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Urban and Rural Differences in Sedentary Behavior among American and Canadian Youth

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Abstract

We examined relationships between urban-rural status and three screen time behaviors (television, computer, video games), and the potential mediating effect of parent and peer support on these relationships. Findings are based on American (n=8563) and Canadian (n=8990) youth in grades 6–10 from the 2005/06 Health Behaviour in School-Aged Children Survey. Weekly hours of individual screen time behaviors were calculated. Urban-rural status was defined using the Beale coding system. Parent and peer support variables were derived from principal component analysis. In comparison to the referent group (non-metro adjacent), American youth in the most rural areas were more likely to be high television users and less likely to be high computer users. Conversely, Canadian youth in medium and large metropolitan areas were less likely to be high television users and more likely to be high computer users. Parent and peer support did not strongly mediate the relationships between urban-rural status and screen time. These findings suggest that interventions aiming to reduce screen time may be most effective if they consider residential location and the specific screen time behavior.

Keywords

Urban-rural health; sedentary behaviour; youth; mediation

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

INTRODUCTION

Sedentary behavior has only recently been recognized as an important determinant of health. Sedentary behavior is not simply the opposite of moderate-to-vigorous physical activity; rather, it is the engagement in activities that involve minimal body movement with little energy expenditure (Salmon et al., 2008; Must and Tybor, 2005). Americans spend 55% of their waking time (7.7 hours/day) in sedentary behavior, and adolescents are one of the population groups with the highest sedentary behavior levels (Matthews et al., 2008). Excessive sedentary behavior in adolescents is of concern as it may be an independent risk factor for obesity and related cardiovascular and metabolic abnormalities (Mark and Janssen, 2008; Ekelund et al., 2006; DeMattia et al., 2007). A major source of sedentary behavior in youth is screen time, or time spent watching television and movies, playing video games, and using computers (Must and Tybor, 2005). To illustrate, the average 11–15 year old in Canada and the United States accumulates more than 4.5 hours of screen time in a typical day (Mark et al., 2006; Iannotti et al., 2009).

Screen time levels vary between different subgroups of the adolescent population. Boys have higher daily screen time than girls and older youth also have notably high levels than younger youth (Iannotti et al., 2009; Mark et al., 2006). A comparison of screen time levels in youth across urban-rural geographic groups also warrants consideration as youth living in extreme urban and rural environments experience increased health risks (Place et al., 2004; Eberhardt and Pamuk, 2004; Cherry et al., 2007). Existing research on this comparison has produced mixed results. Some studies have found no differences in screen time between urban and rural youth (Bathrellou et al., 2007; Davis et al., 2008), while others have found greater daily screen time in urban (Bruner et al., 2008; Springer et al., 2006) and rural populations (Springer et al., 2009). The inconsistencies may be due to the different screen time measures used across studies. For example, some studies have used a summary screen time measure (e.g., television + computer + video games) (Bruner et al., 2008; Bathrellou et al., 2007; Davis et al., 2008), while others have examined individual screen time activities (Springer et al., 2009; Springer et al., 2006). In addition, the inconsistencies may be due to the crude categorization of urban-rural geographic status employed in most studies, despite the fact there may be a marked urban-rural gradient (Parker, 2010; Du Plessis et al., 2002; Vinodrai, 2001). These limitations are problematic since access to certain screen time activities, such as computer and internet, may differ along this gradient (Stenberg et al., 2009). Only one study has considered a multi-point ordinal scale to measure urban-rural geographic status, and it observed a trend of decreasing prevalence of high screen time use when moving from the most urban to most rural group (Bruner et al., 2008). However, this study used a summary screen time measure that might mask relationships with more specific measures of screen time use; thus, it is unknown if this relationship is consistent among individual screen time activities.

Furthermore, to our knowledge no existing study has examined factors that could mediate or explain urban-rural differences in screen time levels among youth. If psychosocial factors account for urban-rural differences, the focus of public health efforts could be on modifying these psychosocial factors; otherwise, the focus would need to be on identifying and modifying structural or environmental urban-rural characteristics that might account for urban-rural differences. Parent and peer support are two potential psychosocial mediators to consider. Traditionally, overall social support has been higher in smaller communities in comparison to large urban areas (House et al., 1988). This may be explained by the social disorganization theory which posits that crime, residential mobility, and ethnic heterogeneity in large urban areas reduces social cohesion (Markowitz et al., 2001) and the quality of social relationships (House et al., 1988; Amato, 2003). Sources of social support may also differ between urban and rural areas. For example, rural populations tend to have close

family-based relationships, whereas urban populations tend to have more nonrelative or friend-based relationships (House et al., 1988). This may partly be explained by differing parenting styles between urban and rural parents. Specifically, urban parents tend to place a greater emphasis on the social development of their children to help them foster friendships with peers (Coleman et al., 1989).

