

Rural and non-rural differences in minutes spent in physical activity and sedentary behavior

by

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Abstract

BACKGROUND: Rural Americans face significant barriers for meeting recommended physical activity guidelines (Trivedi et al., 2015). Although studies have demonstrated adults in rural communities participate in less physical activity than their urban counterparts (Martin et al., 2005; Reis et al., 2004), the differences in physical activity for children and adolescents are not so clear. The main goal of this study was to explore potential differences among school physical activity (SPA), outside of school time physical activity (OSTPA), and sedentary behavior (SB), among rural and non-rural fourth and fifth-grade students. It was hypothesized that rural schools participate in less physical activity and more sedentary behavior than non-rural schools.

Additionally, factors such as student gender and school socio-economic status were considered.

METHOD: Data from the Youth Activity Profile (YAP), collected as part of the NFL PLAY60 FITNESSGRAM Partnership, is utilized to assess physical activity. The YAP captures the three constructs of SPA, OSTPA, and SB with fifteen questions (five questions each). A two-level mixed-model using SAS Proc Mixed was used to test for significant differences among groups.

RESULTS: An analysis of least square means resulted in the following. Rural schools of fifth-grade students reported significantly more minutes in SPA (MD=8.68, 95% CI=-17.38, 0.01) than non-rural schools of fifth-grade students. Fourth-grade girls reported significantly fewer minutes in SPA (MD=11.1, 95% CI=9.09, 13.11), OSTPA (MD=19.55, 95% CI=17.54, 21.57), and more minutes in SB (MD=16.82, 95% CI=-22.85, -10.80) than fourth-grade boys. Fifth-grade girls reported significantly fewer minutes in SPA (MD=8.41, 95% CI=7.15, 9.67), OSTPA (MD=18.99, 95% CI=17.28, 20.70), and significantly more minutes in SB (MD=21.66, 95% CI=-26.92, -16.40) than fifth grade boys. High SES schools of fourth-grade students reported

significantly fewer minutes in SB (MD=7.18, 95% CI=-14.42, 0.04) compared to low SES schools of fourth-grade students.

CONCLUSION: There were no significant differences among rural and non-rural schools of fourth and fifth-grade students with respect to outside of school time physical activity and sedentary behavior. Rural schools of fifth-grade students reported more minutes in school physical activity. Gender differences were observed as girls reported significantly lower school physical activity, out of school physical activity, and significantly higher sedentary behavior than boys. Future studies need to more closely examine definitions of rural and non-rural environments, the physical activity domains under question, as well as, to examine of socio-economic status.

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Chapter 1 - Introduction

The United States Department of Health and Human Services recommends children aged five to seventeen accumulated sixty minutes of moderate to vigorous physical activity each day (United States Department of Health and Human Services, 2008). Meeting regular physical activity recommendations results in numerous health benefits such as lowering blood pressure, reducing metabolic syndrome, and reducing obesity rates (Janssen & Leblanc, 2010). Children who adopt healthy behaviors early in life tend to maintain these behaviors throughout childhood and into adulthood (Telama et al., 2005).

Sedentary behavior has only recently been recognized as an important determinant of health. One study estimates that Americans spend 7.7 hours a day in sedentary behavior and point to children and adolescents with the highest levels of participation in sedentary behavior (Matthews et al., 2008). For youth, screen time including time spent watching television, and movies, playing video games and using computers occupies a significant part of their days. According to several studies, eleven to fifteen year old children accumulate more than 4.5 hours of screen time in a typical day (Iannotti, Kogan, Janssen, & Boyce, 2009; Mark & Janssen, 2008).

Rural America is represented not only by a geographic location but as described by the W.K. Kellogg Foundation (2002, p. 1), “a repository of traditional American values where a long history of life experiences are shared amongst close-knit communities of people.” In recent years, however, reflective of the changing nature of rural life, children living in rural areas have experienced an increasing rate of obesity and physical inactivity. As pointed out by Joens-Matre and colleagues (2008), life in rural environments no longer entails physically demanding tasks and contributes to the growing frequency of chronic health conditions. Several studies have

indicated leisure-time physical activity levels are significantly lower in rural adults compared to urban adults (Martin et al., 2005; Reis et al., 2004).

The results are not so clear in children. Several studies have shown urban and suburban children are more active than rural children. In a systematic review by Sandercock and colleagues (2010), suburban children were significantly more active than children living in rural areas. In a study by Lutfiyya et al. (2007), rural children were found to be less likely to engage in physical activity compared with urban children. The authors concluded exercise facilities, parks, and PE classes were more limited in the rural setting, compared to urban settings. A study by Kenney, Wang, and Iannotti (2014) also reported students in urban areas were more likely to meet daily physical activity recommendations, as compared to rural students. Felton and colleagues (2002) reported lower levels of physical activity among rural South Carolina female middle school students compared to urban South Carolina girls.

Not all studies have reported lower levels of physical activity among rural children. In a study of third to eighth grade students in eight regions in Texas, rural students were more active than urban students and experienced higher access to physical activity facilities (Springer, Hoelscher, Castrucci, Perez, & Kelder, 2009). Children in rural Iowa were also found to be more active than their urban student counterparts, with urban students participating in more screen time than rural students (Joens-matre et al., 2008). Liu, Bennett, Harun, and Probst (2008) reported rural children aged ten to seventeen were more physically active than urban children of the same age. Kasehagen, Busacker, Kane and Rohan (2012) in a nationwide sample of children aged ten to seventeen, reported rural children were more likely to meet physical activity guidelines than their urban counterparts. Although some studies have shown children in rural communities participate in lower rates of physical activity than their urban counterparts, other

studies suggest the results are inconsistent and require further need to examine urban and rural physical activity settings.

