Journal Pre-proof

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PII: S2095-2546(20)30071-5
DOI: https://doi.org/10.1016/j.jshs.2020.06.005
Reference: JSHS 630

To appear in: *Journal of Sport and Health Science*

Received date: 15 May 2020
Revised date: 20 May 2020
Accepted date: 25 May 2020

Please cite this article as: Michelle D. Guerrero , Leigh M. Vanderloo , Ryan E. Rhodes , Guy Faulkner , Sarah A. Moore , Mark S. Tremblay , Canadian children's and youth's adherence to the 24-h movement guidelines during the COVID-19 pandemic: A decision tree analysis, *Journal of Sport and Health Science* (2020), doi: https://doi.org/10.1016/j.jshs.2020.06.005

Original article

Canadian children's and youth's adherence to the 24-h movement guidelines during the COVID-19 pandemic: A decision tree analysis

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Running title: 24-h movement behaviors during a pandemic

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Received 15 May 2020; revised 20 May 2020; accepted 25 May 2020

Highlights

- High parental perceived capability to restrict children's screen time best predicted children's and youth's adherence to all movement recommendations as well as the screen time recommendation.

- Increases in children's and youth's outdoor physical activity/sport since the COVID-19 pandemic best predicted adherence to the physical activity recommendation.
- No to little changes in children's and youth's sleep duration since the COVID-19 pandemic best predicted adherence to the sleep recommendation.

Abstract

Purpose: The purpose of this study was to use decision tree modeling to generate profiles of children and youth who were more or less likely to meet the Canadian 24-h movement guidelines during the COVID-19 outbreak.

Methods: Data for this study were from a nationally representative sample of 1472 Canadian parents ($Mean_{age}$ = 45.12, SD = 7.55) of children (5–11 years old) or youth (12–17 years old). Data were collected in April 2020 via an online survey. Survey items assessed demographic, behavioral, social, micro-environmental, and macro-environmental characteristics. Four decision trees of adherence and non-adherence to all movement recommendations combined and each individual movement recommendation (physical activity, screen time, and sleep) were generated.

Results: Results revealed specific combinations of adherence and non-adherence characteristics.

Characteristics associated with adherence to the recommendation(s) included high parental perceived capability to restrict screen time, being a boy, increases in children's and youth's outdoor physical activity/sport since the COVID-19 outbreak began, having parents younger than 43 years old (for adherence to screen time recommendation), having no to little change in sleep duration since the COVID-19 outbreak began, and having parents older than 35 years old (for adherence to the sleep recommendation). Characteristics associated with non-adherence to the recommendation(s) included low parental perceived capability to restrict screen time, decreases in children's and youth's outdoor physical activity/sport since the COVID-19 outbreak began, primary residences located in all provinces except Quebec, low parental perceived capability to support children's sleep, and increases in sleep duration since the COVID-19 outbreak began.

Conclusion: Our results show that specific characteristics interact to contribute to (non)adherence to the movement behavior recommendations. Results highlight the importance of targeting parents' perceived capability for the promotion of children's and youth's movement behaviors during challenging times of the COVID-19 pandemic, paying particular attention to enhancing parental perceived capability to restrict screen time.

Keywords: Decision tree analysis; Parental perceived capability; Physical activity; Screen time; Sleep

1. Introduction

COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020.[1] Shortly thereafter, states of emergency or public health emergency were declared worldwide, including in provinces and territories across Canada, resulting in community-wide lockdowns and "stay-at-home" orders.[2] Initial COVID-19-related closures and restrictions undoubtedly disrupted daily routines, arrangements, and rhythms of individual and family lives. For children and youth, closures of schools and parks, cancellations of organized sports and recreational activities, and increased accessibility to and time spent on screens may have negatively impacted their physical activity (PA), sedentary, and sleep behaviors. Data from China[3] have confirmed this assumption; children's and youth's PA levels have decreased and screen time has increased since the COVID-19 outbreak.

Unambiguous evidence has shown that sufficient levels of PA, limited screen time, and adequate sleep are linked to indicators of physical and mental well-being among children and youth.[4–6] This accumulation of evidence ultimately led to the release of the Canadian 24-h Movement Guidelines for Children and Youth (5–17 years), which recommend a minimum of 60 min of moderate-to-vigorous PA per day, no more than 2 h of recreational screen time per day, and 9–11 h and 8–10 h of uninterrupted sleep per night for those aged 5–13 years and 14–17 years, respectively.[7] Children and youth who meet all recommendations have better physical, cognitive, and mental health compared to those who meet none or one movement behavior.[8]

As the COVID-19 pandemic continues and chances of a second wave occurring remain, identifying characteristics of (non)adherence to the movement behavior recommendations during this pandemic is crucial. Such insights can inform the development of interventions aimed at mitigating the negative impact of COVID-19 on children's and youth's movement behaviors, and, by extension, their overall health and well-being. Accordingly, the purpose of this study was to use decision tree modeling to generate profiles of children and youth (for simplicity, hereafter referred to as children) who were more or less likely to meet the 24-h movement recommendations during the COVID-19 outbreak. Decision tree modeling is a machine learning technique that has been applied in medicine and public health to identify people at risk of health conditions such as colon cancer,[9] major depressive disorder,[10] and postmenopausal weight gain.[11] It is a powerful statistical tool used to recursively split independent variables into groups to predict an outcome. Unlike more common methods (e.g., logistic regression) that assume predictors behave independently, decision tree modeling assumes interactions among predictors.