While urban-rural geographic status may influence parent and peer support; parent and peer support may in turn influence the engagement in screen time activities. For example, a recent study of American and Canadian youth reported that the quality of parent (negative) and peer (positive) relationships was associated with screen time use (Iannotti et al., 2009). Similarly, perceptions of parent and peer behaviors influence the engagement in other health behaviors among youth, including smoking, drug use, and alcohol consumption (Iannotti et al., 1996; Bush et al., 1994). Interestingly, perceptions of parents' behaviors and peer use mediate the relationship between the neighborhood environment and youths' smoking and alcohol consumption behaviors (Chuang et al., 2009). Thus, parent and peer support warrant study as potential mediators of the geographic relationship with screen time.

The purpose of this study was to comprehensively examine the relationships between urban-rural geographic status, parent and peer support, and screen time behaviors in representative samples of American and Canadian youth. The primary objectives were to (1) examine urban-rural differences in individual screen time behaviors using geographic measures that take into account population size and proximity to metropolitan settlements; and (2) examine whether parent and peer support variables mediate the relationship between urban-rural geographic status and individual screen time behaviors. A secondary objective was to determine whether the relationship between urban-rural geographic status and screen time is consistent across our two countries. Since screen time is negatively associated with a variety of health outcomes (Iannotti et al., 2009), geographic differences in screen time may help explain the increased health risk associated with living in extreme urban and rural environments. Thus, it is of public health importance to understand if and why geographic differences exist in screen time behaviors. This knowledge can help guide interventions and initiatives aiming to reduce screen time in an effort to improve the health of youth across geographic regions.

METHODS

Study Overview

The study was based on population-based samples of American and Canadian youth in grades 6–10 who participated in the *Health Behaviour in School-aged Children Survey* (HBSC). Responses from the HBSC questionnaire were used to measure three screen time behaviors (television, computer, video games), parent and peer support, and the potential confounders. Based on the location of the school, HBSC participants were placed into 7 different urban-rural geographic status groups according to the Beale continuum coding system (Du Plessis et al., 2002; Parker, 2010; Vinodrai, 2001). Regression models and a contemporary multiple mediation analysis approach (Hayes, 2009; Preacher and Hayes, 2008) were used to assess the 'total effect', 'direct effect', and 'indirect effect' of urban-rural geographic status on the screen time measures, as illustrated in Figures 1 and 2. The 'total effect' represents the relationship between urban-rural geographic status and the screen time variables, without taking into account mediator variables. The 'direct effect' represents the relationship between urban-rural geographic status and the screen time variables after accounting for the parent and peer support mediator variables. The 'indirect effect' represents the relationship between urban-rural geographic status and the screen time measures that occur through the parent or peer support mediator variables.

Participants—The study is based on the American and Canadian records of the 2005/2006 HBSC. The HBSC is an ongoing World Health Organization sponsored cross-sectional survey and in 2005–2006 it was conducted in 44 countries (Currie et al., 2001). The survey consisted of a classroom-based questionnaire that requests information about health behaviors, lifestyle factors, and demographic information. The US and Canadian samples were designed according to the international HBSC protocol in that a cluster design was used with school class being the basic cluster. The distribution reflected the distribution of US and Canadian students in grades 6 to 10.

The US sample included an oversample of African-American and Hispanic youth and was weighted accordingly. Approximately 62% of the schools contacted consented to participate, and 87% of eligible students consented and completed the survey resulting in a sample of 9,016 from 226 schools. 8,563 participants completed items relevant to these analyses and constituted our sample. There were no significant differences in body mass index ($P>0.05$) between the participants that were included or excluded from the final sample. However, the final sample was slightly older (0.28 years) and included slightly more females (5.5%; $P<0.01$). The study protocol was reviewed and approved by the Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development.

The Canadian sample was self-weighted as per the international protocol. Approximately 74% of the students selected consented to participate and completed the questionnaire. The total sample consisted of 9,672 students from 188 schools across Canada; we excluded participants who did not respond to the measures of interest, leaving a total of 8,990 students. Ethics approval was obtained from the Queen's University General Research Ethics Board. There were no significant differences in body mass index ($P>0.05$) between the participants that were included or excluded from the final sample. However, the final sample was slightly older (0.33 years) and included slightly more females (7.3%; $P<0.01$). Consent was also obtained from participating school boards, individual schools, parents, and students.

