA intention (with the exception of subjective norm at 6 weeks), whereas instrumental attitude did not predict family PA intention at any time point. The results were very similar for the residual models. Affective attitude, subjective norm, and perceived behavioral control were consistent significant ($p < .05$) predictors of change in PA intention (with the exception of affective attitude baseline to 6 weeks), whereas change in instrumental attitude did not predict change in PA intention at any time point. Condition did not predict intention in three of the four models; condition had a significant negative effect ($p < .05$), favoring the education only condition, on PA intention at 13 weeks in the standard model. Condition had no significant ($p > .05$) effects on any of the TPB constructs across any time-point.

Discussion

The purpose of this study was to examine the effect of a family intervention on the least active parent's perceptions of family co-physical activity, social cognitions about family PA, and family PA habit. The intervention included comparing an education group (receiving information about the benefits of family PA) to an education +planning group (receiving additional information on planning for PA for their child) over 26 weeks. We hypothesized (H1) that the education+planning condition would show higher family PA and planning intention because this was the key focus of the intervention. Our analysis supported this hypothesis. Parent reported family PA frequency was slightly higher ($p = .06$; $\eta^2 = .04$) at the six-week and 26 week assessment times in the education+planning group compared to the education group and planning intention was higher in the planning+education group compared to the education group following the six-week and 13 week assessments, but not at 26 weeks.

The effect of the education+planning intervention upon family PA replicates the findings from our pilot study at the six-week point [36], and the small yet practically meaningful effect size [64] is similar to prior meta-analyses of family-based interventions [6,65]. The results underscore the challenges of modifying family PA and the small shifts in behavior that can be attributed to a family-based intervention [66,67]. Further, our family PA variable, measured as family co-physical activity, was not the only target of the family-based intervention. Parental support behaviours in the forms of encouragement and logistical support for child PA [68] were also promoted but were not measured.

Our results for planning intention serve as a supportive manipulation check, particularly because planning intention was only different between the groups after the intervention (6 weeks) and the intervention booster (13 weeks) delivery periods, but not in 26 week follow-up. It should also be noted that planning intention dropped considerably across the trial for both groups, suggesting a lessening of enthusiasm to use planning. This finding aligns with the process evaluation findings reported in our primary outcome paper [26], where some families reported disengaging from planning techniques by study end. Planning tactics may be cumbersome and tiring over time, and it may be necessary to acquire more automatic action control means such as habit for PA continuation [9,17]. Change in habit was not significantly different between conditions across the trial, but there was a significant increase in habit strength from baseline to 26 weeks that supports the premise of habit formation over time.

While we specifically hypothesized that family PA and planning intention would change as a result of our family-based intervention, we adopted a null hypothesis (H2) for the intervention impact on social cognitive variables of the TPB compared to the education only condition. This hypothesis was supported and once again reflect pilot trial findings [36], where intention and perceived behavioral control weren't significantly different as a result of the planning intervention. We have now extended this finding to show that attitude and subjective norm were also invariant to condition assignment. The results support the theoretical premise of post-intentional action control theories [27], and specific theories such as the health action process approach [14], where planning is positioned as an intermediary between intention and behavior. With the exception of affective attitude, all theory of planned behavior variables showed a considerable decrease across the intervention from high initial values. This response shift is

456 common in experimental trials, as participants re-set their expectations after more experience
457 with the condition [69].

458 The second aim of this study was to gain a better understanding of the predictors of both
459 PA change and overall PA performance across the trial. To achieve this, we used an augmented
460 TPB that included planning intention and habit as additional predictors of family PA, and family
461 PA as a predictor of child MVPA (see Figure 1). We hypothesized (H3) that planning intention
462 would predict family PA, family PA would predict child MVPA, and planning intention and
463 family PA would collectively mediate the relationship between the intervention conditions and
464 child MVPA. Our results did not generally support this hypothesis. The family PA variable did
465 predict child MVPA and change in child MVPA at 13 weeks and the magnitude of the effect was
466 medium [64], but this was not replicated at other time-points. Furthermore, planning intention did
467 not predict family PA or family PA change at any time-point; this also meant there was no
468 evidence that planning intention mediated the relationship between the intervention and changes
469 in family PA or child MVPA. Several child PA interventions have failed to demonstrate the
470 putative mediator was responsible for the change in PA attributed to the intervention [22,23] and this
471 study concurs with this null literature.