Screen time is often used as a proxy measure for sedentary behavior. Not much is known regarding differences in screen time between rural and urban youth. One study reported adolescents who live in rural areas are less likely to experience problem gaming (Shi, Boak, Mann, & Turner, 2018). Carson and colleagues (2010) found American youth from rural areas are more likely to be high television users and less likely to be high computers users.

Children accumulate physical activity throughout the week in a variety of places such as home, school, and out-of-school. The focus on the school environment for addressing the physical activity needs of children is based largely on the assumption that many behavioral patterns are developed in childhood. For families who do not have access to individual or community resources for physical activity, the school setting may be the single best setting where children have the opportunity to be physically active (McElroy, 2002).

School is not the only place where children participate in physical activity. Outside the school setting children are exposed to numerous opportunities to participate in physical activity. For example, the home represents a likely place where physical activity opportunities are made available to children. In a study by Spurrier et al. (2008), children who live in homes in which they had access to a variety of outdoor play equipment resulted in more time spent in physical activity than children who had few outdoor play equipment.

The neighborhood also provides children with a physical activity environment separate from the home. As park and recreation areas increase, children in those neighborhood report more physical activity time (Epstein et al., 2006; Roemmich et al., 2006) The overall socio-economic status (SES) and availability of physical activity resources in neighborhoods has been

shown to impact physical activity and sedentary time in children (Estabrooks, Lee, & Gyuresik, 2003). A systematic review by Stalsberg and Pedersen (2010) revealed low SES neighborhoods typically have less and worse physical activity facilities. In another study by Gordon-Larsen et al. (2006), consisting of youth in North Carolina, reported all types of physical activity facilities (schools, public facilities, parks, etc.) are unevenly distributed depending on the SES of the community. Low SES communities located in rural areas have fewer physical activity resources compared to their high SES communities in populated areas (Powell, Slater, Chaloupka, & Harper, 2006). Along with the policies and programs of a school, the physical activity resources can also play a part in the activity levels of a child, and these resources are typically reliant on the money available to the school to promote these features.

Outside of the school environment also contributes to excesses in sedentary behavior. The presence of electronic media devices in the home, such as televisions, computers, and video games contribute to high rates of sedentary habits among children (Roemmich, Epstein, Raja, & Yin, 2007). Television viewing represents the most time consuming sedentary habit for children (Pate, O'Neill, & Lobelo, 2008). Francis et al. (2011), using self-reported data of eleven year old children, showed 63% of boys and 50% of girls watch TV at least two hours a day, and 60% of boys and 32% of girls played video games at least one hour a day. In a study by Jago et al. (2005), children reported significant increases in sitting, television viewing, and video game play during weekend days compared to during the weekday.

Gender differences have also been noted regarding the physical activity and sedentary levels of children (Janssen & Leblanc, 2010; Sallis, Prochaska, & Taylor, 2000). Female adolescents participate in less physical activity than males (Hallal et al., 2012). In a study conducted by Troiano et al (2008), across all age groups, from child to adolescent, boys were

found to be more physically active than girls. Studies involving rural girls and physical activity are somewhat scarce. One exception, the study by Liu et al. (2008) reported female children and adolescents participated in less physical activity than male children and adolescents. The lower female participation rates held true regardless of living in a rural residence or not.

It is important to determine if students living in rural environments are at a disadvantage regarding opportunities for physical activity and sedentary behavior. Although a number of studies have examined the physical activity levels of children in urban and rural areas, these studies have been typically limited to small sample sizes or concentrated in only one specific state (Felton et al., 2002; Joens-matre et al., 2008; Kasehagen et al., 2012; Liu et al., 2008; Lutfiyya et al., 2007; Springer et al., 2009). Previous studies have also not examined the differences in the school environment and the levels of physical activity each child is performing during the school day. Previous studies have also not examined the relationship between school SES and participation in physical activity.

The goals of this study are threefold: 1) to examine school physical activity, outside of school time physical activity, and sedentary behavior, among rural and non-rural schools of fourth and fifth-grade students, 2) to examine whether school socio-economic status is related to school physical activity, outside of school time physical activity, and sedentary behavior, and 3) to examine if gender differences in school physical activity, outside of school time physical activity, and sedentary behavior between rural and non-rural students exist. The following hypotheses are examined:

1. Rural schools of fourth and fifth-grade students report lower levels of school physical activity and outside of school time physical activity than non-rural students.

2. Rural schools of fourth and fifth-grade students report higher levels of sedentary behavior than non-rural schools of fourth and fifth-grade students.
3. High SES schools of fourth and fifth-grade students report higher levels of school physical activity, outside of school time physical activity.
4. High SES schools of fourth and fifth-grade students report lower levels of sedentary behavior than low SES schools of fourth and fifth-grade students.
5. Girls report lower levels of school physical activity, outside of school time physical activity than boys.
6. Girls report higher levels of sedentary behavior than boys.

It is of public health importance to understand if geographic differences exist in sedentary behavior and physical activity behaviors. This knowledge can help guide interventions and initiatives aimed at increasing physical activity and reducing sedentary behavior in an effort to improve the health of youth living in rural and non-rural regions.

