Preventive Medicine Reports 19 (2020) 101145

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Understanding factors associated with children achieving recommended amount of MVPA on weekdays and weekend days

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ARTICLE INFO

Keywords:
Physical activity
Child health
Exercise
Accelerometry
Rural
Urban

ABSTRACT

Low levels of moderate-to-vigorous physical activity (MVPA) are consistently reported for children from industrialized countries. Perennially inadequate levels of MVPA have been linked to increased chronic disease risks. Very few studies have compared physical activity levels among children from geographically diverse places, and how they differ on weekdays versus weekends. The purpose of this research is to examine the factors that influence whether children achieve 60 min of MVPA on weekdays compared to weekend days. Data were analyzed on children (n = 532) aged 8–14 years from communities in Southern and Northern Ontario, Canada that participated in the study between 2009 and 2016. Children's MVPA was measured using an Actical accelerometer, environmental features measured with a geographic information system, and demographic data came from child/parent surveys. Variables were selected using a least absolute shrinkage and selection operator. The variables were entered into logistic regression models to assess the relationship between children meeting the MVPA guidelines. During the week, boys were more active than girls (OR = 4.652 p < 0.001) and as age increased children were less likely to reach the MVPA guidelines (OR = 0.758 p = 0.013). On weekends boys were still more likely to meet the guidelines (OR = 1.683 p = 0.014) and children living in rural Northern Ontario were more likely to reach the MVPA guidelines compared to all groups in Southern Ontario. The findings indicate that different variables influence whether children meet the MVPA guidelines on weekdays compared to weekends. Comparing weekdays and weekends provides more useful information for creating effective MVPA interventions.

1. Introduction

Low levels of physical activity (PA) is a major health problem in industrialized countries around the world. (Hallal et al., 2012) In North America, <35% of children and youth are achieving the recommended 60 min of moderate to vigorous PA (MVPA) per day. (Barnes et al., 2018; Katzmarzyk et al., 2018) This figure has remained consistent over the past ten years. (Colley et al., 2011; Katzmarzyk et al., 2018) Increasing the proportion of children meeting the MVPA guidelines of 60 min of MVPA per day is imperative, as higher levels of MVPA are linked to a decrease in chronic disease risk factors, such as obesity, high blood pressure, and waist circumference. (Carson et al., 2013, 2014; Janssen and Leblanc, 2010)

Health researchers have used the socio-ecological model (SEM) to help develop an understanding of the factors that influence children's health behavior, (Ohri-Vachaspati et al., 2014) including MVPA. (Elder et al., 2007) This model offers researchers a framework to move beyond thinking about variables in isolation to an approach that tries to understand an individual's health behavior as a complex interaction among numerous variables. This comprehensive approach is beneficial as it can suggest multiple strategies to improve children's MVPA. Using the SEM allows researchers to examine how intrapersonal, interpersonal, physical environment, and policy factors interact to influence behavior at different time points. At the intrapersonal level, age typically has an inverse relationship with PA, (Sallis et al., 2000; Biddle et al., 2011) boys are more active than girls, (Sallis et al., 2000; Biddle

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https://doi.org/10.1016/j.pmedr.2020.101145
Received 26 December 2019; Received in revised form 29 April 2020; Accepted 10 June 2020
Available online 14 June 2020

et al., 2011; Kavanaugh et al., 2015) PA may vary with ethnicity, (Singh et al., 2008) and research has shown that how children perceive their ability to do certain activities can have a positive relationship with PA. (Belanger et al., 2018; Biddle et al., 2011) Variables at the interpersonal level are not always the clearest, but social, neighborhood, and safety barriers can impact children's PA, (Ding et al., 2011; Taylor et al., 2018) children from a two-parent household are more likely to participate in sports compared to other households, (McMillan et al., 2016) children who own a dog tend to accumulate more PA, (Westgarth et al., 2019; Christian et al., 2014) parental support has shown a positive association on PA, (Biddle et al., 2011; Sallis et al., 2000; Wilk et al., 2017) and socioeconomic status (SES) can influence PA. SES has been measured through parental employment (Estabrooks et al., 2003; Lasheras et al., 2001) and median household income. (Mitchell et al., 2016; Shearer et al., 2012) At the policy level, girls who attend a school with a balanced school day are more active. (Clark et al., 2019)