472 The results of our analyses means that our putative mediators provided limited
473 explanation for why the outcomes changed by intervention condition. Planning intention is linked
474 to actual planning behavior [28], but the two constructs are not synonymous. Actual planning
475 behavior may have served as a better mediator, and thus we recommend a measure of planning
476 behavior in future research. Our exploratory analyses also showed some evidence that the
477 intervention had an indirect effect through habit when predicting family PA, but not change in
478 family PA. Habit was also a predictor of family PA at 13 weeks and 26 weeks in the medium
479 effect size range [64]. Given that planning behavior change techniques and habits have theoretical
480 linkages [17,70], it may be that some of the planning intervention assisted in fostering family PA
481 habits. Additional mediators of the intervention may reside in unmeasured variables, particularly
482 at the child level [22], and also with other family members such as the more active parent. Family-
483 based interventions, such as this one, include multiple stakeholders in the family system who
484 interact and co-determine behavior [71]. Our study is likely limited by the focus on the contact
485 parent's social cognitions about family PA. Following the suggestions of Davison et al. [72], we
486 recommend that family interventions collect data on all stakeholders if possible.

Finally, the augmented TPB provided some additional information that was helpful to explain family PA outcomes more generally. We hypothesized (H4) that perceived behavioral control over family PA, and PA intention would predict family PA independent of the intervention conditions. We further hypothesized that affective attitude, subjective norm, and perceived behavioral control would predict family PA intention in concordance with TPB [8]. Perceived behavioral control was a predictor of family PA at six weeks and 13 weeks but not at 26 weeks, nor did it predict change in family PA. Intention did not predict family PA at any time-point, yet affective attitude, subjective norm, and perceived behavioral control predicted intention and change in intention consistently. Taken together, the results support past research in family PA that shows large intention-behavior discordance; yet, a more consistent association with perceived behavioral control [9,10]. The null effects of intention on family PA are likely heightened further in this study by the volunteer nature of the trial, which makes having good intentions a necessary function of even participating in the first place [12].

Given the negligible impact of intention on family PA, the results do not position great import to intervening upon its proposed TPB antecedents, with the possible exception of perceived behavioral control. Parenting skills may be necessary for effective perceived control e.g., [73], yet occupational and other time demands are frequent barriers to spending time together as a family [25]. Intervening to improve perceived behavioral control may be difficult, given parental time-demands, but some family time-management and problem solving may be prudent in interventions [72]. Still, the results of our models suggest the best intervention effort may be spent on developing family PA habits. This literature is sparse at the moment but a focus on building consistency in family PA practice with critical cues to action that precede the behavior is recommended to build the learned cue-behavior associations responsible for habits [74].

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 [75], the generalizability to other regions worldwide is unknown. Second, while our measurement of study variables had generally acceptable reliability, there were some circumstances where measures had internal consistencies below rule of thumb (i.e., .70) which may compromise the findings. As noted previously, planning intention may not be a sound proxy of actual planning, and a self-report of family co-PA frequency is likely to contain biases that could easily explain why it did not link reliably to

child MVPA min measured with accelerometry [76]. A better synchrony between these measures may be achieved with more recent advances in technology where blue-tooth connections can pair co-activity via accelerometry. The measurement of habit via self-report is also an ongoing controversy although no alternative has yet been validated [77]. Finally, while our sample size was adequate to detect small-medium effects, it was not powered to detect very small effect sizes [64].