Chapter 2 - Methods

Sample

This sample was collected as part of the NFL PLAY60 FITNESSGRAM Partnership. The NFL PLAY60 FITNESSGRAM Partnership is a collaboration between the National Football League (NFL) and the Cooper Institute. It is a comprehensive youth fitness initiative in which each of the thirty-two NFL franchises collaborate with schools in their market to promote NFL PLAY60 programs. The partnership is unique in that it uses a participatory model to examine factors that could be influencing program implementation under naturalistic conditions. Schools voluntarily opt into the project, and work directly with members of the Cooper Institute's team to provide insights into how to promote physical activity (Welk, Bai, Saint-Maurice, Allums-Featherston, & Candelaria, 2016). Although the data from the youth may not be representative in nature, the data is more generalizable than studies using convenience samples.

The Youth Activity Profile (YAP) was developed by Dr. Pedro Saint-Maurice and Dr. Gregory Welk (2014), and was used as part of the NFL PLAY60 FITNESSGRAM Partnership. Schools were encouraged, but not required, to use the YAP. Schools were provided with instructions on how to administer the survey, and all data were collected directly by the teachers involved with the project. Data were collected at one time point for each student from January 2017 to December of 2017. Student and school responses were de-identified. The 2017 NFL PLAY60 FITNESSGRAM Partnership YAP dataset contained 4,538 students, from grades three to twelve. The dataset contained sixty-four schools in the United States, thirty-nine non-rural and twenty-five rural schools. Schools were located in twenty states in all major regions of the country. Students from the fourth and fifth-grade were used in this study.

Participant characteristics are found in Table 1. The sample used for this study consisted of 1,277 students in fourth-grade (n=548) and fifth-grade (n=729) enrolled in public schools, 630 boys and 647 girls, with 827 attending non-rural schools and 450 attending rural schools. The students resided in eight states, with 769 students attending high-SES schools and 508 students attending low-SES schools. The average age of the participants was 9.57 ± 0.49 years (range: 9-10 years).

The fourth-grade sample consisted of 548 students, 266 boys and 282 girls. The sample consisted of sixteen schools, nine non-rural schools and seven rural schools. The students resided in eight separate states, with 375 students in non-rural schools and 173 in rural schools. Additionally, 338 students attended high SES schools and 210 students attended low SES schools.

The fifth-grade sample consisted of 729 fifth-grade students, 364 boys and 365 girls. The sample consisted of sixteen schools, eight non-rural and eight rural. Students resided in eight separate states, with 452 students in non-rural schools and 277 in rural schools. Additionally, 431 students attended high SES schools, and 298 students attended low SES schools.

Measures

Youth Activity Profile. The YAP is an online self-report questionnaire used to assess physical activity and sedentary behavior in children and adolescents (Saint-Maurice & Welk, 2014). The YAP is a 7-day physical activity recall measure consisting of fifteen items, each question on a one to five categorical scale. The fifteen questions assess school physical activity, outside of school time physical activity, and sedentary behavior. The YAP is calibrated to predict an estimate of minutes of moderate to vigorous physical activity (MVPA) and sedentary behavior.

School Physical Activity. School Physical Activity (SPA) consists of five questions focusing on physical activity during the school day: How many days did you walk or bike to school?; During PE how often were you running and moving as part of the planned games or activities?; During recess how often were you playing sports, walking, running, or playing active games?; During lunch break how often were you moving around, walking or playing?; and How many days did you walk or bike from school? The five questions are quantified on a one to five categorical scale, one indicating low physical activity and five indicating high physical activity. Scores are then used to predict an estimate of the number of minutes the child spends in MVPA during the average day at school, creating the variable school physical activity (SPA).

Outside of School Time Physical Activity. Outside of school time physical activity (OSTPA) includes all forms of physical activity performed outside of the regular school day and consists of the five following questions: How many days before school (6:00-8:00 am) did you do some form of physical activity for at least 10 minutes? (i.e. physical activity at home, but not walking or biking to school); How many days after school (between 3:00 - 6:00 pm) did you do some form of physical activity for at least 10 minutes? (i.e. playing with friends/family, or team practices, but not walking or biking home from school); How many school evenings (6:00 - 10:00 pm) did you do some form of physical activity for at least 10 minutes? (i.e. playing with friends/family, or team practices, but not walking or biking home from school); How much physical activity did you do last Saturday?; and How much physical activity did you do last Sunday? All questions were assessed on a one to five categorical scale with one indicating low physical activity and five indicating high physical activity. The scores are then used to predict an estimate of the number of minutes the child spends in MVPA during the average day, creating the variable outside of school time physical activity (OSTPA).

Sedentary Behavior. Sedentary Behavior (SB) involved the amount of time a child spent in front of technological devices outside of school, as well as other sedentary behavior, and is assessed with five questions: How much time did you spend watching TV outside of school time?; How much time did you spend playing video games outside of school time?; How much time did you spend using computers outside of school time?; How much time did you spend using your cell phone after school?; and Which of the following best describes your typical sedentary habits at home? All questions were quantified on a one to five categorical scale, with a one indicating more time in sedentary behavior and a five indicating less time in sedentary behavior. The scores of each child are then used to predict an estimate of the number of minutes the child spends in sedentary behavior during the average day outside of school, creating the variable sedentary behavior (SB).