Drawing broadly from ecological system theory,[12] profiles in the current study were generated based on 5 broad categories of variables: (1) demographic (child age and gender, parental age and level of education), (2) behavioral (changes in children's play and movement behaviors and changes in family play and movement behaviors), (3) social (family distress, ownership of dog, parental support, and parental perceived capability), (4) micro-environmental (household dwelling and number of children in house), and (5) macro-environmental (region of primary residence). The variables employed in our study have been commonly identified as correlates of children's movement behaviors in previous works;[13–16] thus, specific relationships were expected to emerge. However, no a *priori* hypothesis were forwarded because decision tree modeling is a data-driven analysis and requires no formal theoretical structure.

2. Methods

2.1. Study design and participants

Data for this study were from a survey conducted in April 2020 by ParticipACTION (www.participaction.com), a national non-profit organization that promotes PA among Canadians. The purpose of the survey was to inform the upcoming release of its biennial Report Card on Physical Activity for Children and Youth by assessing changes in children's movement behaviors during the COVID-19 pandemic. A sample of 1503 parents who were representative of the Canadian population based on socio-demographic characteristics was invited to complete a 15-min online survey (in English or French) approximately 1 month after the WHO declared COVID-19 a global pandemic. Recruitment was conducted by a third-party market research company, Maru/Matchbox, that has a consumer online database of >120,000 Canadian panellists. Panel participants were recruited online via email invitation and website sign-up. Data were collected over 4 days. Participants who completed the survey received a small cash incentive ($0.50–$3.00) and were entered into prize contests. Parents with more than one child were instructed to answer the survey based on the child whose given name came first alphabetically. Participants were screened out from the study if someone in their household was diagnosed with COVID-19 or if their household was under a self-isolation or quarantine order. Thirty-one participants were excluded for various reasons (i.e., implausible data, incomplete data, diagnosed with COVID-19, or in self-isolation). Panel participants provided written consent when they chose to participate in survey-based studies and when they agreed to complete the survey in the current study. Ethics approval for this secondary data analysis was obtained from the University of British Columbia Research Ethics Board (#H20-01371).

Data included in this study were from 1472 parents (Mean_{age} = 45.1 years, SD = 7.5) of children aged 5–17 years living in Canada. Most respondents were female (54.0%), of European ancestry (79.2%), married/common-law (84.1%), employed full-time (70.1%), and had a college/university degree (72.4%). Household income ranged from ≤$49,999 (14.8%) to $50,000–$99,999 (33.9%) to ≥$100,000 (39.8%). Annual household income was not reported for approximately 11% of the sample. The sample was stratified by gender and age of the child, resulting in a relatively equal balance of boys (52.6%) and girls (46.9%), and of those aged 5–11 years (47.1%) and 12–17 years (52.9%). Two parents reported that their child identified as non-binary and 5 parents declined to respond. These children were categorized as “other” (0.5%). The primary residence of most of the children was a house (72.2%), with fewer living in an apartment/townhouse (26.6%). A small proportion of parents (1.2%) reported their primary residence as “other”.

2.2. Measures

2.2.1. Exposures

We included 33 explanatory variables. These included demographic variables (*n* = 6; child age and gender, parental education and age, marital status, household income) and behavioral variables (*n* = 14), namely, changes in child movement and play behaviors and changes in family movement behaviors. Changes in child movement and play behaviors included biking/walking in neighbourhood, outdoor PA/sport, indoor PA/sport, household chores, outdoor play, indoor play, recreational screen time, social media, non-screen-based sedentary activities, sleep duration, sleep quality, and overall movement behaviors. Changes in family movement behaviors included family time spent in PA and sedentary behaviors. Social variables (*n* = 10) included dog ownership, family distress, changes in parental support since COVID-19 (encouragement of PA/sport, co-participation, encouragement of chores, encouragement of restricted screen time, and encouragement of sleep), and parental perceived capability to support their children's PA and sleep and limit their children's screen time over the next 2 weeks. Micro-environmental variables (*n* = 2; type of household dwelling and number of children in household) and macro-environmental variables (*n* = 1; region of primary residence) were also assessed. Supplementary File 1 outlines the response scale for each variable as well as variable type (e.g., nominal and ordinal) and number of levels.