Overall, our results showed some evidence that the family intervention focused on education+planning increased our contact parent's planning intention and self-report of family PA compared to an education only group. The effect of the condition on the proposed mediators from our augmented TPB did not explain these changes, and family PA had mixed evidence for an association with child MVPA across the trial. The findings showed a small indirect effect of the intervention via habit on overall family PA, favoring the education+planning group, yet the results generally suggest that other variables from the family system (e.g., child motivation, other parent's motivation and plans) are likely needed to fully understand the intervention effects. PA intention and planning intention from the contact parent was unable to predict family PA across the study; yet, perceived behavioral control and habit were consistent predictors of family PA. Thus, the promotion of perceived behavioral control and habit to assist in family PA is recommended for future research in this population.

Figure Caption

Figure 1: Prediction of child MVPA and family PA using the augmented theory of planned behavior (A) baseline to six weeks; (B) six weeks to 13 weeks; and (C) 13 weeks to 26 weeks. Note: N = 102; slotted lines = $p > .05$; full lines = $p < .05$.

References

1. Poitras VJ, Gray CE, Borghese MM, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism.* 2016;41:S197-S239.
2. Ahn JV, Sera F, Cummins S, Flouri E. Associations between objectively measured physical activity and later mental health outcomes in children: findings from the UK Millennium Cohort Study. *Journal of epidemiology and community health.* 2018;72:94-100.
3. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *Lancet Child and Adolescent Health.* 2019.
4. Cox MJ, Paley B. Family as systems. *Annual Review of Psychology.* 1997;48:243-267.
5. Gustafson S, Rhodes RE. Parental correlates of child and early adolescent physical activity: A review. *Sports Medicine.* 2006;36:79-97.

6. Brown HE, Atkin AJ, Panter J, Wong G, Chinapaw M, Van Sluijs EM. Family-based interventions to increase physical activity in children: a systematic review, meta-analysis and realist synthesis. *Obesity Reviews.* 2016;17:345-360.
7. Rhodes RE, Perdew M, Malli S. Correlates of parental support of child and youth physical activity: A systematic review. *International Journal of Behavioral Medicine.* 2020.
8. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes.* 1991;50:179-211.
9. Rhodes RE, Berry T, Faulkner G, et al. Application of the multi-process action control framework to understand parental support of child and youth physical activity, sleep, and screen time behaviors. *Applied Psychology: Health and Well-Being.* 2019;11:223-239.
10. Rhodes RE, Spence JC, Berry T, et al. Understanding action control of parent support behavior for child physical activity. *Health Psychology.* 2016;35:131-140.
11. Rhodes RE, de Bruijn GJ. How big is the physical activity intention-behaviour gap? A meta-analysis using the action control framework. *British Journal of Health Psychology.* 2013;18:296-309.
12. Rhodes RE, Rebar A. Conceptualizing and defining the intention construct for future physical activity research. *Exercise and Sports Sciences Reviews.* 2017;45:209-216.
13. Fishbein M, Ajzen I. *Predicting and changing behavior: The reasoned action approach.* New York, NY: Psychology Press; 2010.
14. Schwarzer R. Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology.* 2008;57:1-29.
15. Hagger MS, Luszczynska A, de Wit J, et al. Implementation intention and planning interventions in Health Psychology: Recommendations from the Synergy Expert Group for research and practice. *Psychology & Health.* 2016;31:814-839.
16. Rhodes RE. The evolving understanding of physical activity behavior: A multi-process action control approach. In: Elliot AJ, ed. *Advances in Motivation Science.* Vol 4. Cambridge, MA: Elsevier Academic Press; 2017:171-205.
17. Fleig L, Pomp S, Parschau L, et al. From intentions via planning and behavior to physical exercise habits. *Psychology of Sport & Exercise.* 2013;14:632-649.
18. Baranowski T, Anderson C, Carmack C. Mediating variable framework in physical activity interventions: How are we doing? How might we do better? *American Journal of Preventive Medicine.* 1998;15:266-297.
19. Rhodes RE, Boudreau P, Weman Josefsson K, Ivarsson A. Mediators of physical activity behavior change interventions among adults: A systematic review and meta-analysis. *Health Psychology Review.* in press.
20. Yao CA, Rhodes RE. Parental correlates in child and adolescent physical activity: A meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity.* 2015;12:10.
21. Hutchens A, Lee RE. Parenting Practices and Children's Physical Activity: An Integrative Review. *The Journal of School Nursing.* 2018;34: 68-85.
22. Brown HE, Hume C, Pearson N, Salmon J. A systematic review of intervention effects on potential mediators of children's physical activity. *BMC Public Health.* 2013;13:165.
23. Cohen KE, Morgan PJ, Plotnikoff RC, Hulteen RM, Lubans DR. Psychological, social and physical environmental mediators of the SCORES intervention on physical activity among children living in low-income communities. *Psychology of Sport & Exercise.* 2017;32:1-11.