Predicted Estimated Minutes in SPA, OSTPA, and SB. The self-report questions can be used to predict an estimated minutes per day or week spent in SPA and OSTPA and SB. The process utilizes regression for individual survey items along with the age and gender of the individual. The individual survey items are aggregated to a composite score by weighting the frequency of days of SPA (5), OSTPA (7), and SB (7). The aggregate composite score is transformed into a predictor of the estimated minutes for SPA, OSTPA, and SB, and has been cross-validated with accelerometer data over the same 5 to 7-day period the survey assessed. Correlations of the regression equation and accelerometer data was calculated, with SPA moderately correlated ($r=0.58$), OSTPA not significantly correlated ($r=0.19$), and SB strongly correlated ($r=0.75$). The YAP measurement tools have been found to be significant predictors of estimated minutes in physical and sedentary behavior (Saint-Maurice & Welk, 2015).

Rurality. Rurality is dichotomized as rural or non-rural. The National Center for Education Statistics, Education, Demographic, and Geographic Estimates Database is used to determine rurality (National Center for Education Statistics, 2016). The National Center for Education Statistics (NCES) rurality codes are designed to categorize type of geographic area in which a school is located. Rurality definitions from the U.S. Census Bureau are used, and rurality codes are assigned to each school.

The Education Demographic and Geographic Estimate (EDGE) Program codebook was utilized to categorize the schools in this study (Geverdt, 2017). Schools were classified according to the coding system provided and were divided into two categories: Non-rural or Rural. Due to a higher number of suburban than urban students, schools in urban or suburban areas were classified as non-rural. Urban was classified as any core area containing greater than 50,000 people that is within a principal city. Suburban was classified as any area outside of a principal city but inside an urbanized area with a population greater than 50,000 people. Rural classification included any school classified by the EDGE program as Town or as Rural. Town was classified as any territory inside an urban cluster, with a population of 2500-5000. Rural was classified according to census-defined rural territory and had to be classified as rural to be considered rural unlike the other categories.

School Socio-Economic Status. Information from the Title 1 Elementary and Secondary Education Act is used to determine school socio-economic status (SES) (Office of State Support, 2015). The Title 1 Elementary and Secondary Education Act is a federal grant program used to provide financial assistance to schools with high percentages of children from low-income families. School SES is determined by the percentage of children qualifying for Free and Reduced-Price Lunch program (FRPL). The NCES school database provides the total number of

students per school, as well as the total number of students who qualify for FRPL. FRPL eligibility guidelines are set forth by the National School Lunch Program, and is determined by the income level of a family (Department of Agriculture, 2018). The percent of students per school who qualified for FRPL were then calculated and classified according to the Title 1 Elementary and Secondary Education Act. A nominal scale was used with 1 representing high school SES (<40% of students qualifying for FRPL) and 2 representing low school SES ($\geq 40\%$ of students qualifying for FRPL). FRPL has been validated by Nicholson et al. (2014) to be an adequate proxy for adolescent SES in school based studies.

Statistical Analysis

A two-level mixed model (school and child) was used in this analysis. School nested within Season*Rurality*SES Group were used as random effects. The analysis was conducted using Proc Mixed (SAS University Edition, SAS Institute Inc., Cary, NC).

Chapter 3 - Results

Rurality

Relationships among rurality and minutes spent in SPA, OSTPA, and SB are presented in Table 2. Among rural and non-rural schools of fourth-grade students, no significant differences were found for SPA ($F=0.55$, $p=0.4757$), OSTPA ($F=1.37$, $p=0.2659$), and SB ($F=2.30$, $p=0.1574$). Rural and non-rural schools of fifth-grade students minutes spent in SPA, OSTPA, and SB are presented in Table 2. Rural schools of fifth-grade students reported significantly more minutes in SPA ($F=4.84$, $p=0.0502$) than non-rural schools of fifth-grade students. Rural schools of fifth-grade students reported 8.68 (95% CI=-17.38, 0.01) more minutes of SPA than non-rural schools of fifth-grade students. There were no significant differences in minutes in OSTPA ($F=1.40$, $p=0.2153$), or SB ($F=2.30$, $p=0.1574$).

Gender

Relationships among gender and minutes spent in SPA, OSTPA, and SB is presented in Table 3. Among fourth graders, girls reported significantly fewer minutes in SPA ($F=117.73$, $p<.0001$), OSTPA ($F=363.51$, $p<.0001$), and more minutes in SB ($F=30.08$, $p<.0001$) compared to boys. Fourth-grade girls reported 11.1 (95% CI=9.09, 13.11) less minutes in SPA, 19.55 (95% CI=17.54, 21.57) less minutes in OSTPA, and 16.82 (95% CI=-22.85, -10.80) more minutes in SB than fourth-grade boys. Among fifth-graders, girls reported significantly fewer minutes in SPA ($F=172.50$, $p<.0001$), OSTPA ($F=475.78$, $p<.0001$), and significantly more minutes in SB ($F=65.47$, $p<.0001$) compared to boys. Fifth-grade girls reported 8.41 (95% CI=7.15, 9.67) less minutes in SPA, 18.99 (95% CI=17.28, 20.70) less minutes in OSTPA, and 21.66 (95% CI=-26.92, 16.40) more minutes in SB than fifth-grade boys.

