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Are associations between the perceived home and neighbourhood environment and children’s physical activity and sedentary behaviour moderated by urban/rural location?
Introduction

Public health recommendations in Australia suggest that children spend 60 minutes or more every day in at least moderate-intensity physical activity, and no more than two hours per day in screen-based behaviours for entertainment (e.g., television viewing, electronic games, computer use) (Australian Government Department of Health and Ageing, 2004). However, the 2007 National Nutrition and Physical Activity Survey found that just 20-40% of 9-16 year olds meet the physical activity recommendations and only 3% met the screen-based guidelines (Commonwealth Scientific Industrial Research Organisation (CSIRO), 2008). The distribution of these behaviours across the population is not homogenous and has been found to differ, for example, according to gender, socio-economic status (Brug et al., 2012b) and ethnicity (Brug et al., 2012a), as well as area of residence.

Related to the latter, in a study of over 3,000 children in the US, urban children engaged in less self-reported physical activity than did their rural counterparts, while children from small cities reported the highest levels of activity (Joens-Matre et al., 2008). A study of 11-12 year old Greek children used pedometers to examine differences in steps on weekdays according to urban/rural location (Loucaides et al., 2004). Seasonal differences in children’s steps by location were found, with children in urban areas recording significantly more steps in winter and rural children recording significantly more steps in summer. While these differences are intriguing, none of the aforementioned studies adjusted for socioeconomic position (SEP), a potentially important confounder of urban/rural differences in health behaviour.

A recent study of almost 5,000 Canadian adolescents in school years six to 10 that did adjust for SEP found no differences in self-reported physical activity by region of residence, but young people living in more rural areas were significantly less likely to be in the high screen
time category compared with participants living in large metropolitan areas (Bruner et al., 2008). These findings are similar to those of the Australian READI study of 373 5-12 year olds which reported that boys living in low SEP rural areas were three times more likely to exceed screen recommendations compared with boys living in low SEP urban areas (Hume et al., 2012). That study also adjusted for maternal education; however, no differences in children’s objectively-assessed physical activity by urban or rural location were identified.

Even with inconsistent evidence of variations in physical activity and sedentary behaviour among urban and rural children, there may be differences in family and neighbourhood environmental influences on these behaviours by area of residence. Ecological models of health behaviour (Bronfenbrenner, 1979; Brug et al., 2010; Davison and Birch, 2001) suggest that aspects of the home and neighbourhood environment are likely to be related to children’s physical activity and sedentary behaviour (Davison and Lawson, 2006; Ferreira et al., 2007), and these associations may be moderated by a range of social demographic as well as personal variables. However, few studies have examined whether perceived home and neighbourhood environmental correlates of children’s physical activity and sedentary behaviour differ by urban or rural location.

This study aimed to examine associations between parents’ perceived home and neighbourhood environments and children’s objectively-assessed physical activity and sedentary time, and proxy-reported screen-based behaviours (main effects), and then to examine whether these associations were moderated by living in urban versus rural low SEP areas controlling for maternal education level. Examining whether living in an urban or rural location moderates associations between the perceived home and neighbourhood environments and children’s physical activity and sedentary behaviour is important for
informing the development of interventions that are appropriately tailored for the population of interest. We hypothesised that living in an urban versus rural location would moderate the association between the perceived neighbourhood environment and children’s physical activity and sedentary behaviour, and that the neighbourhood environment would be less important among rural compared with urban children.

Methods

Participants

Between 2007-8, data were collected from a cohort of women (aged 18-45 years) and their children (5-12 years) participating in the Resilience for Eating and Activity Despite Inequality (READI) study. The methods have been described in more detail elsewhere (Ball et al., 2012). Ethics approval to conduct the study was received from the Deakin University Human Research Ethics Committee, the Catholic Education Office and the Victorian Department of Education and Early Child Development.