Physical environment variables have generally shown a positive association with PA and are normally based on accessibility to features, such as distance to recreation facility, (Davison and Lawson, 2006; Ding et al., 2011; Tucker et al., 2009) distance to school, (Davison and Lawson, 2006; Larsen et al., 2009; Wilson et al., 2018) and if a park is near you house based on a distance buffer. (Davison and Lawson, 2006; Ding et al., 2011; Mitchell et al., 2016) One part of the physical environment that is essential to examine is the general type of environment in which a child lives, specifically measured as the level of urbanicity. Urbanicity attempts to capture the characteristics of different environments including built forms and social norms that are inherent to different urbanicities. Some studies have suggested a difference in MVPA from rural to urban areas. (Larouche et al., 2019; Rainham et al., 2012) However, these studies are limited, as it is difficult to determine if their samples only include rural areas that are near major population centers. This creates a gap in the research as it misses nuances that could exist between different levels of urbanicity between varying geographical areas. (Gilliland, 2010) Using more discrete measures of urbanicity while including different geographical areas can further our understanding of how the general environment influences health-related outcomes. (Sandercock et al., 2010; Taylor et al., 2018)

One factor from the SEM that is often omitted is the impact of time, but temporal changes can significantly impact children's PA. (Spence and Lee, 2003; Comte et al., 2013) Specifically, research suggests that children are more active during the week than on weekends. (Comte et al., 2013) Researchers have examined correlates of MVPA on weekdays and weekend days, (Fairclough et al., 2012) but there is little research that takes a comprehensive approach to examining MVPA on weekdays and weekend days.

There are two main gaps in the literature this paper is trying to address. First, there is a lack of understanding as to the factors that are related to children getting 60 min of MVPA on weekdays and weekend days that uses a comprehensive approach during the school year. Second, most researchers treat children living in urban, suburban, urban small towns, and rural areas the same or lack geographically separate places while research has shown that there are differences in the environments and the lives of children in these various urbanicities and locations. (Moore et al., 2010; Gilliland, 2010) To address these gaps in the literature, this paper will address two research questions:

(1) What factors at the intrapersonal, interpersonal, physical environment, and policy levels influence children's ability to get 60 min of MVPA on a weekday?
(2) What factors at the intrapersonal, interpersonal, and physical environment levels influence children's ability to get 60 min of MVPA on a weekend day?

By addressing these questions, this paper will be able to inform researchers and health promoters to create more targeted policies by furthering the understanding of the variables that influence MVPA at different time points.

2. Methods

Data were collected as part of the Spatial Temporal Environmental and Activity Monitoring (STEAM) project. A full description of the project is available elsewhere. (Loebach and Gilliland, 2010; Mitchell et al., 2016) The STEAM project examines health behaviors of 1,068 children in grades 4 to 8 (ages 8–14 years) from 33 elementary schools in Ontario, Canada. The elementary schools were located in two distinct geographical regions: 29 schools from Southern Ontario and four schools from Northern Ontario. The schools in Southern Ontario were selected from groups of schools stratified by neighborhood SES and urbanicity. The schools in Northern Ontario included four schools that were in a rural region of the Thunder Bay District. Students were invited to attend a presentation given by a member of the research team where a brief presentation about the project was given. Researchers discussed that each student has a different lifestyle, and all different lifestyles should participate in the study. To further encourage participation, a small incentive was given to students based on conversations with principals, ensuring that the sum would no induce participation. This study was carried out in accordance with the Declaration of Helsinki and was conducted with approval from the Non-Medical Research Ethics Board at Western University and all seven of the participating school boards. Before participating in this study, children were required to obtain parental consent and sign their own assent form.