School Socio-Economic Status

Means for school socio-economic status and minutes spent in SPA, OSTPA, and SB are presented in Table 4. High SES schools of fourth-grade students reported significantly fewer minutes in SB ($F=4.79, p=0.0511$) compared to low SES schools of fourth-grade students. High SES schools of fourth-grade students reported 7.18 (95% CI=-14.42, 0.04) less minutes in SB than low SES schools of fourth-grade students. There was no significant difference for high or low SES schools of fourth-grade students for SPA ($F=0.01, p=0.9189$) or OSTPA ($F=0.64, p=0.4420$). No significant differences existed between high or low SES schools of fifth-grade students in minutes spent in SPA ($F=0.70, p=0.4196$), OSTPA ($F=0.04, p=0.8368$), or SB ($F=0.69, p=0.4247$).

Interaction Models: Gender by Rurality by School SES

As presented in Table 5, no significant interactions for boys and girls students attending rural and non-rural schools for SPA ($F=3.25, p=0.0720$), OSTPA ($F=0.86, p=0.3544$), or SB ($F=2.08, p=0.1494$) were observed. Similarly, among fifth graders attending rural and non-rural schools, no significant interactions were observed for SPA ($F=0.51, p=0.4734$), OSTPA ($F=0.70, p=0.4045$), or SB ($F=1.30, p=0.2542$).

Potential interactions among rurality, gender, and School SES regarding minutes spent in OSTPA, SPA, and SB are presented in Table 6. Among fourth grade boys and girls attending high and low SES rural and non-rural schools, no significant differences were found in SPA ($F=0.21, p=0.6461$), OSTPA ($F=0.85, p=0.3558$), and SB ($F=0.67, p=0.4151$). Fifth-grade rural and non-rural boys and girls attending high and low SES rural and non-rural schools, minutes in OSTPA, SPA, and SB is presented in Table 6. No significant differences were found in SPA ($F=0.03, p=0.8590$), OSTPA ($F=0.12, p=0.7238$), and SB ($F=0.96, p=0.3264$).

Chapter 4 - Discussion

The purpose of this study was to investigate the differences of rural and non-rural schools with respect to physical activity and sedentary behavior among fourth and fifth-grade boys and girls. This study used two domains of physical activity, school physical activity and outside of school physical, and a measure of sedentary behavior. The results revealed only partial support for rural and non-rural differences. Rural schools of fifth-grade students participated in 8.68 more minutes of school physical activity than non-rural schools of fifth-grade students. Low SES schools of fourth-grade students participated in 7.18 more minutes of sedentary behavior than high SES schools of fourth-grade students. Fourth-grade girls reported 11.1 less minutes in SPA, 19.55 less minutes in OSTPA, and 16.82 more minutes in SB than fourth-grade boys. Fifth-grade girls reported 8.41 less minutes in SPA, 18.99 less minutes in OSTPA, and 21.66 more minutes in SB than fifth-grade boys.

Rural schools of fifth-grade students participated in significantly more school physical activity than non-rural schools of fifth-grade students. Although there were no differences between rural and non-rural schools of fourth-grade students, the partial support for higher school physical activity among the fifth-grade schools is consistent with previous studies. For example, Joens-Matre et al. (2008) found rural students in Iowa participated in more school physical activity than urban students. Springer et al. (2009) found rural fourth and eleventh-grade students attended school physical education classes more than their urban counterparts. The findings from the current study provide partial support that rural environments may present an environment more conducive for school physical activity than in non-rural areas.

Rural schools of fifth-grade students participated in significantly more school physical activity, however there were no significant differences among rural and non-rural schools of

fourth or fifth-grade students in school physical activity, outside of school time physical activity, and sedentary behavior. The failure to find consistent differences is consistent with previous findings. For example, Davis et al. (2011) used a nationwide sample of urban and rural children, and reported no significant differences in physical activity. Kenney et al. (2014) examined a national sample of more than 8000 students in grades six to ten, and found no urban or rural differences in physical activity participation. However, this study did not examine school physical activity. It is important that future studies carefully specify the domains of physical activity being examined.

Rurality was found significant for rural schools of fifth-grade students regarding school physical activity. A reason for why rural schools may experience higher school physical activity may be due to the availability of playground space at school. For example, in a study of nine and ten-year-old children attending eight elementary schools, Ridgers, Fairclough, and Stratton (2010) found play space, a measure derived from playground size and class size, related to physical activity. Rural schools may also have more activity at school because school facilities may provide more resources to be physically active in contrast to other community resources. Rural communities are often faced with limited access to recreational facilities, sidewalks, and trails, resources critical for physical activity (Whaley & Haley, 2008).

Low SES schools of fourth-grade students reported significantly more minutes in sedentary behavior compared to high SES schools of fourth-grade students. This finding is in agreement with a systematic review by Gebremariam et al. (2015), which reported an inverse relationship between SES and time spent in sedentary behavior. The authors identified several possible reasons why living in lower social class neighborhoods may serve to bolster sedentary behavior, factors such as neighborhood safety concerns and absence of physical activity

resources within the home and neighborhood. These correlates may contribute to an environment conducive to sedentary behavior as low SES neighborhoods have less walkability, a risk factor for less physical activity and high sedentary behavior time (Sallis et al., 2018). As a result, students in low SES neighborhoods are more likely to stay home and participate in sedentary behaviors such as watching television and playing video games. Morgenstern and colleagues (2009) study of more than 4000 students revealed young people from low SES backgrounds spend more screen time including watching television, particularly watching television in the bedroom, than those from high SES homes.