Using the electoral roll (voting is compulsory in Australia), participants were randomly selected from a total sampling pool of 11,940 women identified as living in the bottom third of socioeconomically disadvantaged areas of Victoria, Australia (approximately 150 women from each of 40 rural and 40 urban areas). Disadvantage was based on the Socioeconomic Index for Areas (SEIFA) developed by the Australian Bureau of Statistics from census data (Australian Bureau of Statistics, 2006). Using a classification of cities (urban), fringe and rural areas consistent with the Australian Regional Infrastructure Development Fund Act 1999 (Version No. 003), urban areas were defined as metropolitan Melbourne, rural cities with a population >20,000, and all suburbs completely within a 10km radius of the centroid of these rural cities. Rural areas were defined as falling outside of metropolitan Melbourne.
and outside of a 25km radius of the rural cities with a population >20,000. The average population and geographic area of the 40 rural areas was 4,450 (SD=3,196) residents and 95.1 (SD=74.1) km² respectively, whereas the 40 sampled urban areas had an average population of 10,703 (SD=7,616) and average geographic area of 7.3 (SD=7.4) km². To maximize response rates, a reminder protocol (Dillman, 2000) was employed with letters sent to non-responders ten days after the initial survey package was mailed, followed by a second reminder letter including another copy of the survey a further ten days later.

A total of 4,934 young women (41%) responded to a postal invitation to complete a questionnaire. All participants’ residential addresses were geocoded and if they lived outside of the above definition they were excluded from the study. Participants were also deemed ineligible if they had moved from the sampled suburb prior to completing the survey (n=571), if the person who completed the survey was not the intended participant (n=3), if the respondent withdrew their data after completing the survey (n=2), or if the respondent was <17 or ≥46 years old (n=9). Of the 4,349 eligible women, those with a 5- to 12-year old child (n=1,457) were invited to complete an additional survey about their child (based on the next-birthday method), with 771 (53%) agreeing to do so. Those mothers were mailed a survey and a reply paid envelope, and a time was arranged to visit the child’s school or home for the administration of an accelerometer to objectively measure children’s physical activity and sedentary behaviour. Child surveys were received from 613 mothers, and these 613 children were included in this analysis.

Measures

The READI study was based on an ecological framework (Bronfenbrenner, 1979), with survey measures designed to capture personal or individual-level factors, social and family
environmental factors and neighbourhood environmental factors based on previous literature (Davison and Birch, 2001; Gorely et al., 2004; Sallis et al., 2000; van der Horst et al., 2007) and hypothesised to be associated with children’s physical activity and sedentary behaviour. Children’s physical activity and sedentary time was objectively assessed using accelerometry, and the time spent in screen-based behaviours was assessed by maternal proxy-report. The explanatory variables assessing the proxy-reported home and neighbourhood environments were derived from previously published measures (Salmon et al., 2005; Timperio et al., 2004; Timperio et al., 2008).

**Physical activity and sedentary behaviour**

*Physical activity and sedentary time from accelerometry*

Children wore an Actigraph accelerometer (GT1M, Pensacola, FL) for eight consecutive days during waking hours. During the home/school visit, children were fitted with the accelerometer on their right hip and provided with instructions on the care of the accelerometer as well as a reply-paid envelope to post the accelerometer back to the research team. The accelerometers were pre-programmed to collect data in one-minute epochs and once returned, data were downloaded. Minutes per day in at least moderate-intensity physical activity (≥4 metabolic equivalents of rest, METs) were calculated using an established age-adjusted regression equation (Trost et al., 2002). Time spent sedentary was calculated based on the number of minutes spent at <100 counts per minute for each day (Treuth et al., 2004).

Using an MS Excel Macro, durations of non-wearing periods were identified (defined as 20-minutes or more of consecutive zeros) (Cain et al., In press; Esliger et al., 2005) and subtracted from the total possible wear time for each 24-hour period. The average time (mins/day) spent in physical activity and being sedentary was calculated for children who had
at least three valid weekdays and one valid weekend day of data \( (n=467, 146 \text{ excluded}) \). Those who complied with wearing the device had significantly older mothers \( (M=38.9, SD=4.9) \) than those who did not \( (M=37.1, SD=5.4) \). A valid day was defined as having between eight hours \( \text{Anderson et al., 2005; Rowlands et al., 2008} \) and 18 hours \( \text{to exclude children who wore the device to bed} \) of wear time. The proportion of children who met the current Australian physical activity recommendations \( \geq 60 \text{ minutes/day of at least moderate-intensity physical activity on each recorded valid day} \) was calculated.