2.2.2. *Outcomes*

Each movement behavior was assessed using a 1-item measure taken from the Canadian Health Measures Survey. Participants were asked to rate their children's current (i.e., during COVID-19 outbreak) PA, screen time, and sleep behavior using the following respective items: (a) "In the last week, on how many days did your child engage in moderate-to-vigorous PA for a total of at least 60 min per day?", (b) "On average, how many total hours and minutes per day did your child watch TV, use the computer, use social media and inactive video games, during their free time over the last week?", and (c) "In the last week, how many hours did your child usually spend sleeping in a 24-h period (including naps but excluding time spent resting)?" Children were coded as 1 if they did not meet the behavior recommendation and as 0 if they did meet the recommendation.

2.3. Statistical analyses

Decision tree models were generated using the Exhaustive CHAID (Exhaustive Chi-Square Automatic Interaction Detector) algorithm.[17] Exhaustive CHAID, a form of binary recursive partitioning, allows researchers to identify mutually exclusive subgroups of a diverse population using various characteristics. This algorithm uses the χ^2 test of independence to identify relationships between independent (explanatory) variables and then selects the explanatory variables that best explain the dependent (response) variable based on "IF-THEN" logic.[18] Exhaustive CHAID is a non-parametric method and therefore is robust against issues pertaining to multicollinearity, outliers, distribution, structure, and missing data.[18] It is an exploratory technique that is designed to handle a mixture of data types (continuous and categorical data).[18,19] Exhaustive CHAID is especially appropriate when examining large quantities of data because it is able to examine higher-order interactions among predictors before selecting which variables should be included in the model.[18,20,21] The Exhaustive CHAID model estimation begins with the entire sample (called "parent node") and then subsequently splits the parent nodes into meaningful homogeneous subgroups ("child nodes"). Splitting continues until pre-determined stopping criteria are met. The following statistical model specifications and stopping criteria were applied in the current study: (1) the significant level for splitting nodes was set at $p < 0.05$; (2) the Bonferroni method was used to obtain the significant values of adjustment; (3) the minimum change in expected cell frequencies was 0.001; (4) Pearson's χ^2 was used; (5) model depth was set at 3; (6) the minimum number of cases in parent nodes was set at 147 (10% of sample) and in child nodes was set at 74 (5% of sample); (7) cross-validation (10-folds) was used to assess the tree structure; and (8) the misclassification risk was calculated as a measure of model reliability. Data were analyzed using SPSS (Version 25.0; IBM, Armonk, NY, United States). A total of 4 models were generated, one for all movement behavior recommendations combined and one for each individual movement behavior recommendation. Adherence and non-adherence profiles were identified for each model, whereby children in the adherence group were those who were most likely to meet the recommendation(s) and children in the non-adherence group were those who were least likely to meet the recommendation(s). Missing values (<1%) were handled using the Exhaustive CHAID method.

3. Results

3.1. All movement behaviors

Fig. 1 shows the final 2-level model comprising eight nodes, five of which were terminal subgroups (i.e., nodes that do not split any further). Three predictor variables reached significance and were selected because they best differentiated children who met all 3 movement behaviors (2.1%) from those who did not (97.9%). The first level of the tree was split into three initial branches according to parental perceived capability to restrict children's screen time, meaning that this variable was the best predictor of adherence and non-adherence to all movement behavior recommendations. The adherence group included children whose parents reported very high perceived capability (responded *strongly agree*) to restrict children's screen time (Node 3) and children who were boys or who identified as "other" (i.e., parents who reported their child's gender identity as non-binary or who declined to respond) (Node 6; 11.0%

meeting). The probability decreased when children were girls (Node 7, 1.9% meeting). The non-adherence group included children whose parents did not report high or very high perceived capability (responded *neutral*, *disagree*, *strongly disagree*) to restrict screen time (Node 1, 0.6% meeting). Decision rules for the prediction of non-adherence to all recommendations are presented in Table 1, which also shows detailed "IF-THEN" rules. These "IF-THEN" rules mirror the results of the decision tree model but are displayed in plain text and show the probability of non-adherence. For example, in Table 1, the row for the adherence group (Node 6) reads: IF parental perceived capability to restrict screen time was *strongly agree* AND child was a boy THEN 89.0%. A lay interpretation of this "IF-THEN" rule is as follow: IF parents felt strongly about their capability to restrict their children's screen time AND their child was a boy, THEN the probability of their child not meeting all 3 recommendations was 89.0%. The classification tree model explained 97.9% of total variance after cross-validation analysis.

3.2. PA

Fig. 2 shows the final 3-level decision tree model including a total of 12 nodes, 7 of which were terminal subgroups. Five variables were selected that best differentiated children who met the PA recommendation (18.2%) from those who did not (81.8%). The first level of the tree was split into 3 initial branches according to changes in children's outdoor PA/sport since COVID-19, meaning that this variable was the best predictor of adherence and non-adherence to the PA recommendation. The adherence group included children whose parents reported an increase (responded *a little more* or *a lot more*) in their children's outdoor PA/sport since COVID-19 (Node 3) and who were boys (Node 8, 45.0% meeting). The probability decreased when children were girls or when children identified as "other" (i.e., parents who reported their child's gender identity as non-binary or who declined to respond) (Node 9, 26.3% meeting). The non-adherence group included children whose parents reported a large decrease (responded *a lot less*) in their children's outdoor PA/sport since COVID-19 (Node 1) and whose parents did not report very high perceived capability (responded *strongly disagree*, *disagree*, *neutral*, or *agree*) to support their children's sleep (Node 4, 8.0% meeting). In contrast, the probability of meeting the recommendation increased when parents reported very high perceived capability (responded *strongly agree*) to support their children's sleep (Node 5, 18.1% meeting). Decision rules for the prediction of adherence to the PA recommendation are presented in Supplementary File 2. The classification tree model explained 81.8% of total variance after cross-validation analysis.