Urban-Rural Geographic Status (Exposure)—Urban-rural geographic status was defined in both country samples using the Beale continuum coding system, which classified each participant based on the zip code or postal code of their school. The Beale system was first developed by the US Department of Agriculture (Parker, 2010; Du Plessis et al., 2002; Vinodrai, 2001). This system has been modified in Canada to correspond with census divisions; Canadian census divisions compare reasonably well to counties in the US (Du Plessis et al., 2002; Vinodrai, 2001). The 7 categories in the Beale system consisted of: 1) Large Metro, a county (US) or census division (Canada) in a metro area with a population of 1 million or greater; 2) Medium Metro, a county or census division in a metro area with a population of 250,000 to 999,999; 3) Small Metro, a county or census division in a metro area with a population of 50,000 to 249,999; 4) Non-Metro (adjacent), an urban population or census division that shares a boundary with a metro area and has a population greater than 20,000; 5) Non-Metro (non-adjacent), an urban population or census division that does not share a boundary with a metro area and has a population greater than 20,000; 6) Rural (adjacent), an urban population or census division that shares a boundary with a metro area and has a population of 19,999 or less; 7) Rural (non-adjacent), an urban population or census division that does not share a boundary with a metro area and has a population of 19,999 or less (Parker, 2010; Vinodrai, 2001; Du Plessis et al., 2002). The Beale coding system has been previously applied to study of urban-rural geographic status and a variety of health issues in both the US and Canada (Bruner et al., 2008; Jiang et al., 2008; Jemal et al., 2005; Reis et al., 2004).

Screen Time (Outcome)—The three screen time measures were determined using the following questions: “About how many hours a day do you usually watch television (including videos and DVDs) in your free time?”, “About how many hours a day do you usually play video games on a computer or games console (Playstation, Xbox, GameCube, etc.) in your free time?” and “About how many hours a day do you usually use a computer for chatting on-line, internet, emailing, homework, etc. in your free time?” For each question there were 9 response options ranging from “none at all” to “about 7 or more hours a day”. Weighted means of weekday and weekend use were used to calculate the total hours per week. A previous validation study has been conducted on a television viewing time questionnaire that was similar to the one used in the HBSC. It found an adequate and significant correlation ($r=0.47$) with television viewing time, measured by a seven day detailed log among adolescents (Schmitz et al., 2004).

Mediators—Parent mediator variables included family structure, parent-child communication, and parental employment. Family structure was assessed by asking participants a question about who they lived with most of the time, and from these responses four groups were formed: both parents, parent and step parent, single parent, and other (Griesbach et al., 2003). Parent-child communication was assessed by asking participants how easy it is to talk to their father and how easy it is to talk to their mother about things that really bother them. There was a 5-point response scale for each question, ranging from “very easy” to “don’t have or see this person” (Currie et al., 2001). Parental employment was assessed by asking participants if their mother had a job or if their father had a job. Responses formed three groups: yes, no, and other for both mother and father (Currie et al., 2001). The “other” group was for participants who did not know if their mother/father was employed or if they did not have or see their mother/father.

Peer mediator variables included time spent with peers, social environment in the classroom, and communication with peers. Time spent with peers was assessed by the response to two questions regarding the number of days they spend with peers right after school (0–5) and in the evenings (0–7) (Currie et al., 2001). Class social environment was assessed by 3 statements that had a 5-point response (strongly disagree to strongly agree): “The students in my class(es) enjoy being together”, “most of the students in my class(es) are kind and helpful”, and “other students accept me as I am”. Communication with peers was assessed by asking participants, “How often do you talk to your friends(s) on the phone or send them text or e-mail messages or have contact through internet?” The five response options for this question varied from rarely/never to everyday (Currie et al., 2001).

Principal component analysis was conducted for item reduction of the parent support mediator variables and the peer support mediator variables. For parent support, two components with eigenvalues greater than one emerged from the principal component analysis; together these components explained 57.4% of the total variance. For the first component, the strongest loadings were for the family structure (0.69), father-child communication (0.74), and father employment (0.79) items. For the second component, the strongest loadings were for the mother-child communication (0.75) and mother employment (0.74) items. For peer support, two components with eigenvalues greater than one emerged from the principal component analysis; together these components explained 61.4% of the total variance. For the first component the strongest loadings were for the three school class social environment items (0.80, 0.84, 0.76). For the second component, the strongest loadings were for the time spent with peer items (0.83, 0.86) and the communication with peer item (0.58). The Anderson-Rubin method was used to calculate z-scores for each component that was derived from the parent and peer support principal components analyses. Therefore, the scores had a mean of zero, a standard deviation of one and were uncorrelated (Pallant, 2007).

Potential Confounders—Potential confounding variables included age, gender, and socioeconomic status (SES). The family affluence scale was used to assess SES. Participants were divided into 3 categories (low, medium, high) based on 4 indicators of family wealth (car ownership, bedroom sharing, holiday travel, and computer ownership) (Boyce et al., 2006). Physical activity was not considered as a confounder because it is not an independent risk factor for high screen time (Salmon et al., 2008; Biddle et al., 2004).