*Screen-based behaviours*

Mothers reported the time \( \text{hours/minutes} \) their child spent in a typical week watching television/videos/DVDs Mondays to Fridays and Saturdays and Sundays. Mothers also reported the time their child spent playing electronic games and using the computer/Internet Mondays to Fridays and Saturdays and Sundays \( \text{Salmon et al., 2005} \). Reliability of these items ranged from ICC \( 0.6-0.8 \), and validity from Rho \( 0.44-0.61 \). The total time spent in these screen-based behaviours Monday to Friday was summed and divided by five \( \text{minutes per weekday} \), time spent on weekends was summed and divided by two \( \text{minutes per weekend day} \), and the total weekly time was summed and divided by seven \( \text{minutes per day} \).

Children meeting Australian screen-based recommendations of \( <120 \text{ minutes per day} \) \( \text{Australian Government Department of Health and Ageing, 2004} \) was calculated as the percentage of children who had an average screen time of \( <120 \text{ minutes on weekdays and <120 minutes on an average weekend day} \).
Personal, home and neighbourhood perceived environmental factors

Mothers’ and children’s demographic information

Mothers self-reported their age (years), whether they were born in Australia or elsewhere, their level of education, which was used as an indicator of SEP (no formal education or year 10/equivalent = ‘<12 years’; having completed year 12 or equivalent, a trade/apprenticeship, or certificate/diploma = ‘12 years’; or having a university degree or higher university degree =>12 years’), their employment status (full-time, part-time, not currently employed), and their marital status (not married, married/de facto, previously married). They also reported on the sex and age (years) of their child, and the child’s siblings (none, one or more).

Home physical activity environment

Parental social support for physical activity

Parental social support and praise for their child’s physical activity was assessed using four items: How often do the following people provide support for your child’s participation in physical activity? (e.g. take him/her to training, provide money for participation, buy sports clothing/equipment): ‘You’, ‘Child’s co-carer’. How often do each of the following people praise your child for participating in physical activity? (e.g., say positive things to him/her, seem happy that he/she does it): ‘You’, ‘Child’s co-carer’. Response options were converted into a frequency score per week: don’t know/doesn’t apply=0, never=0, less than once a week=0.5, 1-2 times per week=1.5, 3-4 times per week=3.5, 5-6 times per week=5.5, daily=7. Mother and co-carer scores (where applicable) for providing support and praise were summed to give an overall score (range 1-28) for parental social support for physical activity (Cronbach’s alpha = 0.74) with a higher score indicating greater social support for physical activity.
Importance of doing physical activity as a family

The importance of being physically active with their child as a family was measured using one item: How important is it (to you) that the family does sport or other physical activity together (e.g. goes for walks)? (response scale: very important=1, quite important=2, not really important=3).

Home access to physical activity equipment

This variable was assessed with an audit list of 12 physical activity items (0=no, 1=yes):
Which of the following do you have outside of your home or in your yard? ‘swimming pool / spa’, ‘trampoline’, ‘basketball ring’, ‘sandpits / swings / play equipment’. Does your child have access to the following things at home? ‘balls’, ‘bats/racquets/golf clubs’, ‘bikes’, ‘home gym equipment’, ‘rollerblades’, ‘skateboard’, ‘skipping rope’, ‘scooter’. These were summed into a total physical activity equipment score (range 0-12).

Home sedentary behaviour environment

Maternal self-efficacy for preventing child from engaging in sedentary behaviours

Mothers’ self-reported self-efficacy for reducing their child’s sedentary behaviour (How confident are you that you could do the following over the next year?) was assessed (with a 5-point scale ranging from not at all confident=1, extremely confident=5) using 3 items: ‘Say no to my child’s demands to watch TV/videos/DVD’, ‘Say no to my child’s requests to play on the computer’, ‘Get my child to do something physically active, like dancing, skipping, playing outside, when they want to play on the computer or watch TV’. These items were summed and averaged to create a maternal self-efficacy score for reducing their child’s sedentary behaviour (Cronbach’s alpha = 0.82) with a higher score indicating greater maternal self-efficacy.
Sedentary behaviour as a reward for good behaviour

Allowing the child to participate in sedentary behaviour as a reward for good behaviour was assessed with two items (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘I let my child watch TV as a reward for good behaviour’, ‘I let my child play computer/video games in exchange for good behaviour’. These items were summed and averaged (Cronbach’s alpha = 0.85) with a higher score indicating greater use of sedentary behaviour as a reward for good behaviour.