3.3. Screen time

As illustrated in Fig. 3, the final model had 2 levels, 11 nodes, and 7 terminal subgroups. Four variables were selected that best differentiated children who met the screen time recommendation (11.3%) from those who did not (88.7%). The first level of the tree was split into 4 initial branches according to parental perceived capability to restrict children's screen time, indicating that this variable was the best predictor of (non)adherence to the screen time recommendation. The adherence group included children whose parents reported very high perceived capability (responded *strongly agree*) to restrict screen time (Node 4) and whose parents were ≤43 years old (Node 9; 39.0% meeting). The probability of meeting the recommendation decreased when parents were >43 years old (Node 10, 16.5%). The non-adherence group included children whose parents reported very low or low perceived capability (responded *strongly disagree* or *disagree*) to restrict screen time (Node 1) and whose primary family residence was located in British Columbia; the Prairies; Ontario; or the Atlantic Provinces (Node 5, 1.4% meeting). The probability of meeting the recommendation slightly increased when the children's primary family residence was located in Quebec (Node 6, 8.8% meeting). Decision rules for the prediction of adherence to the screen time recommendation are presented in Supplementary File 2. The classification tree model explained 88.7% of total variance after cross-validation analysis.

3.4. Sleep

As shown in Fig. 4, the final model had 3 levels, 9 nodes, and 6 terminal nodes (subgroups). Three variables were selected that best differentiated children who met the sleep duration recommendation (79.7%) from those who did not (20.3%). The first level of the tree was spilt into 3 initial branches according to changes in children's sleep duration since COVID-19, indicating that this variable was the best predictor of (non)adherence to the sleep duration recommendation. The adherence group included children whose parents reported no change or a slight change (responded *about the same* or *a little more*) in their children's sleep duration since COVID-19 (Node 2), whose parents were >35 years old (Node 5), and whose parents reported an improvement (reported *a little better* or *a lot better*) in their children's overall movement behaviors since COVID-19 (Node 8, 92.8% meeting). The probability decreased when parents reported that their children's overall movement behaviors worsened (responded a *little less* or *a lot less;* Node 6, 89.2% meeting) or remained the same (responded *about the same;* Node 7, 80.0%) since COVID-19. The non-adherence group included children whose parents reported a large increase (responded *a lot more*) in their children's sleep duration since COVID-19 (Node 3, 59.9% meeting). Decision rules for the prediction of adherence to the sleep recommendations are presented in Supplementary File 2. The classification tree model explained 79.7% of total variance after cross-validation analysis.

4. Discussion

The current study aimed to generate models that describe profiles of school-aged children (5–17 years old) who were more or less likely to meet the 24-h movement behaviors during the COVID-19 outbreak. The models, derived from a decision tree method, showed profiles based on a wide range of characteristics, including demographic, behavioral, social, micro-environmental, and macro-environmental. Four decision tree models were generated to identify how demographic, behavioral, social, micro-environmental, and macro-environmental characteristics contribute to adherence and non-adherence to all three recommendations combined and to each individual recommendation (PA, screen time, and sleep).[7] A total of 10 unique characteristics best predicted non(adherence) to the movement behavior recommendations.

Parental perceived capability to restrict children's screen time was the strongest contributor to meeting all recommendations combined as well as to meeting the screen time recommendation. Parental perceived capability is defined as "perceptions of physical and mental ability, capacity or competence to perform a specific circumscribed behavior independent of motivation to perform the behavior."[22,23] It differs from self-efficacy in that it assesses one's capability and not their motivation to perform the behavior.[22] In both models, higher parental perceived capability was associated with higher adherence to the movement behavior recommendation(s). The adherence proportion of meeting all recommendations was highest among children whose parents reported high perceived capability to restrict screen time and children who were boys (11.0% meeting) and lowest among children whose parents did not report high or very high perceived capability to restrict screen time (0.6%). Parents who believed they were capable of restricting their children's screen time were likely enforcing screen time rules, which consequently limited children's time spent on screens and safeguarded time spent in other activities (e.g., PA and sleeping). The finding that parental perceived capability was the strongest contributor of meeting the screen time recommendation aligns with previous research showing an inverse relationship between parental self-efficacy and children's screen time.[24–26] The adherence prevalence of meeting the screen time recommendation was highest among children whose parents reported very high perceived capability to restrict children's screen time and whose parents were ≤43 years old (39% meeting). While the relationship between parental age and children's screen time is mixed,[27,28] results of the current study suggest that the interactive relationships between parental perceived capability to limit screen time and parental age were important to children's screen time adherence during the COVID-19 outbreak.