Girls reported significantly lower school physical activity, out of school physical activity, and significantly higher sedentary behavior than boys. A systematic review by Vanderhorst et al. (2007) examined over 60 studies, and found being a boy was a correlate for higher overall physical activity. Girls have been shown to participate in significantly less physical activity than boys (Hallal et al., 2012; Trost et al., 2002). The finding that girls participated in significantly less physical activity than boys is in agreement with a study of 555 boys and girls by Telford et al. (2016), which reported girls participated significantly less often in physical activity per day than boys. The authors identified less perceived competence in physical education in girls, more boy focused physical activity opportunities at school, and less participation in out of school sports clubs as reasons for why girls reported less time in physical activity. In a study of 2262 fourth-grade students, examined over a two year period, girls reported a significantly lower enjoyment of PE class compared to boys with enjoyment decreasing over time (Cairney et al., 2012). Addressing the low levels of physical activity in girls is also critical because only 20.2% of girls meet the daily recommended sixty minutes of physical activity per day as recommended by the Physical Activity Guidelines (Data Resource Center for Child and Adolescent Health,

2017). By the time young girls reach the age of eighteen, Kimm and colleagues (2002) found 56% of black and 31% of white girls report not engaging in any leisure-time physical activity.

Girls reported significantly higher sedentary behavior than boys. Sedentary behavior between boys and girls have contradicting results in the literature. Our study is in agreement with a study by Hallal et al. (2012). Their study evaluated sedentary behavior of thirteen to fifteen-year-old boys and girls in North America and Europe using World Health Organization survey data and found 68% of girls watch greater than two hours a day of television compared to 66% of boys. The finding that girls participated in greater amount of sedentary behavior is not corroborated in some previous research. For example, in a cross-sectional study of nine countries and 12,538 eleven-year-old children, Te Velde and colleagues (2007) found boys engage in higher amounts of sedentary behavior compared to girls. In another study, Saunders et al. (2018) reported boys spent more time in sedentary behavior during the day than girls.

With the exception of the study conducted by Saunders, screen time in the articles mentioned above was assessed by children self-reporting time watching television or playing video games. Hager (2006) indicated the choices for screen time, television and video games as a limitation in his study where boys engaged in significantly higher amounts of sedentary behavior compared to girls. Girls, according to Hager, may participate in different types of sedentary behavior compared to boys, such as talking on the telephone. Atkin and colleagues (2008) reported girls experience the most negative health impacts due to the amount of time spent in sedentary behaviors. As technology continues to advance and become more attractive to girls, future research should examine the sedentary consequences of newer forms of technology.

This study is one of the few that uses a measure of physical activity directed at the specific school environment, including activities performed during the school day as well as

actively commuting to and from school, most studies use a more general approach to measuring participation in children's physical activity. A specific measure of school physical activity allows us to examine whether school socio-economic status is related to the specific physical activity performed as part of the school day.

This study is not without its limitations. The use of a dichotomous variable to classify rural and non-rural schools may fail to capture substantial differences in children's physical activity. Sandercock and colleagues (2010) recommend adding suburban environments as a stand-alone category to study rural and non-rural physical activity. Suburban areas are often characterized by high road interconnectivity, high walkability, and increased availability to PA facilities, features that are promote higher physical activity time in children. Grouping the most active children (suburban) with those least active and comparing these heterogenous groups with individuals from rural areas serve to undermine the presence of physical activity differences.

Nelson and colleagues (2006) suggested that even considering suburban spaces may fail to capture the dynamics associated with places of residence. The presence of more physical activity in suburban areas may be due to the fact that suburban areas contain higher SES households and typically have few ethnic minority residents. The present study included a measure of school socioeconomic status which served as a proxy for student's SES status, however, future studies would benefit from a more comprehensive focus on social factors e.g. SES, race of children and their families in order to capture the dynamics of how geography influences children's participation in physical activity (Sandercock et. al, 2010).

The measurement of children's physical activity has presented significant challenges to researchers. Studies typically use child self-report or parental-report measures both which have limitations. Self-reports are the most commonly used type of measure of children's physical

activity due to their convenience of administration, low cost, and ability to collect a variety of physical activity variables over time. It is reasonable to ask subjects to report their own physical activity because they have experienced it, and many physical activities are salient events that even children are likely to remember to some extent (Sallis, 1991).

Children, particularly younger children, may find it difficult to recollect specific activity and the time spent in each activity poor recall among younger children and poor knowledge or insight of parents are likely sources of inaccuracy in the reporting of physical activity. Varni and colleagues (2007) concluded self-report measurements in children are adequate when the questionnaire asks questions that are age-appropriate. The present study uses a validated, self-report measurement tool that provides estimations of minutes of physical activity for children (Saint-Maurice & Welk, 2015).

Outside of school time physical activity included physical activity conducted in and around the home. Although the physical activity of children is likely strongly influenced by the attitudes, values, and role modeling behavior of parents the role of parents was only indirectly captured in the outside of school time physical activity variable. One of the most important correlates of physical activity is social support from family (Allender, Cowburn, & Foster, 2006; Sallis, Prochaska, Taylor, Hill, & Geraci, 1999). In a systematic review by Biddle and colleagues (2005), out of school physical activity in girls is influenced by social support from family and peers.