Rules to limit sedentary behaviour

This variable was assessed with five items (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘My child is not allowed to watch TV/play Playstation©/Nintendo© until his/her homework is done’, ‘During meal times, I do not allow the TV to be on’, ‘My child must be supervised when watching TV’, ‘My child must be supervised on the Internet or when playing Playstation©/Nintendo©’, ‘I limit the amount of time my child spends watching TV/using the computer (internet and games)’. These items were summed and averaged (Cronbach’s alpha = 0.65) with a higher score indicating more rules to limit sedentary behaviour (Timperio et al., 2008).

Home access to sedentary items

Access to sedentary items in the home was assessed with an audit checklist of six items (no=0, yes=1): Does your child have access to the following things at home? ‘free to air TV’, ‘pay TV’, ‘video / DVD player’, ‘Playstation© / Nintendo© / Gameboy© / X-box©’, ‘computer’, ‘internet’. These were summed into a total sedentary items score (range 0-6).
Presence of a television in the child’s bedroom

Whether the child had a television set in the bedroom was assessed as a separate item (no=0, yes=1): Does your child have a TV in his/her bedroom?

Perceived neighbourhood social and physical environments

Descriptive norms for physical activity

Descriptive norms for physical activity were assessed with two items (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘Lots of kids we know play sport’, ‘Lots of kids we know play outdoors’. These scores were summed and averaged (Cronbach’s alpha = 0.61) with a higher score indicating higher descriptive norms for physical activity.

Neighbourhood has good places to play

The mothers’ perception of the neighbourhood physical environment was assessed using a single item (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘The neighbourhood I live in has lots of good places for my child to play and be active’.

Knowledge of neighbourhood

The child’s familiarity or knowledge of his or her neighbourhood was assessed using a single item (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘My child knows our local area very well’.

Neighbourhood social network

The mothers’ perceptions of the strength of their child’s social network were assessed using three items (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘My child often visits other children and families in my area’, ‘My child’s friends live too far
away from home to see on a regular basis’ (reverse-coded), and ‘There are not many other children nearby for my child to play or hang around with’ (reverse-coded). These scores were summed and averaged (Cronbach’s alpha = 0.75) with a higher score indicating a stronger social network.

**Neighbourhood personal safety**

Maternal perceptions of personal safety for their child in the neighbourhood were assessed using four items (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘My neighbourhood is safe for children’, ‘My neighbourhood is safe for my child to walk/cycle around in the daytime’, ‘Concerns about stranger danger prevent my child from going outside in my local area’ (reverse scored), and ‘My child would be safe walking home from a bus or train stop’. These scores were summed and averaged (Cronbach’s alpha = 0.79) with a higher score indicating greater perceived personal safety.

**Neighbourhood road safety concerns**

Mothers’ concerns for their child regarding road safety in the neighbourhood were assessed using four items (with a 5-point scale ranging from strongly disagree=1, strongly agree=5): ‘There are major barriers to walking/cycling that make it hard for my child to get from place to place (e.g. freeways, major roads)’, ‘There are no lights/crossings/pedestrian overpasses for my child to use’, ‘My child would have to cross several roads to get to areas where he/she can play or hang out’, and ‘My child would have to cross a busy road / major highway to get to areas where he/she can play or hang out’. These scores were summed and averaged (Cronbach’s alpha = 0.78) with a higher score indicating greater concerns about road safety.
Data analysis

Proxy-reported time spent in screen-based behaviours was significantly skewed and so a square-root transformation was used to render this measure normal. Descriptive statistics for this measure were calculated for the raw variable, while the transformed variable was used in all inferential analyses. Chi-square tests were used to compare differences in categorical dependent and independent variables between urban and rural location. Differences according to urban and rural location were calculated using independent-samples t-tests or ANCOVA for the continuous dependent and independent variables. Main effects were examined using linear regression models to explore associations between home and neighbourhood variables and the average minutes per day spent in physical activity, the average minutes per day spent sedentary (as measured by accelerometers), and the average minutes per day spent in screen-based behaviours (as assessed by parental reports).

Moderator effects were subsequently examined by additionally including into the linear regression models the main effect of urban/rural location (the moderator) followed by the interaction between each of the independent variables and urban/rural location (Frazier et al., 2004). All main and moderator effects were adjusted for maternal education, children’s age and sex, and clustering by neighbourhood (the unit of sampling). Models that included accelerometer-based physical activity and sedentary time were also adjusted for average daily accelerometer wear time. If there was a significant moderator effect (defined as an alpha level of p<0.05), then the sample was stratified by urban/rural location and linear regression models were performed to examine associations between the independent and dependent variables within area of residence. All analyses were performed using Stata (Version 12, StataCorp, College Station, USA).
Results

A total of 613 children (47% boys; mean age 9.4 ±2.2 years) and their mothers were included in the study. There were a number of significant differences in sociodemographic characteristics between mothers living in rural compared to urban areas (Table 1). Mothers in rural areas were more likely to be born in Australia and to be in a married/de facto relationship than mothers living in urban areas. A higher proportion of children living in rural areas had one or more siblings compared with children living in urban areas.