A mixed tool protocol was used to collect data on individual and family characteristics, PA, perceptions of the physical environment, and other health behaviors. Data for this study was collected over an eight-day period. Child participants and parents completed a survey with questions about demographics, PA, health-related quality of life, and perceptions of their neighborhood environments. These survey questions were based on the Neighborhood Environment and Walkability Survey, (Cerin et al., 2006) Pediatric Quality of Life Measurement Model (PedsQL), (Varni et al., 1999) and other highly used surveys. (Mitchell et al., 2016) Immediately after children completed the surveys, they were outfitted with a hip-worn accelerometer and a passive-GPS data logger that they wore for the duration of the study.

The cross-sectional sample for this study includes the spring season from Southern Ontario (2009–2013) schools and the fall season of the Northern Ontario schools (2016) to control for general temperature differences. Historical weather data suggests the spring and fall seasons were closer in temperature compared to fall in both locations. (Government of Canada, 2018) The original sample of 1,068 children, was reduced after eliminating participants who did not meet the following inclusion criteria: 1) meet an accelerometer wear-time minimum of 10-h per day (see Outcome Variable); 2) have at least two valid weekdays and one valid weekend day 3) completed the child survey; and 4) have a valid home location identified by GPS. The final sample consisted of n = 532 cases. A chi-square test was performed on age and gender between the students included and excluded from the sample, and no significant differences were found.

2.1. Dependent Variable: PA

This study has two dependent variables derived from objective measures of PA using an accelerometer: (1) a binary measure of whether a child had an average of at least 60 min of MVPA per day on weekdays; and (2) a binary measure of whether a child had an average of at least 60 min of MVPA per day on weekend days. MVPA was measured using an Actical® Z Accelerometer (Philips Respironics, Murrysville, PA, USA), a device worn around the hips sitting on either hipbone. Participants were instructed to wear the accelerometer for all waking hours, only removing it for sleep, bathing, and swimming. The accelerometers measured PA in 30-sec epochs, which is an epoch length used in this age group. (Edwardson and Gorely, 2010) The

Table 1
Variables associated with children's PA by the level of the SEM.

Variable	Source	Description
Intrapersonal		
Gender	Child survey (categorical) (boy/girl)	Self reported gender as boy or girl (Sallis et al., 2000; Biddle et al., 2011; Kavanaugh et al., 2015)
Ethnicity	Child survey (categorical) (Caucasian/other)	Ethnicity coded as either Caucasian or other (Singh et al., 2008)
Physical functioning	Child survey PedsQL (categorical) (high/low)	A categorical variable based on face validity from four questions based on how hard it was to do physical tasks (Belanger et al., 2018; Biddle et al., 2011)
Age	Child survey (continuous)	Age in years (Sallis et al., 2000; Biddle et al., 2011)
Interpersonal		
Parental support	Child survey (categorical) (agree/disagree)	A categorical variable based on if children agree or disagree that their parents take part in activities with them (Biddle et al., 2011; Sallis et al., 2000; Wilk et al., 2017)
Maternal employment	Parent survey (categorical) (unemployed/ employed)	Mother's employment status (Estabrooks et al., 2003; Lasheras et al., 2001)
Family composition	Child survey (categorical) (two parent/lone parent)	Number of parents in the main household (McMillan et al., 2016)
Dog ownership	Child survey (categorical) (yes/no)	Categorical variable on if a child's family owns a dog (Westgarth et al., 2019; Christian et al., 2014)
Social barriers	Child survey (composite score)	Composite score of social barrier questions (Taylor et al., 2018)
Neighborhood barriers	Child survey (composite score)	Composite score of neighborhood barrier questions (Taylor et al., 2018)
Safety barriers	Child survey (composite score)	Composite score of safety barrier questions (Taylor et al., 2018)
Environment		
Urbanicity	GIS (categorical) (urban large city, suburban large city, urban small town, rural south, and rural north)	Categorical variable on different levels of urbanicity (Sandercock et al., 2010)
Park in 500 m buffer	GIS (yes/no)	If any section of a park was within a 500 m buffer of a child's home based on GPS (Davison and Lawson, 2006; Ding et al., 2011; Mitchell et al., 2016)
Home school	GIS (continuous)	Shortest distance along the street network between each child's home and the school they attended (Davison and Lawson, 2006; Larsen et al., 2009; Wilson et al., 2018)
Recreation facility	GIS (continuous)	Shortest distance along the street network between each child's home and the nearest arena or public/private recreational facility (Davison and Lawson, 2006; Ding et al., 2011; Tucker et al., 2009)
Census average median household income (continuous) was taken from the 2011 census	Census 2011 (continuous)	Census average median household income (continuous) was taken from the 2011 census (Mitchell et al., 2016; Shearer et al., 2012)
Policy		
School day	School data (categorical) (balanced/traditional)	Variable based on school policy (Clark et al., 2019)