Results of our study showed interactive relationships between changes in children's outdoor PA/sport since the COVID-19 outbreak and children's gender in predicting adherence to the PA recommendation. Boys were more likely to meet the PA recommendation (45.0% meeting) than were girls or 'other' (26.3%), even though parents of both groups reported an increase in their children's outdoor PA/sport since COVID-19. These results align with previous research that has shown that children are more active outside than inside[29,30] and the consistent and well-documented discrepancy in PA levels between boys and girls,[31,32] suggesting that these trends persists even during a viral pandemic. The adherence prevalence to the PA recommendation was lowest among children whose parents reported a decrease in their outdoor PA/sport and whose parents reported low perceived capability to support their children's sleep (8% meeting). Although outdoor closures have varied substantially across Canada, these restrictions coupled with the fear of going outdoors likely contributed to the low adherence of meeting the PA recommendation (18%). Nevertheless, the relationship between outdoor PA/sport and meeting the PA recommendation supports the importance of ensuring that children get outdoors during the pandemic, while simultaneously following COVID-19 public health measures.

That the majority of children in the sample (79.9% meeting) met the sleep recommendation is encouraging. The adherence prevalence for meeting this recommendation was highest among children whose parents reported no change or a slight increase in their children's sleep duration since COVID-19, whose parents were >35 years old, and whose parents reported an improvement in their children's overall movement behaviors since COVID-19 (92.8% meeting). In contrast, the adherence prevalence for meeting the sleep recommendation was lowest among children whose parents reported a significant increase in their children's sleep duration since the pandemic (59.9% meeting). The relatively small change in sleep duration among children meeting this recommendation during the pandemic suggests that these children likely had healthy sleeping habits prior to the pandemic. It is possible that children in the non-adherence group who increased their sleep duration during COVID-19 yet still did not meet the recommendation had poor sleeping habits prior to COVID-19. Establishing healthy behaviors is crucial in order to minimize disruptions during unexpected events and barriers.

This study suggests that parental perceived capability to support children's healthy movement behaviors, and particularly their perceived capability to restrict screen time, is an important characteristic to determine (non)adherence to the 24-h movement behavior guidelines during the COVID-19 pandemic. Challenges associated with this pandemic can be overwhelming for parents. Many are faced with balancing work demands, maintaining regular household responsibilities (e.g., cleaning, cooking, and grocery shopping), and helping their children transition to online learning, all while ensuring everyone is physically and mentally healthy. Some parents are faced with additional hardships, such as unemployment, financial worry, and/or death/sickness of a loved one. Therefore, it is critical that parents feel confident in their ability to facilitate their children's movement behaviors during these unprecedented times. One way to accomplish this is by using sources of self-efficacy to facilitate parents' perceived capability.[33] Enhancing parents' perceived capability to restrict screen time, for example, might include encouraging parents to join online groups or use online resources (e.g., Common Sense Media) aimed at helping families navigate the digital world with their kids. These groups and resources can foster a social network for likeminded parents, serving as a platform to share helpful advice, tips, and effective monitoring/limiting techniques (vicarious experience), as well as to offer encouragement and support for one another (social persuasion). It may also be important to target parents' motivation to deal with children's resistance to screen time restrictions, because capability is often confused for motivation in health behavior.[22] Research has shown that parents of children (6–13 years old) may be hesitant to impose rules restricting children's screen time because it could potentially lead to more conflict between the dyad as well as between siblings.[34,35] Thus, parents not only need to feel capable in their ability to restrict screen time but also feel assured of the importance of restricting screen time despite the potential subsequent pushback.

There are several strengths of this study. First, data for this study included a nationally representative cohort of parents whose children were 5–17 years old. Second, findings from our study advance the field by demonstrating the relevance of using Exhaustive CHAID as an analytic method for building classification models aimed at identifying important factors that influence children's movement behaviors during the COVID-19 pandemic. The decision tree modeling approach produced clear, interpretable results despite the use of different types of variables (e.g., continuous and categorical data). Third, this study is the first to document how public health measures (e.g., social distancing, "stay-at-home" orders, and closures of schools), while necessary, have disrupted nearly all aspects of our ordinary life, including children's movement behaviors. Fourth, we used a contemporary measure of perceived capability.[22] Unlike most self-efficacy measures, which are often flawed because they measure perceived capability and motivation, our perceived capability measure included a vignette (i.e., stem) that preceded each item. This vignette has been shown to clarify the meaning of the self-efficacy item and holds motivation constant, thereby improving the validity of the measure.

One limitation of our study is that data were parent-reported and therefore social desirability and/or recall bias may have influenced our findings. Most parents are unlikely spending entire days with their children due to work and regular household responsibilities, and they may have therefore mistakenly overestimated or underestimated their children's play and movement behaviors. Another limitation of our study is its cross-sectional design, which prevents any causal relationships to be inferred. Finally, the data-driven approach ignores any potential causal hierarchies within the selected predictor variables, which can lead to chance pairings. Socio-ecological theory suggests that variables at any level of abstraction may interact, thus supporting the decision-tree approach taken in this paper. However, an a priori structured model may yield different findings.