Statistical Analysis—Analyses were completed using SAS version 9.2 [SAS Institute Inc., Cary, NC]. Descriptive statistics were initially calculated, including the prevalence of screen time behaviors by urban-rural geographic status. To address the two study objectives, the total, direct, and indirect effects illustrated in Figures 1 and 2 were estimated. The total and direct effects were estimated using multiple logistic regression models. The indirect effects were estimated using a bootstrap sampling procedure with 1000 resamples, that took into account multiple mediators (Hayes, 2009; Preacher and Hayes, 2008). This procedure calculated point estimates and bootstrap percentile 95% confidence intervals based on the product of regression coefficients estimated in multiple linear regression models (indirect effects a_1 and a_2 in Figure 2) and multiple logistic regression models (indirect effects b_1 and b_2 in Figure 2) for each resample (Hayes, 2009). There was evidence of mediation if zero was not included in the confidence interval (Hayes, 2009). Multiple mediator models were used to estimate the indirect effect of one mediator variable (e.g., parent support) while controlling for the effects of other mediators (e.g., peer support) (Preacher and Hayes, 2008). Findings from simulation research suggest that this bootstrap sample procedure is one of the most valid and powerful methods for testing mediation (MacKinnon et al., 2002). Age, gender, and SES were the potential confounders identified for the regression analyses based on previous literature describing relationships between urban-rural geographic status and screen time (Bruner et al., 2008; Springer et al., 2009; Springer et al., 2006). However, age and gender were not associated with urban-rural geographic status, and therefore did not meet the assumptions of confounding (Rothman et al., 2008). Thus, all regression models were adjusted for SES only. Additionally, error estimates and 95% confidence intervals (CI) were adjusted in all regression models using either SURVEYLOGISTIC or SURVEYREG procedures to account for clustering by school class. These procedures calculate variance estimates within each cluster and then pool the estimates together. These procedures were also used to weight the US sample based on the oversampling of ethnic groups. Since the screen time categories were not rare outcomes, odds ratios (ORs) obtained from logistic regression models do not approximate relative risk. Therefore, rate ratios (RRs) were derived by adjusting ORs according to the proportion of the outcome in the referent groups (P_0) as follows: $RR = OR / ((1 - P_0) + (P_0 \times OR))$ (Zhang and Yu, 1998). The highest quartile of the screen time variables was predicted in all logistic regression analyses. The middle or non-metro adjacent group was the referent for all analyses involving urban-rural geographic status. The use of this referent group allowed for the exploration of risk in both the extreme urban and extreme rural groups.

RESULTS

Descriptive Analyses

Participant information for the US and Canadian samples are shown in Table 1. Sex and the peer mediator variables were not statistically different in the US and Canadian samples. However, the US sample was slightly younger, had a higher proportion of low SES participants, and had lower percentages of employed parents and two parent homes compared to the Canadian sample. In the US, the average weekly hours of screen time across urban-rural geographic groups ranged from 17.6 to 22.1 for television, 7.9 to 9.3 for video games, and 7.3 to 12.1 for computer use (Table 2). In Canada, the average weekly

hours ranged from 18.4 to 20.7 for television, 10.3 to 12.2 for video games, and 11.9 to 16.2 for computer use. Two sample t-tests revealed that the average weekly hours of television (19.3 vs. 18.9), video game (11.1 vs. 8.4), and computer (14.2 vs. 9.3) use were significantly higher in the Canadian sample than in the US sample.

Total Effect

There were a number of statistically significant differences in high television, video game, and computer use between participants in the non-metro adjacent group and other groups within both the US and Canadian samples (Table 3). Within the US, the most meaningful patterns were observed for the most rural (rural non-adjacent) group, who were 1.97 (95% CI: 0.97–3.96, $P=0.06$) times more likely to be high television users and 0.62 (95% CI: 0.47–0.84) as likely to be high computer users compared to participants in the non-metro adjacent group. Within Canada, the most meaningful patterns were observed for the large metropolitan and medium metropolitan groups. These groups had decreased risks for high television use and increased risks for high computer use in comparison to the non-metro adjacent group.

Direct Effect

Most of the patterns and significant differences between groups that were observed in the total effect models were also found in the direct effect models for both countries (Table 3). The risk ratios for the total effect and direct effect models also tended to be very similar.

Indirect Effects

Because of the fixed residual variance, the outcome variables for different logistic regression models have different scales and the indirect effects for logistic regression models cannot be calculated as the total effects minus the direct effects (Hayes, 2009; MacKinnon, 2008). Therefore, the extent of mediation and the indirect effects need to be interpreted based on the findings from the bootstrapping procedure that are presented in Table 4 (US) and Table 5 (Canada). The point estimates for the indirect effects are based on the original dichotomous scales of the urban-rural geographic status and screen time variables (Hayes, 2009). For example, urban-rural geographic status was coded 1 for exposure and 0 for the reference group, non-metro adjacent. The screen time measures were coded 1 for high or quartile 4 and 0 for quartiles 1 through 3. Therefore, the point estimates can be interpreted as how much the screen time measure is expected to increase (positive point estimate) or decrease (negative point estimate), indirectly through the parent or peer support mediator variables, with one-unit change in urban-rural geographic status (Hayes, 2009; MacKinnon, 2008). Because high screen time is a dichotomous outcome, the potential range of the point estimate is 0 to 1 for positive mediators and 0 to -1 for negative mediators.