accelerometer records movement made by each participant in all directions, summed over one min (counts per min, or CPM). If the device had zero counts for 60 consecutive min that hour was considered invalid wear time (Aadland et al., 2018) and these methods have been used in other studies. (Mitchell et al., 2016)

A valid day was considered six hundred min of valid wear time each day (or 10 h). (Rich et al., 2013) MVPA was considered to be at least 1,500 counts per min. (Orme et al., 2014; Puyau et al., 2002) For this study, children were included if they had at least two valid weekdays and one weekend day. An average of children's valid weekdays and weekend days were used to determine if children met the MVPA guidelines on weekdays and weekend days. These criteria allowed us to maintain a large enough sample size for parametric statistics.

2.2. Independent variables

The independent variables used in this paper are fully described in Table 1. Independent variables for the analyses came from those that are found significant in past research on MVPA of children, including factors at the intrapersonal, interpersonal, physical environment, and policy levels. Intrapersonal factors used in this model include age, gender, ethnicity, and physical functioning as measured using the PedsQL measured from self-reported questions on the child survey. Missing data for child age, gender, and ethnicity were derived from the parent survey. Interpersonal factors in this paper include children's perceptions of social, neighborhood, and safety barriers, dog ownership, family composition, and parental support from the child survey, maternal employment, from the parent survey, as well as the median household income of the child's neighborhood, which was derived from 2011 Census of Canada data at the Dissemination Area level. In cases where missing data could not be derived from the parent survey a separate category for missing data was created. The physical environment factors are represented by four variables, computed based on the child's precise home location: accessibility to a park (i.e., is there a park within a 500 m buffer [y/n]), accessibility to a child's school (shortest network path between home and school [m]), accessibility to a recreation building (shortest network path between home and closes recreation centre [m]), and urbanicity. Children were grouped into different urbanicities based on their precise home location. Urbanicity was created by the research team using information from Statistics Canada and city plans. Urban large city (geographic areas with greater than 100,000 people residing in defined city limits), suburban large city (surrounding larger geographic regions with greater than 100,000 residents), urban small town (regions with a population of 10,000 – 99,999), and rural (population < 9,999). Children in rural areas were further subdivided based on if they lived in rural Southern or Northern Ontario. A critical geographical difference exists between the rural Southern and Northern Ontario communities as the rural Northern communities are located over 100 km [62mi] from its nearest metropolitan centre; whereas the rural towns in Southern Ontario are much closer and therefore much more influenced by larger urban centres. Finally, the policy factors are measured by the type of recess schedule at a child's school: traditional (two 15 min recesses and a 30 min lunch recess) or balanced (two 20 min recesses).

2.3. Statistical analyses

Analyses were performed in STATA version 14 (StataCorp, College

Table 2
Descriptive statistics of the variables of the child participants STEAM study.