24. Morgan PJ, Young MD, Barnes AT, Eather N, Pollock ER, Lubans DR. Engaging fathers to increase physical activity in girls: The "Dads And Daughters Exercising and Empowered" (DADEE) randomized controlled trial. *Annals of Behavioral Medicine.* 2019;53:39-52.
25. Rhodes RE, Lim C. Promoting parent and child physical activity together: Elicitation of potential intervention targets and preferences. *Health Education & Behavior.* 2018;45:112-123.
26. Rhodes RE, Naylor PJ, Blanchard C, Quinlan A, Warburton DER. Family physical activity planning and child physical activity outcomes: A randomized trial. *American Journal of Preventive Medicine.* 2019;57:135-292.
27. Rhodes RE, Yao C. Models accounting for intention-behavior discordance in the physical activity domain: A user's guide, content overview, and review of current evidence. *International Journal of Behavioral Nutrition and Physical Activity.* 2015;12(9):1-15.
28. Mistry C, Sweet S, Latimer A, Rhodes RE. Predicting changes in planning behaviour and physical activity among adults. *Psychology of Sport & Exercise.* 2015;17:1-6.
29. Rhodes RE, Stearns J, Berry T, et al. Predicting parental support and parental perceptions of child and youth movement behaviors. *Psychology of Sport & Exercise.* 2019;41:80-90.
30. Rhodes RE, Spence JC, Berry T, et al. Predicting changes across 12 months in three types of parental support behaviors and mothers' perceptions of child physical activity. *Annals of Behavioral Medicine.* 2015;49:853-864.
31. Casiro N, Rhodes RE, Naylor PJ, McKay HA. Correlates of intergenerational and personal physical activity of parents. *The American Journal of Health Behavior.* 2011;35:81-91.
32. Quinlan A, Rhodes RE, Blanchard CM, Naylor PJ, Warburton DER. Family planning to promote physical activity: A randomized controlled trial protocol. *BMC Public Health.* 2015;15: 1-9.
33. Rhodes RE, Quinlan A, Naylor PJ, Warburton DER, Blanchard CM. Predicting personal physical activity of parents during participation in a family intervention targeting their children. *Journal of Behavioral Medicine.* 2020;43:209-224.
34. Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 Statement: updated guidelines for reporting parallel group randomised trials. *Annals of Internal Medicine.* 2010;152:e24.
35. Tremblay MS, Warburton DER, Janssen I, Paterson DH, Latimer AE, Rhodes RE. New physical activity guidelines for Canadians. *Applied Physiology, Nutrition, and Metabolism.* 2011;36:36-46.
36. Rhodes RE, Naylor PJ, McKay HA. Pilot study of a family physical activity planning intervention among parents and their children. *Journal of Behavioral Medicine.* 2010;33:91-100.
37. Locke EA, Latham GP. *A theory of goal setting performance.* Englewood Cliffs, NJ: Prentice Hall; 1990.
38. Sniehotta FF, Scholz U, Schwarzer R. Bridging the intention-behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. *Psychology and Health.* 2005;20:143-160.
39. Cain KL, Sallis JF, Conway TL, Van Dyck D, Calhoon L. Using Accelerometers in Youth Physical Activity Studies: A Review of Methods. *Journal of Physical Activity and Health.* 2013;10:437-450.

40. Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessments in field-based research. *Medicine & Science in Sports & Exercise.* 2005;37:S531-S543.
41. Ward DS, Evenson KR, Vaughn A, Rodgers A, Troiano RP. Accelerometer use in physical activity: Best practices and research recommendations. *Medicine and Science in Sports and Exercise.* 2005: S582-S588.
42. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Medicine and Science in Sports and Exercise.* 2008;40:181-188.
43. Evenson KR, Cattellier D, Gill K, Ondrak K, McMurray RG. Calibration of two objective measures of physical activity for children. *Journal of Sports Sciences.* 2008;26:1557-1565.
44. Trost SG, Loprinzi PD, Moore R, Pfeiffer KA. Comparison of accelerometer cut points for predicting activity intensity in youth. *Medicine & science in Sports and Exercise.* 2011;43:1360-1368.
45. Esliger DW, Copeland JL, Barnes JD, Tremblay MS. Standardizing and optimizing the use of accelerometer data for free-living physical activity monitoring. *Journal of Physical Activity and Health.* 2005;3:366-383.
46. Ajzen I. Constructing a theory of planned behavior questionnaire. 2006. http://people.umass.edu/aizen/pdf/tpb.measurement.pdf. Accessed August 7, 2012.
47. Godin G, Jobin J, Bouillon J. Assessment of leisure time exercise behavior by self-report: A concurrent validity study. *Canadian Journal of Public Health.* 1986;77:359-361.
48. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise.* 2003;35(8):1381-1395.
49. CDC. *Behavioral risk factor surveillance system survey questionnaire.* Atlanta. GA: U.S. Department of Health and Human Services; 2001.
50. Public Health Agency of Canada. Canada's family guide to physical activity (6-9 years of age). 2002. http://www.phac-aspc.gc.ca/pau-uap/paguide/child_youth/pdf/kids_family_guide_e.pdf. Accessed June 10, 2009.
51. Conner M, Norman P. *Predicting health behaviour: Research and practice with social cognition models.* Berkshire, U.K.: Open University Press; 2015.
52. Ajzen I. Construction of a theory of planned behavior intervention. 2002; http://www-unix.oit.umass.edu/~aizen/pdf/tpb.intervention.pdf. Accessed April 4, 2007.
53. Williams DM, Rhodes RE. The confounded self-efficacy construct: Review, conceptual analysis, and recommendations for future research. *Health Psychology Review.* 2014;9:1-16.
54. Sniehotta FF, Schwarzer R, Scholz U, Schuz B. Action planning and coping planning for long-term lifestyle change: Theory and assessment. *European Journal of Social Psychology.* 2005;35:565-576.
55. Gardner B, Abraham C, Lally P, De Bruijn GJ. Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity.* 2012;9:102.
56. Kim HY. Statistical notes for clinical researchers: Assessing normal distribution using skewness and kurtosis. *Restorative Dentistry & Endodontics.* 2013;38:52-54.
57. Tabachnick BG, Fidell LS. *Using multivariate statistics.* 3rd ed. New York: Harper Collins; 1996.