With one exception, in the US sample there was no statistical evidence that parent or peer support mediated the relationship between urban-rural geographic status and the screen time measures (Table 4). The one exception was in the rural non-adjacent group, where a modest indirect effect for peer support was observed for the computer use measure. The point estimate was 0.18 for this indirect effect; implying computer use is expected to increase 0.18 units indirectly through peer support when moving from the non-metro adjacent group to the rural non-adjacent group. For the remaining indirect effects, the point estimates were 0.07 or less.

In Canada, there was statistical evidence that parent and peer support mediated some of the relationships (11 out of 36) between urban-rural geographic status and the screen time measures (Table 5). However, with one exception the point estimates were 0.05 or less, suggesting that irrespective of statistical significance, the magnitude of the indirect effect

was small. Similar to the US, the one exception was for the rural non-adjacent group wherein a modest point estimate of 0.18 was observed for the indirect effects of peer support.

DISCUSSION

This study examined urban-rural differences in individual screen time behaviors, as well as the potential mediating effect of parent and peer support on these differences, in large cross-sectional samples of American and Canadian youth. In comparison to the referent group, American youth from the most rural areas were more likely to be high television users and less likely to be high computer users. On the contrary, high television use was less likely and high computer use was more likely for Canadian youth living in large and medium metropolitan areas. For the most part, the relationships between urban-rural geographic status and screen time behaviors were not mediated by parent or peer support.

Five previous studies have examined urban-rural differences in screen time among youth. The findings of these studies are mixed. Two of these studies reported no differences in television, video game, and/or computer use between urban and rural youth (Bathrellou et al., 2007; Davis et al., 2008). Conversely, in the 2003 US Youth Risk Behavior Survey, boys living in urban areas were more likely to be high video/computer game users compared to boys living in suburban or rural areas (Springer et al., 2006). The opposite association was observed between urban-rural geographic status and video/computer game use in a sample of grade eight boys from Texas (Springer et al., 2009). The inconsistency in findings across the previous literature and with the present study may be due to different measures of screen time as well as different definitions of urban-rural geographic status. A multi-point ordinal scale to measure urban-rural geographic status was only considered in one previous study (Bruner et al., 2008); however, it is hard to compare this study with the present one since television and computer use were not considered separately. A key observation of our study is that when relations exist between urban-rural status and screen time, they tend to be in opposite directions for the television and computer screen time measures.

As indicated above, there were instances in this study where specific urban-rural geographic status groups had an increased risk for one type of screen time behavior and a corresponding decreased risk for another type. For example, Canadian participants from large and medium metropolitan areas were more likely to be high computer users and less likely to be high television users in comparison to participants from non-metro adjacent areas. This suggests that computer use may have been replacing some of the television use in youth living in large and medium metropolitan areas (Nelson et al., 2006). Conversely, American participants in the rural non-adjacent group were more likely to be high television users and less likely to be high computer users compared to participants in the non-metro adjacent group. Poor accessibility of computers, or perhaps of high speed internet, may explain this relationship. This speculation was supported by additional analyses, which found that families of American participants living in rural non-adjacent areas were less likely (RR= 0.45, 95% CI: 0.20– 1.00) to own two or more computers compared to participants from non-metro adjacent areas.

Interestingly, in the present study different patterns were observed between urban-rural geographic status and screen time activities between the US and Canada. Participants in metropolitan areas in the US did not appear to replace television use with computer use, as was speculated in Canada. This finding may be due to differences in access to computers in metropolitan areas between countries. For example, participants from metropolitan areas in the US were significantly less likely to have access to a family computer compared to participants from metropolitan areas in Canada ($P<0.001$). Lower access to computers may

also explain the different patterns of risk estimates for computer use between American and Canadian participants in rural areas. For example, compared to Canadian participants, a larger proportion of rural adjacent (2% vs. 8%) and rural non-adjacent (6% vs. 14%) American participants did not have access to a family computer. Furthermore, rural areas in the US have lower access to high-speed internet compared to rural areas in Canada. For example, in 2008 it was estimated that 41% of American rural households had broadband internet access (Stenberg et al., 2009), while in 2010 it was estimated that 78% of Canadian rural households had broadband internet access (Canadian Radio-television and Telecommunications Commission). Along with differences in risk estimates, there were also overall differences in average television, video game, and computer use between countries. This could be due to shorter daylight hours and colder temperatures in Canada during the fall and winter months when the survey was completed. Thus, American youth may have spent more of their free time outdoors away from televisions, video game consoles, and computers (Hillman, 2009).