Variable	n	%
Intrapersonal		
Gender		
Boy	223	41.9
Girl	309	58.1
Ethnicity		
Caucasian	395	74.2
Other	137	25.8
Physical functioning, *mean (std dev)*	85.6	15.7
Age, *mean (std dev)*	11.2	1.1
Interpersonal		
Parental support*		
Agree	292	54.9
Disagree	221	41.5
Maternal employment*		
Unemployed	82	15.4
Employed	334	62.8
Family Composition		
Two parent household	377	70.9
Lone parent household	155	29.1
Dog ownership*		
Yes	244	45.9
No	259	48.7
Social score, *mean (std dev)*	−0.7	0.7
Safety score, *mean (std dev)*	−1.0	0.9
Neighborhood score, *mean (std dev)*	−0.9	0.7
Environment		
Urbanicity		
Urban large City	53	10.0
Suburban large City	236	44.4
Urban small town	51	9.6
Rural south	136	25.6
Rural north	56	10.5
Park in 500 m buffer		
Yes	135	25.4
No	397	74.6
Home school (km) *mean (std dev)*	5.3	8.3
Closest rec. (km) *mean (std dev)*	5.0	7.2
Neighborhood income per 10 000 *mean (std dev)*	6.9	2.7
Organizational		
School day*		
Balanced	298	56.0
Traditional	225	42.3
Outcome		
MVPA weekday		
Meet recommendations	269	50.6
Do not meet recommendations	263	49.4
MVPA weekend		
Meet recommendations	131	24.6
Do not meet recommendations	401	75.4

* Does not add up to 100% to account for missing data.

Station, TX, USA) in 2019. One multi-level logistic regression model and one logistic regression model were specified in this paper to answer the research questions: (1) children having an average of 60 min of MVPA on weekdays; and (2) children having an average of 60 min of MVPA on weekend days. First, variables at the intrapersonal, interpersonal, physical environment, and policy levels (i.e., only included during the weekday to account for school day differences) were entered into the model using a least absolute shrinkage and selection operator to make predictions about variables related to MVPA. Once variables were selected, a multilevel logistic regression that controlled for clustering at the school level using the weekday data was conducted and, since children do not attend school on the weekend, a logistic regression was conducted on weekend data.

3. Results

Descriptive statistics are presented in Table 2. The sample has more girls (58%) than boys, the average age was 11 years, and around 75% of children were Caucasian. About one quarter of the children had a park within a 500 m buffer of home, on average their school was about 5 km away from home, and the average distance to the nearest recreation facility from a child's home was 5 km. During the week, nearly half the sample met the MVPA guideline (51%), while on the weekend only about one quarter of the children met the MVPA guideline (25%).

Table 3
Multi-level logistic regression of the association between SEM variables in children on weekday MVPA.

Variable	Odds Ratio	*p*	95% Confidence Interval	
Intrapersonal				
Boy (ref: girl)	4.652	** < **0.001**	3.077	7.032
Age	0.758	***0.013**	0.609	0.947
Physical functioning – high (ref: low)	2.731	** < **0.001**	1.795	4.157
Interpersonal				
Safety barrier	1.244	***0.046**	1.003	1.544
Environment				
Distance to home school	0.987	0.305	0.963	1.012
Constant				
School	0.250		0.075	0.831

Boldface indicates statistical significance (*p < 0.05, **p < 0.001)

The first model addressing research question 1 (Table 3) examines the factors from the SEM that influences the odds of a child getting the recommended 60 min of MVPA on weekdays. The results of this analysis find that three intrapersonal variables and one interpersonal variable are significant. The results show that the odds of boys meeting the recommendations on weekdays are 4.652 times that of girls ($p < 0.001$). Age is also found significant, with each additional year of age decreasing the odds of getting the recommended amount of PA by 0.758 ($p = 0.013$). Children with high self-reported physical functioning are 2.731 ($p < 0.001$) times more likely of getting the recommended amount of PA as compared to children with low physical functioning. Finally, as children's perceptions of safety barriers increase, they are 1.244 ($p = 0.046$) times more likely to get the recommend amount of PA.