58. Allison PD. *Missing Data.* Thousand Oaks: Sage Publications; 2002.
59. Faul F, Erdfelder E, Lang A-G, Buchner A. G*Power 3: A flexible sta-tistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods.* 2007;39:175-191.
60. Rhodes RE, Courneya KS. Modelling the theory of planned behaviour and past behaviour. *Psychology, Health and Medicine.* 2003;8:57-69.
61. Hayes AF. *Introduction to mediation, moderation, and conditional process analysis: Regression-based approach.* New York: Guilford Press; 2013.
62. Kuczmarski RJ. 2000 CDC Growth Charts for the United States: methods and development. *Vital Health Statistics.* 2002;11:1-90.
63. Allison PD. Handling Missing Data by Maximum Likelihood. Paper presented at: SAS Global Forum: Statistical and Data Analysis2012.
64. Cohen J. A power primer. *Psychological Bulletin.* 1992;112:155-159.
65. Dellert JC, Johnson P. Interventions with children and parents to improve physical activity and body mass index: A meta-analysis. *American Journal of Health Promotion.* 2014;28:259-267.
66. van Sluijs EMF, Kriemler S, McMinn AM. The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review. *British Journal of Sports Medicine.* 2011;45:914-922.
67. Kader M, Sundblom E, Elinder LS. Effectiveness of universal parental support interventions addressing children's dietary habits, physical activity and bodyweight: A systematic review. *Preventive Medicine.* 2015;77:52-67.
68. Beets MW, Cardinal BJ, Alderman BL. Parental Social Support and the Physical Activity-Related Behaviors of Youth: A Review. *Health Education and Behavior.* 2010;37:621-644.
69. Campbell DT. Factors relevant to the validity of experiments in social settings. *Psychological Bulletin.* 1957;54:297-312.
70. Kaushal N, Rhodes RE, Meldrum JT, Spence JC. Mediating mechanisms in a physical activity intervention: A test of habit formation. *Journal of Sport and Exercise Psychology.* 2018;40:101-110.
71. Cox MJ, Paley B. Understanding families as systems. *Current Directions in Psychological Science.* 2003:193-196.
72. Davison KK, Lawson HA, Coatsworth JD. The Family-Centered Action Model of Intervention Layout and Implementation (FAMILI) : The Example of Childhood Obesity. *Health Promotion Practice.* 2012;13:454-461.
73. Morgan PJ, Lubans DR, Callister R, et al. The 'Healthy Dads, Healthy Kids' randomized controlled trial: efficacy of a healthy lifestyle program for overweight fathers and their children. *International Journal of Obesity.* 2011;35:436-437.
74. Gardner B, Rebar AL. Habit formation and behavior change. *Oxford Research Encyclopedia of Psychology*. U.S.A.: Oxford University Press; 2019.
75. Statistics Canada. Census Profile, 2016 Census Victoria [Census metropolitan area], British Columbia a [Province]. 2017. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CMACA&Code1=935&Geo2=PR&Code2=59&Data=Count&SearchText=victoria&SearchType=Begins&SearchPR=01&B1=All&TABID=1.

76. Bender JM, Brownson RC, Elliott MB, Haire-Joshu DL. Children's physical activity: using accelerometers to validate a parent proxy record. *Medicine & Science in Sports & Exercise*. 2005;37:1409-1413.
77. Rebar A, Gardner B, Rhodes RE, Verplanken B. The measurement of habit. In: Verplanken B, ed. *The Psychology of Habit*. Cham, Switzerland: Springer; 2018:31-49.

Table 1
Results from the repeated measures equations (N = 102)

	AA	IA	SN	PBC	Intention	Planning	Habit	Family PA (SR)
	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2	$F_{3,98}$ (*p*) η^2
Time	1.72 (.17) .05	8.63 (.00) .21	4.42 (.01) .04	12.06 (.00) .27	29.80 (.00) .48	111.40 (.00) .77	8.51 (.00) .21	7.96 (.00) .07
Time x Condition	0.46 (.71) .01	0.31 (.82) .01	0.22 (.89) .00	0.15 (.93) .00	1.18 (.32) .04	3.32 (.02) .09	2.09 (.11) .06	1.61 (.19) .05