We are unaware of previous studies that have attempted to explain the urban-rural differences in screen time among youth. Thus, our observation that parent or peer support did not strongly mediate the relationships in both American and Canadian samples provides a novel contribution to the literature. This finding could potentially be the result of misclassification of participants due to measurement error associated with the exposure, outcome, and mediation variables as described in more detail below in the limitations paragraph. Conversely, a second potential reason for this finding is parent and peer support may not represent the mechanisms that drive the urban-rural differences in screen time use. Thus, other potential mediator variables should also be explored in future studies. For example, as previously noted, internet accessibility may explain some of the differences. In addition, neighborhood environmental factors that predict excessive screen time use, such as perceptions of safety (Burdette et al., 2004), satisfaction of services (Carson et al., 2010), and availability of sidewalks and parks (Carson et al., 2010), may also differ across urban-rural geographic status groups (Loucaides et al., 2004).

From a public health standpoint, it is important to understand if and why differences exist in individual screen time behaviors among urban-rural subgroups of the youth population. This knowledge could inform future interventions aimed at reducing screen time among young people across geographic regions. For example, perhaps specific subgroups or specific screen-time behaviors should be targeted. The current findings suggest that screen time is high in all youth, regardless of country of residence and urban-rural geographic status. However, youth in the most rural areas in the US, as well as youth from suburban areas in Canada may benefit the most from efforts aimed at replacing some time spent watching television with other non-screen time activities. In addition, youth from metro areas in Canada may benefit the most from efforts aimed at replacing some time spent using the computer with other non-screen time activities.

Strengths of this study include the multiple country evaluation, use of large population-based samples, the multiple mediator analyses, and the comprehensive measure of urban-rural geographic status. A primary limitation of this study is the cross-sectional design, which limits the ability to make causal inferences about the relationships observed. Also, our final samples were not representative of the population in terms of age and gender, although this was unlikely to influence the observed relationships. An additional limitation is the use of self-report data for the screen time measures as well as the parent and peer support variables. Biases associated with these self-reported data may have resulted in over or under estimates of the true effect. Finally, because all surveys were anonymous, the calculation of urban-rural geographic status was based on the postal codes of participants' schools and not

their residences. Therefore, we are making the assumption that all participants' residences can be categorized with the same geographic status as their schools.

In conclusion, there were some differences in screen time activities in youth according to the size of their community and its proximity to metropolitan settlements; however, parent or peer support did not strongly mediate any relationships. Nonetheless, these findings suggest that interventions and public health initiatives aiming to reduce screen time in youth may be most effective if they consider the location of residence and the specific screen time behavior.

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Figure 1.
The total effect of urban-rural geographic status on screen time behaviors (television, video games, and computers) (Hayes, 2009).

Figure 2.

The direct effect and indirect effects of urban-rural geographic status on screen time behaviors (television, video games, and computers), when considering parent and peer support as mediator variables (Hayes, 2009).

Table 1**Participant information**

	US (N = 8563)	Canada (N = 8990)
<i>Potential Confounders</i>		
Sex (%)		
Male	47.9	46.8
Female	52.1	53.2
Grade (%)		
6	25.5	17.1
7	20.2	18.3
8	20.0	19.8
9	16.4	24.1
10	17.9	20.8
SES (%)		
Low	26.9	9.1
Medium	48.9	39.5
High	24.2	51.4
<i>Parent Support Mediators</i>		
Family Structure (%)		
Both Parents	48.2	64.6
Parent + step parent	21.1	17.2
Single Parent	12.3	9.9
Other	18.4	8.4
Parent-Child Communication		
Mother [†]	4.0 (1.0)	4.0 (1.0)
Father [†]	3.5 (1.0)	3.6 (1.2)
Mother Employment (%)		
Yes	74.4	81.8
No	22.1	16.2
Other	3.5	2.0
Father Employment (%)		
Yes	77.5	89.3
No	5.4	4.7
Other	17.1	6.1
<i>Peer Support Mediators</i>		
Time Spent with Peers [†]	2.6 (1.8)	2.7(1.7)
Social Class Environment [†]	3.5 (0.9)	3.7 (0.7)
Communication with Peers [†]	3.3 (1.5)	3.7 (1.39)

Data presented as mean (standard deviation) or %.

SES = socioeconomic status

[†]Range of values was 1–5.

[†]Range of values was 0–7.

Table 2

Mean (standard deviation) weekly hours for screen time (television, video games, and computer) per urban-rural geographic status.