Table 2 shows that there were no significant differences in the average time per day spent in objectively-assessed moderate- to vigorous-intensity physical activity between urban and rural children, or in the objectively-assessed average time per day spent sedentary. However, children in urban areas spent significantly more time in proxy-reported screen-based behaviours per day than did children from rural areas. Just one-in-five children met the physical activity recommendations and even fewer (15%) met the screen recommendations. More children met screen recommendations on weekdays (53%) compared with weekend days (17%). No differences were observed between urban and rural children in terms of meeting recommendations for physical activity or screen time.
Table 3 presents differences between perceived home and neighbourhood factors by urban or rural location. Mothers from rural locations reported significantly more physical activity equipment in the home compared with mothers from urban locations. Compared with mothers from urban areas, those from rural locations also had significantly higher scores on descriptive norms for physical activity, on their child’s proxy-reported knowledge or familiarity with their neighbourhood, their child’s neighbourhood social network, and on their child’s personal safety in the neighbourhood.

Main effects for the perceived home and neighbourhood environment and physical activity

Table 4 shows results of multiple linear regression models estimating the associations of the perceived family and neighbourhood environment with children’s physical activity, sedentary and screen time. Descriptive norms for physical activity, child’s neighbourhood social network, and neighbourhood personal safety were positively associated with children’s objectively-assessed physical activity.

Main effects for the perceived home and neighbourhood environment and sedentary time

Parental social support for physical activity and access to physical activity equipment in the home were inversely related to children’s objectively-assessed sedentary time (Table 4). Descriptive norms for physical activity and neighbourhood personal safety were also inversely associated with sedentary time.
Main effects for the perceived home and neighbourhood environment and proxy-reported screen time

There were significant associations between several of the perceived home and neighbourhood environment variables and children’s proxy-reported screen time (Table 4). For example, maternal self-efficacy for preventing her child from engaging in screen behaviours, and rules to limit these behaviours were inversely associated with children’s proxy-reported screen time per day. However, access to sedentary items in the home and having a television in the bedroom were positively associated with children’s proxy-reported screen time. Descriptive norms for physical activity, having good places to play, and knowledge of the neighbourhood were inversely associated with children’s daily average screen time.

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INSERT TABLE 4 HERE

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Moderator effects of urban/rural location

There were five significant interactions between the home and neighbourhood environment and the three outcome variables according to urban/rural location (Table 4). These included: neighbourhood road safety concerns and physical activity; importance of doing physical activity as a family (quite important and not very important with very important as the referent category) and neighbourhood road safety concerns and total sedentary time; and neighbourhood social network and road safety concerns and screen time. These are presented graphically in Figures 1-5.
When stratified by urban/rural location, neighbourhood road safety concerns were not significantly associated with physical activity for children living in urban (B=3.9, 95 % CI=-0.6–8.4) or rural (B=-3.3, 95 % CI=-6.8–0.3) areas. Children living in urban areas whose mothers reported that doing physical activity as a family was ‘quite important’ (B=-29.1, 95 % CI=-49.0–9.2) or ‘not really important’ (B=-36.8, 95 % CI=-60.6–13.0) engaged in less sedentary time compared with children whose mothers considered doing physical activity as a family as ‘very important’; the association was non-significant for children living in rural areas (B=-1.0, 95 % CI=-12.5–10.6 for ‘quite important’; B=9.5, 95 % CI=-8.2–27.2 for ‘not really important’). Neighbourhood road safety concerns were not significantly associated with sedentary time for children once stratified by urban (B=-3.6, 95 % CI=-12.6–5.5) and rural (B=5.2, 95 % CI=-1.0–11.4) areas. When stratified by urban/rural location, neighbourhood social network (urban: B=0.4, 95 % CI=-0.2–1.0; rural: B=-0.3, 95 % CI=-0.8–0.1) and neighbourhood road safety concerns (urban: B=-0.6, 95 % CI=-1.1–0.0; rural: B=0.2, 95 % CI=-0.4–0.8) were not significantly associated with screen time for either children living in urban or rural areas.