Parents may also contribute to the sedentary behavior of their children at home. A study by Jago et al. (2010), reported the overall sedentary time of parents was associated with the overall sedentary time of daughters, suggesting parents contribute to sedentary home

environments. It is important that future studies focus more directly on the role of parents in impacting their children's physical activity and sedentary behavior.

Based on our results, there is a possibility our study is underpowered. As a result, our study may be subject to Type II Error. Future studies should recruit more schools and students to properly evaluate the effect of rurality.

Conclusion

Understanding variables that influences children's physical activity levels within rural and non-rural environments may help to inform future interventions. Focusing specifically on school physical activity, outside school physical activity, and sedentary behavior, this study found only partial support for rural differences. This study also found gender differences, specifically fourth and fifth-grade girls in rural and non-rural schools participated in less physical activity and more sedentary behavior than boys. Future studies need to address the continued challenges girls face regarding low levels of physical activity and high levels of sedentary behavior. Future studies also need to more closely examine definitions of rural and non-rural environments, specify the physical activity domains under question, as well as to explore the role of individual and school socio-economic status.

Chapter 5 - References

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Table 1: Student Characteristics

	Fourth-Grade (n=548)	Fifth-Grade (n=729)
Rurality	% (n)	% (n)
Non-rural	68.4 (375)	62.0 (452)
Rural	31.6 (173)	38.0 (277)
School Socio-Economic Status (SES)		
High School SES	61.7 (338)	59.1 (431)
Low School SES	38.3 (210)	40.9 (298)
Gender		
Boy	48.5 (266)	49.9 (364)
Girl	51.5 (282)	50.1 (365)
Non-rural		
Boy	50.7 (190)	51.1 (231)
Girl	49.3 (185)	48.9 (221)
Rural		
Boy	43.9 (76)	48.0 (133)
Girl	56.1 (97)	52.0 (144)
	Mean (SD)	Mean (SD)
School Physical Activity Minutes mean (SD)	45.52 (12.70)	41.43 (9.39)
Outside of school time physical activity Minutes, mean (SD)	84.91 (13.54)	83.90 (13.83)
Sedentary Behavior Minutes mean (SD)	185.76 (29.97)	204.53 (32.96)

Table 2: Least Squares Mean Estimate of Minutes at SPA, OSTPA, and SB by Rurality

			Mean (95% CI)	Mean Difference (95% CI)	p-value
Fourth Grade (n=548)	School Physical Activity	Non-rural	43.89 (32.39, 55.40)	-4.85 (-19.30, 9.60)	0.4757
		Rural	48.74 (33.23, 64.26)		
	Outside of School Time Physical Activity	Non-rural	84.22 (82.42, 86.02)	-1.28(-3.69, 1.13)	0.2659
		Rural	85.50 (82.73, 88.27)		
	Sedentary Behavior	Non-rural	185.69 (180.31, 191.07)	4.6 (-2.61, 11.81)	0.1875
		Rural	181.09 (172.80, 189.38)		
Fifth Grade (n=729)	School Physical Activity	Non-rural	38.72 (31.27, 46.16)	-8.68 (-17.38, 0.01)	0.0502
		Rural	47.40 (38.68, 56.13)		
	Outside of School Time Physical Activity	Non-rural	81.47 (78.85, 84.09)	-1.60 (-4.58, 1.38)	0.2617
		Rural	83.07 (79.54, 86.61)		
	Sedentary Behavior	Non-rural	213.69 (202.42, 224.95)	9.46 (-4.26, 23.18)	0.1574
		Rural	204.23 (189.10, 219.36)		

Table 3: Least Squares Mean Estimate of Minutes at SPA, OSTPA, and SB by Gender

			Mean (95% CI)	Mean Difference (95% CI)	p-value
Fourth Grade (n=548)	School Physical Activity	Boy	51.87 (41.44, 62.29)	11.1 (9.09, 13.11)	< .0001
		Girl	40.77 (30.41, 51.13)		
	Outside of School Time Physical Activity	Boy	94.64 (92.54, 96.73)	19.55 (17.54, 21.57)	< .0001
		Girl	75.09 (73.08, 77.09)		
	Sedentary Behavior	Boy	174.98 (168.71, 181.25)	-16.82 (-22.85, - 10.80)	< .0001
		Girl	191.80 (185.80, 197.80)		
Fifth Grade (n=729)	School Physical Activity	Boy	47.26 (41.13, 53.39)	8.41 (7.15, 9.67)	< .0001
		Girl	38.85 (32.70, 45.00)		
	Outside of School Time Physical Activity	Boy	91.77 (89.18, 94.36)	18.99 (17.28, 20.70)	< .0001
		Girl	72.78 (70.21, 75.35)		
	Sedentary Behavior	Boy	198.13 (187.58, 208.67)	-21.66 (-26.92, - 16.40)	< .0001
		Girl	219.79 (209.26, 230.31)		