Urban-Rural Geographic Status	Television		Video Games		Computer	
	US	Canada	US	Canada	US	Canada
Large metro	19.0(13.0)	19.3(12.1)	8.4(10.8)	11.8(13.2)	9.9(10.9)	16.2(14.0)
Medium metro	17.6(12.5)	18.8(12.2)	7.9(10.7)	10.6(12.6)	8.4(10.6)	15.3(13.3)
Small metro	19.4(12.9)	19.1 (12.1)	9.3(11.4)	11.1(12.5)	8.6(10.9)	13.4(12.7)
Non-Metro Adjacent	17.8(13.0)	20.3 (12.7)	8.1 (10.5)	11.5(12.7)	8.8(10.8)	13.1 (12.7)
Non-Metro Non-Adjacent	20.7 (13.2)	18.4(11.9)	8.8 (10.2)	10.3(11.3)	12.1(13.1)	13.7(12.3)
Rural adjacent	18.2(12.4)	18.8(11.7)	8.0(10.2)	10.9(11.3)	7.3 (9.7)	11.9(12.2)
Rural Non-Adjacent	22.1 (14.2)	20.7 (12.7)	9.2(10.9)	12.2(12.8)	7.9(10.8)	14.9(13.4)

Table 3

The total and direct effects for the relationship between urban-rural geographic status and screen time use with parent and peer support as mediator variables.

Urban-Rural Geographic Status	Television			Video Games			Computer					
	Total Effect		Direct Effect	Total Effect		Direct Effect	Total Effect		Direct Effect			
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI		
US												
Large Metro	1.15	1.10, 1.21*	1.16	1.03, 1.31*	0.97	0.69, 1.36	0.97	0.68, 1.38	1.19	0.81, 1.75	1.15	0.80, 1.64
Medium Metro	0.95	0.79, 1.17	0.98	0.74, 1.29	0.83	0.48, 1.42	0.84	0.48, 1.46	0.83	0.42, 1.64	0.82	0.41, 1.62
Small Metro	1.22	1.17, 1.27*	1.17	1.07, 1.28*	1.10	1.02, 1.17*	1.07	1.00, 1.13*	0.98	0.58, 1.66	0.89	0.55, 1.45
Non-Metro Adjacent	1.00 (referent)		1.00 (referent)		1.00 (referent)		1.00 (referent)		1.00 (referent)		1.00 (referent)	
Non-Metro Non-Adjacent	0.96	0.30, 3.03	0.94	0.29, 3.05	1.04	0.86, 1.25	1.02	0.85, 1.22	1.67	1.21, 2.30*	1.62	1.30, 2.02*
Rural Adjacent	0.88	0.85, 0.91*	0.91	0.85, 0.99*	0.72	0.71, 0.73*	0.73	0.72, 0.74*	0.83	0.68, 1.02 [‡]	0.85	0.74, 0.99*
Rural Non-Adjacent	1.97	0.97, 3.96 [‡]	1.82	0.84–3.92	0.89	(0.50, 1.56)	0.84	0.45, 1.58	0.62	0.47, 0.84*	0.51	0.36, 0.72*
Canada												
Large Metro	0.79	0.63, 0.99*	0.78	0.62, 0.97*	1.09	0.86, 1.39	1.11	0.87, 1.40	1.40	1.08, 1.81*	1.42	1.10, 1.82*
Medium Metro	0.82	0.67, 0.99*	0.81	0.66, 0.99*	0.93	0.78, 1.11	0.92	0.77, 1.10	1.33	1.06, 1.67*	1.30	1.05, 1.62*
Small Metro	0.77	0.64, 0.94*	0.76	(0.63, 0.92)*	0.98	0.83, 1.14	0.96	0.82, 1.12	1.07	0.88, 1.30	1.03	0.85, 1.24
Non-Metro Adjacent	1.00 (referent)		1.00 (referent)		1.00 (referent)		1.00 (referent)		1.00 (referent)		1.00 (referent)	
Non-Metro Non-Adjacent	0.72	0.54, 0.96*	0.71	0.53, 0.95*	0.87	0.67, 1.12	0.86	0.66, 1.12	1.02	0.77, 1.34	1.01	0.77, 1.32
Rural Adjacent	0.85	0.60, 1.20	0.84	0.59, 1.20	0.90	0.66, 1.20	0.89	0.67, 1.17	0.83	0.46, 1.49	0.80	0.46, 1.37
Rural Non-Adjacent	1.01	0.74, 1.37	1.01	0.74, 1.38	1.10	0.79, 1.53	1.06	0.75, 1.47	1.35	0.91, 1.98	1.15	0.78, 1.70

Data presented as risk ratio (95% confidence interval);

* $P \leq 0.05$;

[†] $P = 0.06$;

[‡] $P = 0.08$.

The total effect models predicted the highest quartile of screen time variables, adjusted for socioeconomic status, and accounted for the clustered sampling design and the US sample weights.

The direct effect models predicted the highest quartile of screen time variables, adjusted for parent and peer support in addition to socioeconomic status, and accounted for the clustered sampling design, and the US sample weights.