Discussion

This study explored urban/rural differences in perceived home and neighbourhood factors, how these factors related to children’s physical activity and sedentary behaviour, and whether these associations were moderated by urban/rural location. Compared with mothers in urban areas, those in rural areas reported greater access to physical activity equipment in the home, higher levels of descriptive norms for physical activity, greater knowledge of the
neighbourhood, a stronger social network and higher personal safety. A range of home and
neighbourhood factors were associated with children’s physical activity and sedentary
behaviour and living in an urban or rural location moderated five of these associations.

Perhaps due to insufficient power, when the significant interactions were stratified by
urban/rural location and re-analysed, only one variable (importance of doing physical activity
together as a family) was significantly positively associated with sedentary time among urban
children. Positive longitudinal associations between parent/child co-participation in physical
activity and children’s physical activity levels have previously been reported among 540
Australian children and adolescents (Cleland et al., 2011); and co-participation in television
viewing has also been found to be cross-sectionally positively associated with children’s
television viewing time in the same cohort (Salmon et al., 2005). The current finding that
urban mothers who perceived being active as a family to be very important had children who
spent more time sedentary is counter-intuitive. Being a cross-sectional study, it may be that
these urban mothers are aware of the amount of time their child spends sedentary; therefore
co-participation in physical activity as a family is more important for them. Also, it is not
known whether perceived importance is predictive of actual co-participation. A qualitative
study in the UK reported that although parents thought it was important, very little time was
spent in physical activity as a family, with most family time being spent sedentary
(Thompson et al., 2010). A recent pilot intervention has shown it is possible to increase
family physical activity among inactive families (Rhodes et al., 2010), suggesting that it is an
important and effective intervention focus.

As previously reported for this sample (Hume et al., 2012), there were significant differences
in screen time (almost 30 minutes more) among children living in urban areas compared with
their rural counterparts. This is consistent with findings reported by Bruner et al (2008) who found that young people in Canada living in urban areas spent more time in screen-based behaviours than those from more rural areas. In contrast, an analysis of more than 8,500 US youth and almost 9,000 Canadian youth in the 2005-6 Health Behavior in School-Aged Children Survey found variations in relative risk of high screen time depending on the type of screen behaviour examined (i.e., television viewing, computer use, or video games) (Carson et al., 2011). For example, rural youth in the US were 1.97 times more likely to be high television viewers but were 0.62 times as likely to be high computer users compared with “non-metropolitan adjacent” youth (an urban population or census division that shares a boundary with a metropolitan area and has a population greater than 20,000) (Carson et al., 2011). Differences in screen time between urban and rural children could be explained by variations in the neighbourhood social and physical environment. Compared to those living in urban locations, mothers living in rural locations had significantly higher scores on descriptive norms for children’s physical activity, their child’s knowledge of the neighbourhood, child’s knowledge of social networks, neighbourhood personal safety, and access to physical activity equipment in the home. Davison et al. recently reported that social capital was associated with physical activity among rural youth and was partially mediated by parental support for physical activity (Davison et al., 2012). In the present study, urban/rural location moderated associations between having a strong perceived neighbourhood social network and road safety concerns with children’s screen time.

Although there were no significant associations between these variables and children’s screen time once the sample was stratified by urban/rural location, Figure 4 suggests a stronger social network relates to higher screen time in urban children but lower screen time in rural children. These findings could mean that rural children are more likely to play outdoors with
friends compared with urban children who may engage in screen behaviours (e.g., dvds, video games) when they see friends (hence rural children with better social networks engage in less screen time, and urban children engage in more). Figure 5 suggests that greater road safety concerns relate to less screen time in urban children and more screen time in rural children. This is in contrast to longitudinal research among urban adolescents in Australia that has reported higher perceived traffic density that makes it difficult or unpleasant for their child to walk in the neighbourhood was negatively associated with TV viewing two years later (Timperio et al., 2012). In the present study, having higher road safety concerns and less screen time may be an indication of parents’ greater awareness of traffic conditions because their child is more actively engaged in physical activity and active transport in the neighbourhood (Timperio et al., 2004) and not spending time indoors in front of electronic screens.