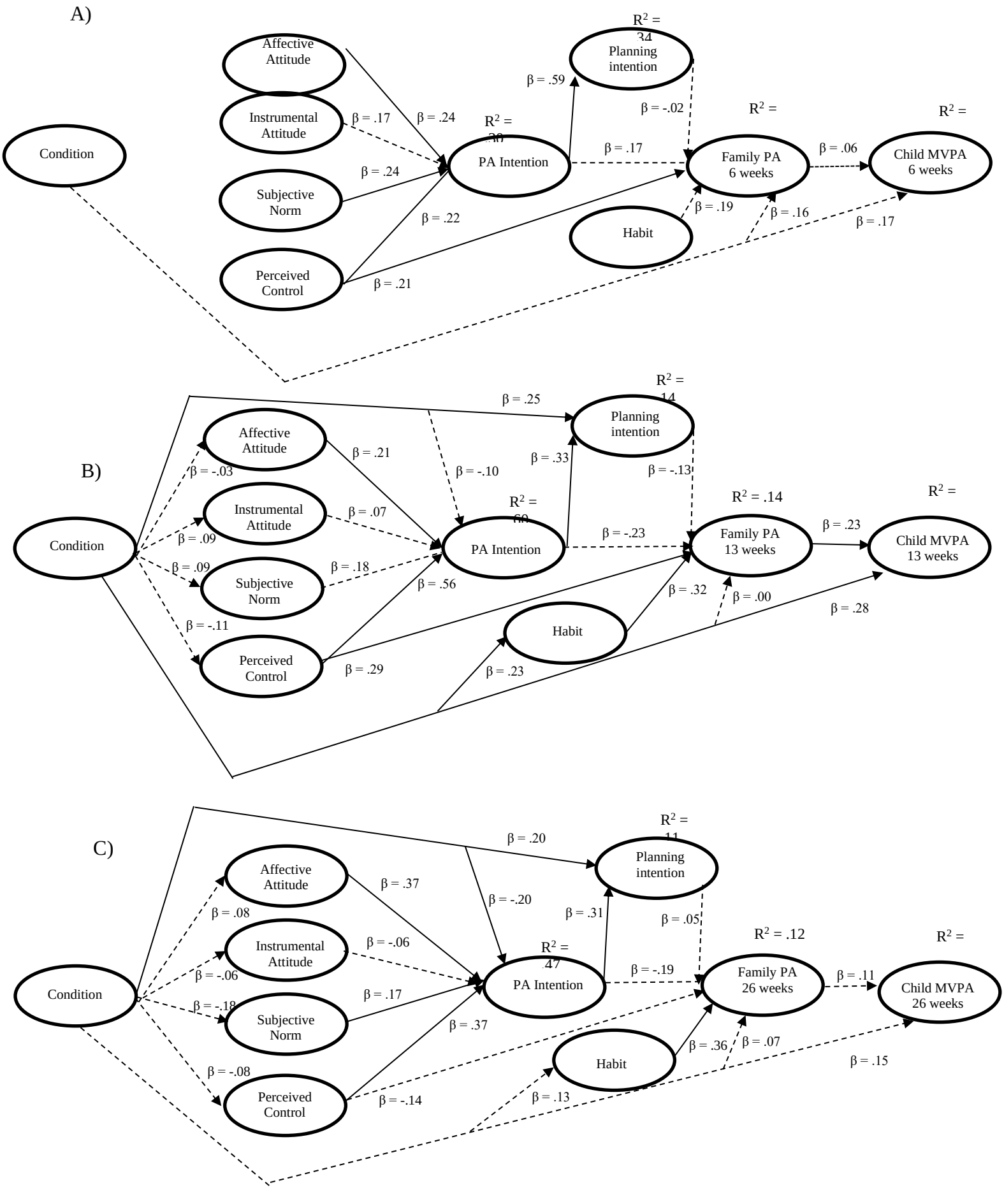
Note. AA = affective attitude; IA = instrumental attitude; PBC = perceived behavioral control; SN = subjective norm; Planning = planning intention; PA = physical activity.