Table 4: Least Squares Mean Estimate of Minutes at SPA, OSTPA, and SB by SES

			Mean (95% CI)	Mean Difference (95% CI)	p-value
Fourth Grade (n=548)	School Physical Activity	High SES	45.96 (33.18, 58.75)	-0.71 (-15.78, 14.35)	0.9189
		Low SES	46.67 (31.89, 61.46)		
	Outside of School Time Physical Activity	High SES	85.30 (83.22, 87.38)	0.88 (-1.54, 3.29)	0.4420
		Low SES	84.42 (81.86, 86.99)		
	Sedentary Behavior	High SES	179.80 (173.56, 186.03)	-7.18 (-14.42, 0.04)	0.0511
		Low SES	186.98 (179.30, 194.67)		
Fifth Grade (n=729)	School Physical Activity	High SES	41.40 (33.13, 49.68)	-3.31 (-12.01, 5.38)	0.4196
		Low SES	44.71 (36.77, 52.65)		
	Outside of School Time Physical Activity	High SES	82.42 (79.53, 85.30)	0.29 (-2.69, 3.27)	0.8368
		Low SES	82.13 (78.82, 85.44)		
	Sedentary Behavior	High SES	206.37 (193.85, 218.90)	5.17 (-18.89, 8.55)	0.4247
		Low SES	211.54 (197.44, 225.65)		

Table 5: Least Squares Mean Estimate of Minutes at SPA, OSTPA, and SB by Gender and Rurality

	Fourth-Grade (n=548)				Fifth-Grade (n=729)			
	Non-rural (95% CI)	Rural (95% CI)	Mean Difference (95% CI)	Rurality*Gender p-value	Non-rural (95% CI)	Rural (95% CI)	Mean Difference (95% CI)	Rurality*Gender p-value
School Physical Activity				0.0720				0.4734
Boy	48.52 (38.20, 58.84)	55.21 (41.17, 69.26)	6.69 (-19.84, 6.46)		42.69 (36.02, 49.36)	51.84 (44.01, 59.66)	-9.15 (-16.98, -1.31)	
Girl	39.27 (28.95, 49.58)	42.27 (28.40, 56.14)	3.00 (-15.97, 9.96)		34.74 (28.07, 41.41)	42.97 (35.08, 50.85)	-8.23 (-16.11, -0.35)	
Outside of School Time Physical Activity				0.3544				0.4045
Boy	93.52 (91.64, 95.40)	95.75 (92.60, 98.91)	2.23 (-5.30, 0.84)		91.33 (88.82, 93.85)	92.21 (88.73, 95.68)	-0.88 (-4.03, 2.28)	
Girl	74.92 (73.02, 76.82)	75.25 (72.36, 78.15)	0.33 (-3.15, 2.49)		71.61 (69.10, 74.12)	73.94 (70.49, 77.39)	-2.33 (-5.50, 0.84)	
Sedentary Behavior				0.1494				0.2542
Boy	179.49 (173.87, 185.11)	170.46 (161.02, 179.91)	9.03 (-0.15, 18.22)		204.39 (193.95, 214.83)	191.87 (177.66, 206.08)	12.52 (-0.78, 25.82)	
Girl	191.89 (186.20, 197.58)	191.72 (183.06, 200.38)	0.17 (-8.26, 8.60)		222.99 (212.55, 233.42)	216.59 (202.38, 230.79)	6.4 (-6.94, 19.75)	

Table 6: Least Squares Mean Estimate of Minutes at SPA, OSTPA, and SB by Gender, Rurality, and School SES

	Fourth-Grade (n=548)					Fifth-Grade (n=729)				
	Non-rural		Rural		Rurality*SES*Gender p-value	Non-rural		Rural		Rurality*SES*Gender p-value
	High SES (95% CI)	Low SES (95% CI)	High SES (95% CI)	Low SES (95% CI)		High SES (95% CI)	Low SES (95% CI)	High SES (95% CI)	Low SES (95% CI)	
School Physical Activity					.6461					.8590
Boy	46.88 (31.98, 61.77)	50.16 (38.13, 62.20)	54.69 (41.38, 67.99)	55.74 (35.16, 76.33)		41.78 (31.01, 52.55)	43.60 (35.94, 51.26)	49.25 (40.45, 58.04)	54.43 (44.32, 64.54)	
Girl	38.61 (23.74, 53.48)	39.92 (27.88, 51.96)	43.67 (30.46, 56.88)	40.87 (20.68, 61.06)		33.90 (23.11, 44.70)	35.78 (27.93, 43.22)	40.68 (31.92, 49.44)	45.25 (35.05, 55.46)	
Outside of School Time Physical Activity					.3558					.7238
Boy	93.70 (91.12, 96.29)	93.34 (91.00, 95.68)	96.07 (93.03, 99.11)	95.44 (90.49, 100.38)		91.56 (88.12, 95.00)	91.10 (88.00, 94.20)	91.70 (88.19, 95.22)	92.71 (87.87, 97.55)	
Girl	74.53 (72.14, 76.93)	75.31 (72.71, 77.90)	76.89 (74.09, 79.70)	73.61 (69.19, 78.04)		72.09 (68.51, 75.68)	71.13 (68.11, 74.15)	74.30 (70.89, 77.71)	73.58 (68.78, 78.37)	
Sedentary Behavior					.4151					.3264
Boy	176.37 (168.65, 184.08)	182.62 (175.62, 189.62)	168.91 (159.81, 178.00)	172.02 (157.21, 186.82)		198.61 (182.97, 214.26)	210.16 (197.27, 223.04)	195.28 (180.54, 210.02)	188.46 (169.33, 207.58)	
Girl	188.76 (181.59, 195.93)	195.02 (187.26, 202.78)	185.15 (176.76, 193.54)	198.28 (185.03, 211.53)		217.03 (201.09, 232.98)	228.94 (216.21, 241.68)	214.56 (200.14, 228.98)	218.61 (199.56, 237.66)	