There were several significant (direct) associations between home and neighbourhood environment variables and children’s physical activity and sedentary behaviour. Having a good neighbourhood social network, high descriptive norms for physical activity, and high neighbourhood personal safety were positively associated with children’s physical activity, which is consistent with previous research (Davison and Lawson, 2006; Trost et al., 1999; Uijtdewilligen et al., 2011). The present study also found significant differences between urban and rural parents’ perceptions for several of these variables; however, associations with physical activity were not moderated by urban/rural location, suggesting that these factors are equally important targets in physical activity interventions among urban and rural children.

Not surprisingly, given that accelerometry is capturing movement or lack of movement (i.e., total time spent sedentary), there was little consistency between the variables that were
related to children’s objectively-assessed sedentary time and proxy-reported screen time. The seven variables that were associated with children’s screen time have also been found to be correlates of this behaviour in previous research (Campbell et al., 2010; Gorely et al., 2004; Salmon et al., 2011; Uijtdewilligen et al., 2011). In contrast, of the four variables, which were all inversely associated with children’s sedentary time, only access to physical activity equipment in the home has been reported as a significant correlate of sedentary time previously (Byun et al., 2011). Parental support for physical activity has frequently been shown to relate to children’s physical activity (Uijtdewilligen et al., 2011); however, we were unable to locate any studies that had reported associations with objectively-measured sedentary time. The same is true for descriptive norms for physical activity, and personal safety. These neighbourhood social variables suggest that having positive perceptions of the neighbourhood may be important for minimising children’s overall sedentary time. Total sedentary time consists of more than just time spent in front of screens, and could also incorporate behaviours such as sedentary transport which may be more directly related to the neighbourhood environment compared with screen-based behaviours which occur primarily in the home.

A study strength was the use of accelerometers to objectively assess children’s physical activity and sedentary time, although collecting physical activity data in 1-minute epochs may have under-estimated children’s vigorous-intensity physical activity (Edwardson and Gorely, 2010). However, the subjective measures of perceived home and neighbourhood environments and children’s proxy-reported screen time, the unknown psychometric properties of these measures for rural populations, the cross-sectional study design, and the lack of adjustment for the amount of time that participating families have lived at their current address are limitations of the present study. It is possible that the moderating effects
of urban/rural location could be explained by unique characteristics of families living in those locations, rather than the area in which they live. However, analyses adjusted for individual-level SEP as well as other key sociodemographic variables (maternal education, children’s age and sex). It is also unknown whether the findings would apply to urban and rural families living in higher SEP areas; however, since it is often difficult to separate the influence of location and SEP it is a strength of the current study that families were randomly sampled from urban and rural areas of low SEP.

There may have been some misclassification of rural locations which could have affected the results. However, examination of objectively-assessed neighbourhood physical activity and food environments (park audits and GIS-mapped availability and access to food and physical activity amenities) showed significant differences between these 40 urban and 40 rural low SEP areas (Thornton et al., 2012; Veitch et al., 2013). Nevertheless, it is not possible to determine whether moderating effects were due to differences in the physical environment between the urban or rural setting, or due to differences in perceptions of the participants living in these environments. The individual neighbourhood environment was not examined in this study, and it is possible that there is considerable variation in environmental characteristics within both urban and rural neighbourhoods. The inclusion of objective, rather than survey measures of the neighbourhood, may change the results of the current study.

In conclusion, a range of home and neighbourhood environmental features were associated with objectively measured physical activity and sedentary time and proxy-reported screen time in children living in disadvantaged neighbourhoods, and living in an urban vs rural location moderated several of these associations. The results may have implications for future intervention design and planning and policy in both urban and rural areas. For example,
interventions targeting concerns about road safety among rural families may have beneficial effects on children’s physical activity and sedentary time. Urban planning or the development of policy could ensure that the road environment in rural areas provides safe access for children to be active such as road crossings to access local parks or the provision of footpaths to safely walk and cycle to places in the neighbourhood. Furthermore, intervention programs promoting children’s physical activity rarely consider the broader social context or community in which these programs take place. Fostering social connections among community members and providing places within the neighbourhood environment that encourage children to gather together and develop social networks (eg. parks, playgrounds), may achieve higher physical activity and lower sedentary behaviour among children.

The results indicate that in general, the same neighbourhood and home environmental features are important for rural and urban children, and that encouraging participation in physical activity as a family may be particularly important among urban children. However, longitudinal research employing objective measures of the environment is needed to confirm these findings.
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