5. Conclusion

In this cross-sectional survey study, we identified profiles of children who are most and least likely to meet the Canadian 24-h movement recommendations. Of the selected 33 characteristics, 10 emerged as the most relevant to the (non)adherence of movement behaviors, including the child's age, child's gender, parental age, region, changes in outdoor PA/sport, changes in sleep duration, changes in overall movement behaviors, and parental perceived capability to support their children's individual movement behaviors (PA, screen time, and sleep). Parental perceived capability emerged as an important indicator in three of the 4 models and was shown to be strongly associated with meeting all movement behavior recommendations and meeting the screen time recommendation. Findings from this study suggest that, to meet the 24-h movement behavior guidelines, PA promotion strategies and interventions during the challenging times of the COVID-19 pandemic should consider targeting parents' perceived capability to restrict their children's screen time.

Authors' contributions

MDG conceptualized the study, conducted all analyses, and prepared the first draft of the paper. LMV, RER, GF, SAM, and MST critically reviewed the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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Table 1

Percentage of classification of non-adherence to all movement behavior recommendations for terminal nodes, by risk probability based on decision rules using the Exhaustive Chi-Square Automatic Interaction Detector (CHAID) method.

Classification	Node	IF	THEN
1st	1	Parental perceived capability to restrict screen time was *neutral*, *disagree*, or *strongly disagree*	99.4%
4th	4	Parental perceived capability to restrict screen time was *agree* AND child was 5–11 years old	95.5%
5th	5	Parental perceived capability to restrict screen time was *strongly agree*	93.0%
6th	6	Parental perceived capability to restrict screen time was *strongly agree* AND child was a boy or “other”	89.0%
7th	7	Parental perceived capability to restrict screen time was *strongly agree* AND child was a girl	98.1%

Note: Decision rules displayed in plain text. An example of a lay interpretation is as follows: for the 6th classification/Node 6, IF parents felt strongly about their capability to restrict their child’s screen time AND their child identified as a boy or “other”, THEN the probability of their child not meeting all 3 recommendations was 89.0%.

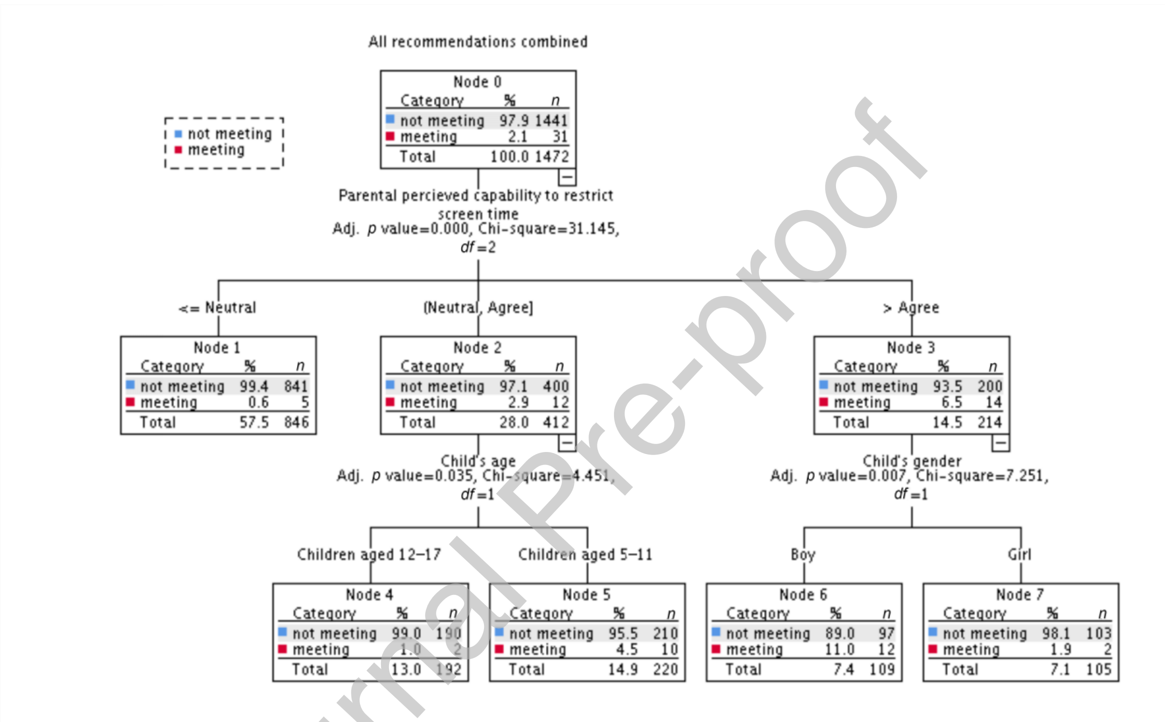

Fig. 1. The classification tree of adherence to all 3 movement behavior recommendations using the Exhaustive Chi-Square Automatic Interaction Detector (CHAID) method.