Table 4

The indirect effects for the relationship between urban-rural geographic status and screen time use with parent and peer support as mediator variables in the American sample

	Parent Support		Peer Support	
	Point Estimate	Percentile 95% CI	Point Estimate	Percentile 95% CI
Urban-Rural Geographic Status				
<i>Television</i>				
Large Metro	-0.01	-0.05, 0.03	<-0.01	-0.02, 0.01
Medium Metro	-0.03	-0.07, 0.01	<-0.01	-0.02, 0.01
Small Metro	0.03	-0.02, 0.08	0.01	-0.01, 0.03
Non- Metro Adjacent	0 (referent)	0 (referent)	0 (referent)	0 (referent)
Non-Metro Non-Adjacent	0.02	-0.03, 0.08	<0.01	-0.02, 0.03
Rural Adjacent	-0.04	-0.09, 0.02	<-0.01	-0.03, 0.02
Rural Non-Adjacent	0.07	-0.01, 0.14	0.02	-0.03, 0.06
<i>Video Games</i>				
Large Metro	<-0.01	-0.02, 0.01	<0.01	-0.02, 0.02
Medium Metro	-0.01	-0.03, 0.01	<-0.01	-0.02, 0.02
Small Metro	0.01	-0.01, 0.04	0.02	-0.01, 0.04
Non- Metro Adjacent	0 (referent)	0 (referent)	0 (referent)	0 (referent)
Non-Metro Non-Adjacent	0.01	-0.01, 0.03	0.01	-0.02, 0.03
Rural Adjacent	-0.01	-0.04, 0.01	-0.01	-0.03, 0.01
Rural Non-Adjacent	0.02	-0.01, 0.06	0.03	-0.02, 0.08
<i>Computer</i>				
Large Metro	<0.01	-0.01, 0.02	0.03	-0.01, 0.08
Medium Metro	<-0.01	-0.02, 0.02	0.01	-0.05, 0.05
Small Metro	0.01	<-0.01, 0.04	0.07	0.02, 0.13
Non- Metro Adjacent	0 (referent)	0 (referent)	0 (referent)	0 (referent)
Non-Metro Non-Adjacent	0.01	-0.01, 0.03	0.03	-0.04, 0.10
Rural Adjacent	-0.01	-0.03, 0.01	-0.02	-0.09, 0.05
Rural Non-Adjacent	<0.01	-0.03, 0.03	0.18	0.10, 0.28*

Point Est. = Point Estimate; Percentile 95% CI = Bootstrap percentile 95% confidence interval. Socioeconomic status was adjusted for in all analyses. The clustered sampling design and sample weights were taken into account in all analyses.

* $P < 0.05$.

Table 5

The indirect effects for the relationship between urban-rural geographic status and screen time use with parent and peer support as mediator variables in the Canadian sample

	Indirect Effect			
	Parent Support		Peer Support	
	Point Estimate	Percentile 95% CI	Point Estimate	Percentile 95% CI
Urban-Rural Geographic Status				
<i>Television</i>				
Large Metro	0.02	0.01,0.03*	-0.01	-0.02,<0.01
Medium Metro	0.01	<0.01,0.02*	<0.01	-0.01,0.01
Small Metro	0.01	<0.01,0.02*	0.01	<-0.01, 0.01
Non- Metro Adjacent	0 (reference)	0 (reference)	0 (reference)	0 (reference)
Non-Metro Non-Adjacent	0.01	<-0.01,0.02	0.01	-0.01,0.02
Rural Adjacent	0.01	<-0.01,0.02	<0.01	-0.01,0.02
Rural Non-Adjacent	<-0.01	-0.01,0.01	<0.01	-0.02, 0.03
<i>Video Games</i>				
Large Metro	0.01	-0.01, 0.02	-0.02	-0.03,<-0.01*
Medium Metro	<0.01	-0.01,0.01	0.01	-0.01,0.02
Small Metro	0.01	<-0.01,0.01	0.02	<0.01, 0.03*
Non- Metro Adjacent	0 (reference)	0 (reference)	0 (reference)	0 (reference)
Non-Metro Non-Adjacent	<0.01	-0.01,0.01	0.01	-0.01,0.03
Rural Adjacent	<0.01	-0.01,0.01	0.01	-0.01,0.04
Rural Non-Adjacent	<-0.01	-0.01,<0.01	0.05	0.02, 0.08*
<i>Computer</i>				
Large Metro	0.05	0.03, 0.07*	-0.04	-0.08,<0.01
Medium Metro	0.03	0.01,0.04*	0.03	-0.01,0.06
Small Metro	0.02	<0.01,0.03*	0.04	<0.01,0.07*
Non- Metro Adjacent	0 (reference)	0 (reference)	0 (reference)	0 (reference)
Non-Metro Non-Adjacent	0.02	<-0.01,0.04	-0.01	-0.06, 0.05
Rural Adjacent	0.02	-0.01,0.05	0.03	-0.04, 0.09
Rural Non-Adjacent	<-0.01	-0.02, 0.02	0.18	0.13,0.24*

Point Est. = Point Estimate; Percentile 95% CI = Bootstrap percentile 95% confidence interval. Socioeconomic status was adjusted for in all analyses. The clustered sampling design and sample weights were taken into account in all analyses.

* $P < 0.05$.