The second model addressing research question 2 (Table 4), examines the factors from the SEM that influence the odds of a child getting 60 min of MVPA on weekend days. The results of this analysis find variables at both intrapersonal and physical environment levels of the SEM are related to children meeting the recommendations on weekend days. The only significant intrapersonal variable was gender, which found that the odds of boys meeting the recommendations are 1.683 that of girls ($p = 0.014$). The other significant variable is

Table 4
Logistic regression of the association between SEM variables in children on weekend day MVPA.

Variable	Odds Ratio	*p*	95% Confidence Interval	
Intrapersonal				
Boy (ref: girl)	1.683	***0.014**	1.111	2.545
Age	0.872	0.151	0.723	1.051
Physical functioning – high (ref: low)	1.267	0.290	0.817	1.964
Interpersonal				
Social barrier	0.761	0.095	0.552	1.048
Dog ownership (ref: no)	1.313	0.218	0.851	2.026
Environment				
Urbanicity (ref: rural north)				
Urban large city	0.320	***0.019**	0.123	0.831
Suburban large city	0.395	****0.006**	0.203	0.722
Urban small town	0.351	***0.022**	0.143	0.860
Rural south	0.347	****0.003**	0.174	0.693
Closest rec. (km)	1.026	0.089	0.996	1.058

Boldface indicates statistical significance (*p < 0.05, **p < 0.01)

urbanicity. The urbanicity measure finds that children living in the rural Northern Ontario are significantly more likely to meet the MVPA guidelines on weekends than children living in urban areas (OR = 0.320, p = 0.019), suburban areas (OR = 0.395, p = 0.006), urban small towns (OR = 0.351, p = 0.022), or in rural Southern Ontario (OR = 0.347, p = 0.003).

4. Discussion

The purpose of this paper was to use the SEM to examine what factors influence whether children achieve the recommended minutes of MVPA on weekdays and weekend days. This was done using logistic regression models, one to represent the weekday and one to represent the weekend day. Previous research has indicated that PA levels and correlates differ from weekday to weekend day and this paper contributes to the literature by taking a more comprehensive approach in identifying what specific factors influence the odds of meeting the MVPA guidelines on weekdays and weekends days. (Comte et al., 2013; Fairclough et al., 2012) Researchers also identified that few studies included geographical setting variables that go beyond an urban/rural dichotomy/trichotomy or include geographically distant places. (Sandercock et al., 2010) This led to one major finding as children living in rural Northern Ontario communities were more likely to meet the MVPA guidelines on weekends when compared to children from Southern Ontario in differing levels of urbanicity.

The results of this study found that boys were more likely than girls to meet the MVPA guidelines on both weekdays and weekends, but the odds dropped from 4.652 on weekdays to 1.683 on weekends. Although gender is commonly found as a factor that influences MVPA, the difference in the strength of the association is an important finding. For example, a report from Statistics Canada found that boys were twice as likely to meet the MVPA guidelines when compared to girls. (Statistics Canada, 2019) This suggests separating weekdays and weekend days provides valuable evidence for program leaders as something during the week is conducive to boys MVPA, but not girls. One potential program that has been successful with girls is offering children a free access pass to facilities (e.g., YMCA, Boys and Girls club, arenas, and pools) that include a wide variety of programs including dance, basketball, and free swimming. (Clark et al., 2019) Another potential weekday intervention could target the school. Multi-component school interventions that include modified physical education lessons, more choice, and a focus on enjoyment has shown some success in increasing girls MVPA. (Owen et al., 2017)

On weekdays the children who reported high physical functioning and perceived more safety barriers were more likely to meet the MVPA guidelines. The physical functioning variable was based on four questions that asked children how difficult it is to walk, run, participate in sports, or lift something heavy essentially their perceived competence in different domains of PA. Previous research has shown that psychological variables based on competence have been positively related to PA. (Belanger et al., 2018; Biddle et al., 2011) In this study we found that this variable was only significant during the weekday. Previous research also indicates that certain psychological correlates of PA are context specific. (Ommundsen et al., 2006) This suggests that there is something about children who scored higher on this scale and the weekday context that makes them more active. Similarly, children's perceptions of safety barriers were only significant during the weekday. Although some research suggests barriers make children less active (Taylor et al., 2018) in this case stronger perceptions of safety barriers meant children were more likely to reach the MVPA guidelines. This could be explained by more active children spending more time exploring their neighbourhood and encountering safety barriers. Further research is needed to explore the difference in strengths of relationships on weekdays and weekend days.