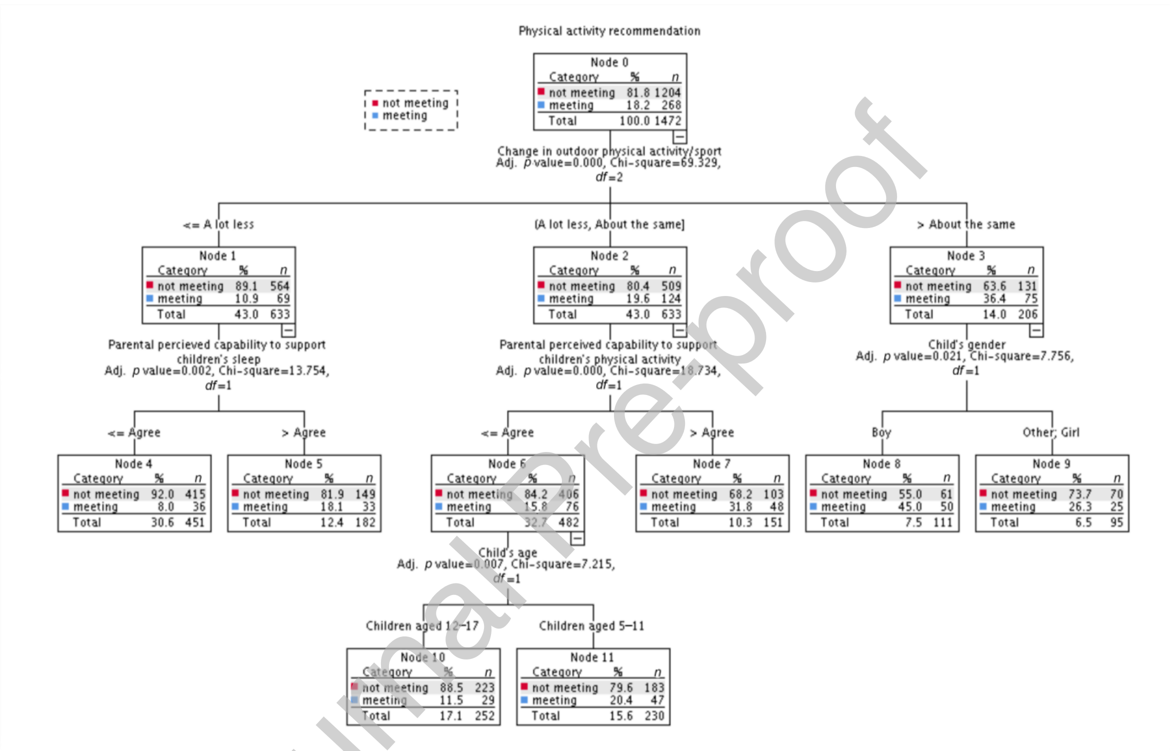

Fig. 2. The classification tree of adherence to the physical activity recommendation using the Exhaustive Chi-Square Automatic Interaction Detector (CHAID) method.