Table 2

Descriptive statistics across physical activity, and extended theory of planned behavior by experimental group (N = 102)

	Intervention Mean (Standard Deviation)				Control Mean (Standard Deviation)			
	Baseline	6 weeks	12 weeks	24 weeks	Baseline	6 weeks	12 weeks	24 weeks
Affective Attitude	5.77 (.80)	5.66(0.73)	5.76 (0.66)	5.70 (0.69)	5.66 (0.71)	5.62 (0.54)	5.66 (0.53)	5.67 (.57)
Habit	3.80 (1.48)	4.23 (1.34)	4.14 (1.31)	4.42 (1.35)	3.31(1.53)	3.61 (1.30)	3.81 (1.29)	4.13 (1.30)
Instrument Attitude	6.53 (0.57)	6.34 (0.45)	6.49 (0.35)	6.38 (0.51)	6.61 (.51)	6.42 (0.44)	6.54 (0.38)	6.50 (0.40)
Intention Strength	6.15 (.61)	5.42 (.94)	5.47 (0.65)	5.67 (0.92)	6.18 (.56)	5.70 (0.60)	5.73 (0.52)	5.83 (.61)
PBC	5.79 (0.64)	5.30 (0.90)	5.44 0(.59)	5.61 (.81)	5.87 (0.68)	5.47 (0.57)	5.53 (0.61)	5.74 (0.53)
Planning Intention	5.53 (1.02)	5.23 (0.67)	4.83 (0.68)	4.42 (0.83)	5.77 (0.99)	4.86 (1.24)	4.62 (1.07)	4.32 (1.16)
Subjective Norm	5.92 (0.75)	5.71 (0.68)	5.79 (.74)	5.85 (0.77)	6.07 (.68)	5.83 (0.68)	6.07 (.66)	6.03 (0.58)
Family PA	3.06 (2.42)	4.34 (2.45)	3.84 (1.37)	4.12 (2.66)	3.02 (1.89)	3.64 (1.34)	3.69 (1.27)	3.31 (2.10)
Child MVPA Accelerometer	50.91(16.66)	54.17(19.52)	57.02(13.58)	56.46 (17.16)	47.67(19.24)	47.87 (17.79)	48.59 (14.19)	50.64 (17.76)

Note: PBC = perceived behavioral control; PA = Physical activity. MVPA = moderate to vigorous intensity physical activity. Family PA is presented as frequency of 30 min bouts per week. Child MVPA is presented as min per day.


A)
Affective Attitude
Instrumental Attitude
Subjective Norm
Perceived Control
Condition
Planning intention
PA Intention
Habit
Family PA 6 weeks
Child MVPA 6 weeks
β = .17
β = .24
β = .24
β = .22
β = .21
β = .59
β = -.02
β = .17
β = .19
β = .16
β = .17
β = .06
B)
Affective Attitude
Instrumental Attitude
Subjective Norm
Perceived Control
Condition
Planning intention
PA Intention
Habit
Family PA 13 weeks
Child MVPA 13 weeks
β = .25
β = .21
β = -.03
β = -.10
β = .33
β = -.13
β = .09
β = .07
β = .09
β = .18
β = .56
β = -.11
β = -.23
β = .32
β = .00
β = .28
β = .29
β = .23
C)
Affective Attitude
Instrumental Attitude
Subjective Norm
Perceived Control
Condition
Planning intention
PA Intention
Habit
Family PA 26 weeks
Child MVPA 26 weeks
β = .20
β = .37
β = .08
β = -.20
β = .31
β = .05
β = -.06
β = -.06
β = -.19
β = .11
β = -.18
β = .17
β = .37
β = .36
β = .07
β = -.08
β = .15
β = -.14
β = .13