At the physical environment level, children from rural Northern Ontario were more likely to meet the MVPA guidelines on the weekend compared to suburban, urban, small town, and rural children from Southern Ontario. This suggests that there is something about the North that increases the chances of children getting the recommended amount of MVPA on weekends, not necessarily the level of urbanicity. As research has only touched on rural children's PA, especially rural children in a Northern setting, it is difficult to determine why these differences exist. (Meyer et al., 2016; Nykiforuk et al., 2018) One potential explanation is that our Northern Ontario study area is more geographically isolated providing children more freedom to explore their environment and be active. Children in the rural Northern Ontario sample lived in a sparsely populated area over 100 km [62mi] away from the closest major city; most people in the these rural Northern communities know one another, potentially making parents feel safer about letting their children out to explore their natural environment. (Eley et al., 2012) Another potential factor could be the community norms. This study took place in the fall, which aligns with hunting season. On weekends children could be out hunting, accumulating higher levels of MVPA as certain types of hunting require hours of walking through difficult terrain. With a substantial portion of the North America population living in rural areas, it is essential to study the variables that influence PA in rural children in different geographic areas. (Statistics Canada, 2016; U.S. Census Bureau, 2016)

5. Limitations

A limitation of this study is that two weekdays and one weekend day were used as inclusion criteria. Some other researchers have used a minimum of four valid days. (Colley et al., 2017) Using more valid days could help improve the overall accuracy of the model as more days used helps capture a better overall average estimate of a child's PA levels. Another limitation is this study did not examine summer MVPA when children are out of school and researchers could not account for MVPA during water-based activities.

6. Conclusion

This paper identified that different factors influence whether children meet the MVPA guidelines during different timepoints, weekdays compared to weekends. Finding different factors at different timepoints can help recreation programmers as they can use this information to create more targeted programs. Conceptually, this study has important implications for how researchers think about the SEM and predictors of PA. In some children's PA research, the temporal realm is either omitted or inadequately explained even though it is considered part of the model. (Spence and Lee, 2003) If researchers ignore temporal differences and use an average value which lumps together weekdays and weekend days, some nuances are lost, and there is a possibility that factors that influence MVPA during the weekday are driving the overall significance of that variable. Another important finding from this study is that children in Northern Ontario were significantly more likely to meet the MVPA recommendations than those in Southern Ontario on weekend days. Research needs to further investigate these regional differences in MVPA, especially on weekends when children have more time to access community based features and are potentially more influenced by community norms. Allowing program leaders to focus their efforts on smaller time points, specific groups, and specific regions could lead to more efficient and cost-effective interventions for improving children's PA levels.

CRediT authorship contribution statement

Brenton L.G. Button: Methodology, Formal analysis, Writing - original draft, Project administration. **Andrew F. Clark:** Methodology, Data curation, Writing - review & editing, Project administration. **Jason A. Gilliland:** Conceptualization, Methodology, Resources, Writing - review & editing, Supervision, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The STEAM study was jointly-funded by Canadian Institutes of Health Research and the Heart and Stroke Foundation of Canada, with seed funding from the Social Sciences and Humanities Research Council of Canada. Additional support was provided by the Children's Health Research Institute and the Children's Health Foundation. We thank the students, parents, teachers, principals, and school research boards. We would also like to acknowledge the dozens of research assistants from the Human Environments Analysis Lab who helped with the STEAM project.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2020.101145.

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