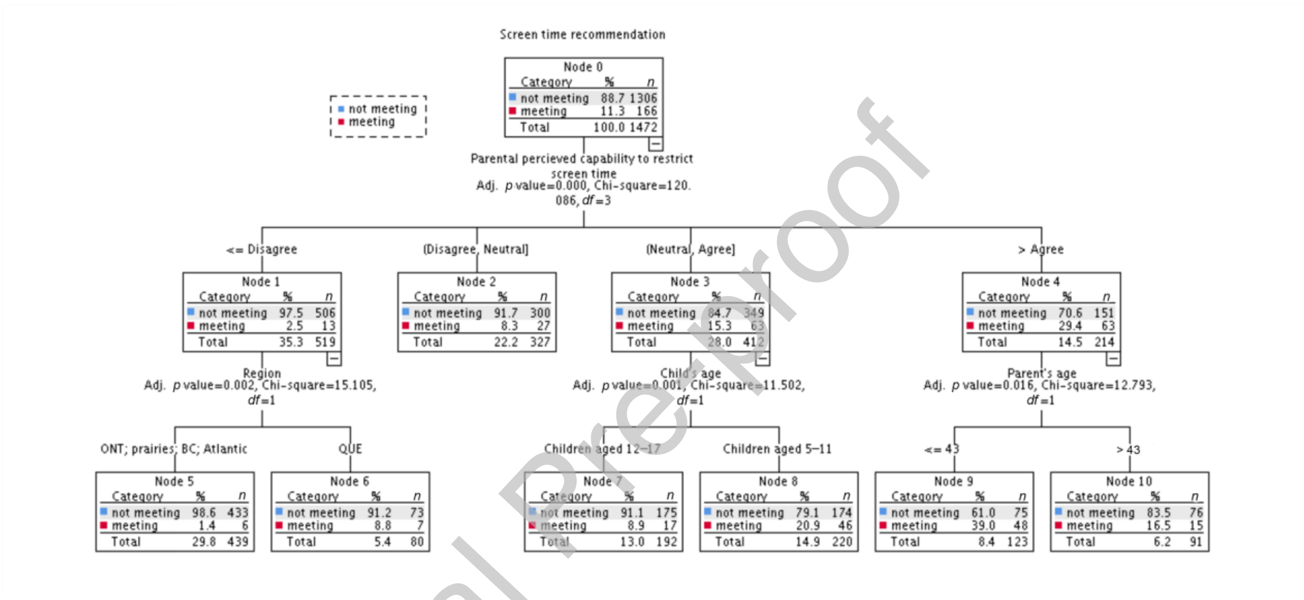

Fig. 3. The classification tree of adherence to the screen time recommendation using the Exhaustive Chi-Square Automatic Interaction Detector (CHAID) method.

BC = British Columbia; ONT = Ontario; QUE = Quebec.

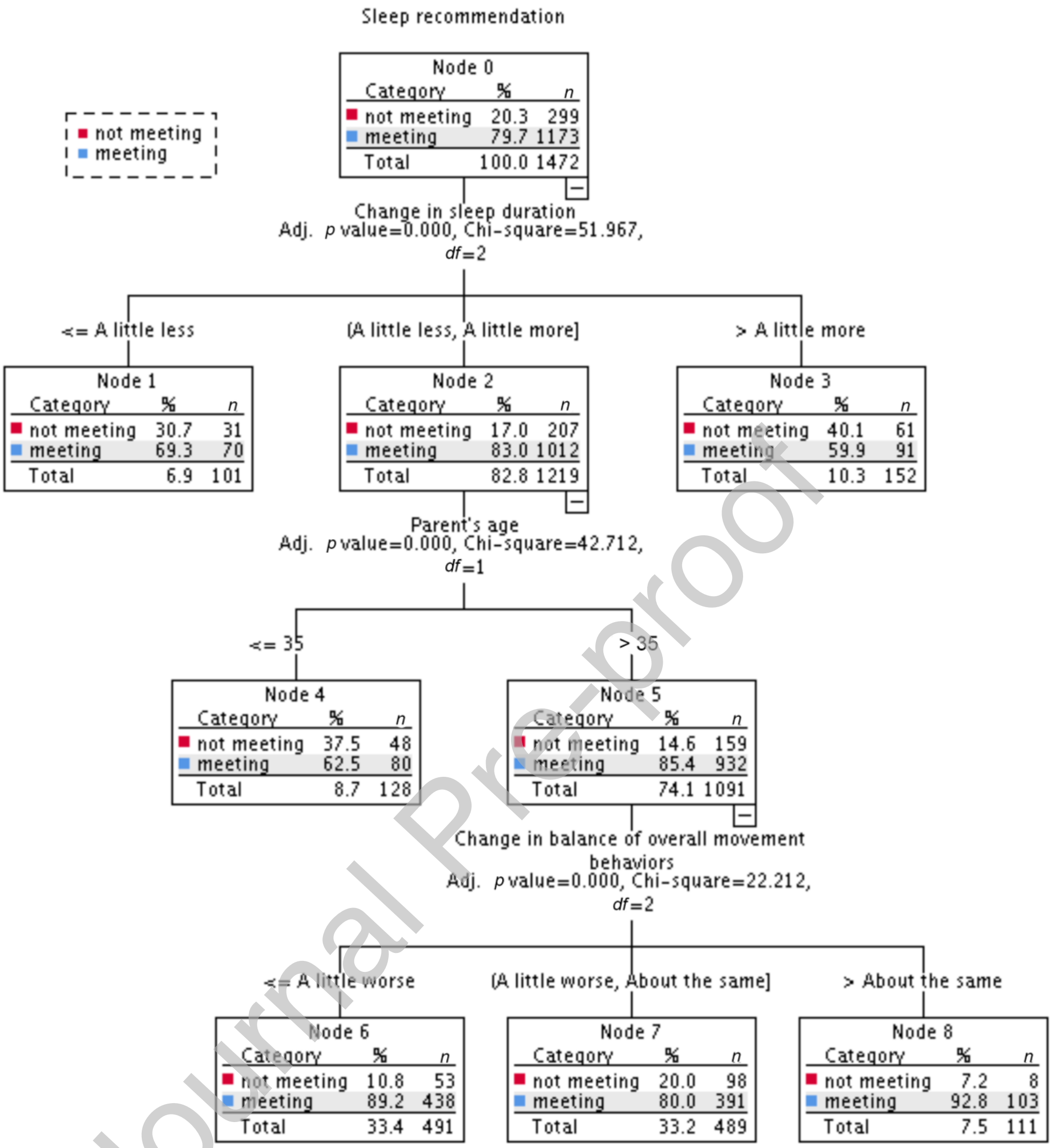

Fig. 4. The classification tree of adherence to the sleep recommendation using the Exhaustive Chi-Square Automatic Interaction Detector (CHAID) method.

Graphic Abstract