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Do sedentary behavior and physical activity spatially cluster? Analysis of a population-based sample of Boston adolescents

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Abstract

Sedentary behavior and lack of physical activity are key modifiable behavioral risk factors for chronic health problems, such as obesity and diabetes. Little is known about how sedentary behavior and physical activity among adolescents spatially cluster. The objective was to detect spatial clustering of sedentary behavior and physical activity among Boston adolescents. Data were used from the 2008 Boston Youth Survey Geospatial Dataset, a sample of public high school students who responded to a sedentary behavior and physical activity questionnaire. Four binary variables were created: 1) TV watching (>2 hours/day), 2) video games (>2 hours/day), 3) total screen time (>2 hours/day); and 4) 20 minutes/day of physical activity (≥ 5 days/week). A spatial scan statistic was utilized to detect clustering of sedentary behavior and physical activity. One statistically significant cluster of TV watching emerged among Boston adolescents in the unadjusted model. Students inside the cluster were more than twice as likely to report > 2 hours/day of TV watching compared to respondents outside the cluster. No significant clusters of sedentary behavior and physical activity emerged. Findings suggest that TV watching is spatially clustered among Boston adolescents. Such findings may serve to inform public health policymakers by identifying specific locations in Boston that could provide opportunities for policy intervention. Future research should examine what is linked to the clusters, such as neighborhood environments and network effects.

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Compliance with ethical standards

Competing interests: The authors declare no conflict of interest.

Ethical standards

We obtained passive consent from parents (i.e., they had the opportunity to opt out from the study) and students read the informed assent before the survey administration. The Human Subject Committee (i.e., the Institutional Review Board) at the Harvard T.H. Chan School of Public Health approved the ethics of the original study protocols.

Keywords

TV viewing; exercise; youth; spatial scan statistics; urban city; geographical patterns

Introduction

Despite the well-documented benefits of physical activity, the 2013 Youth Risk Behavior Surveillance System (YRBSS) reported that only 27.1% of adolescents (9–12th graders) meet the recommended level of at least 60 minutes/day in a week of physical activity at the national level, with only 23% in Massachusetts and 15.3% in Boston (Kann et al. 2014). Additionally, adolescents spend excessive amounts of time in sedentary behaviors (defined as any behaviors while awaking: 1.5 metabolic equivalent [MET]) (Tremblay et al. 2017), including TV viewing and other screen-time activities, such as computers, tablets, and cell-phone use (Kim et al. 2016). Specifically, across the U.S., 41.3% (38.8% in Massachusetts and 41.5% in Boston) of adolescents spent 3 or more hours/day for computer use, whereas 32.5% (25.0% in Massachusetts and 34.8% in Boston) spent 3 or more hours/day for TV viewing (Kann et al. 2014). Sedentary behavior and the lack of physical activity are key behavioral risk factors for chronic health issues, including obesity, type 2 diabetes, metabolic syndromes, and cardiovascular disease (Hamilton et al. 2007; Booth et al. 2012).

A recent study on youth physical activity and sedentary behavior reported that parks and trails are components of the neighborhood environment that can help children and adolescents increase their physical activity levels and reduce their sedentary behaviors (Lou 2014). A review study on neighborhood environments in relation to physical activity among children and adolescents has indicated that numerous studies demonstrated positive associations between parks, green space, recreational centers, and walkability and physical activity (Ding et al. 2011). However, these previous studies may be limited in their ability to elucidate how neighborhood social-demographic and environmental characteristics influence physical activity levels, specifically when these associations vary geospatially in a study area (Huang et al. 2009). Clustering, defined as greater concentration of individuals with a specific outcome (Centers for Disease Control and Prevention 1990), has not been well-studied for behavioral risk factors (i.e., sedentary behaviors and physical activity). Only a few studies have investigated whether physical activity geospatially clusters (Huang et al. 2009; Tamura et al. 2014). For example, researchers investigated whether active transportation may geospatially cluster among adults in Los Angeles and San Diego County, California (Huang et al. 2009). Another recent study testing for geospatial clusters of physical activity among older women in California, Massachusetts, and Pennsylvania found geospatial clusters of physical activity in California and Massachusetts (Tamura et al. 2014).

There are several limitations related to the previous studies. Few studies have applied cluster detection methods to children and adolescents, a growing population known to spend a tremendous amount of time in front of a screen, such as TV viewing, internet browsing, and tablet use (Kim et al. 2016). Furthermore, other spatial analytic methods, for example, Moran's *I* (i.e., an indicator for spatial patterning/similarity on one specific variable) do not allow adjustment for covariates to detect spatial clustering of a certain outcome (Waller

2004). Understanding the specific locations of sedentary behavior and physical activity is crucial since areas with high sedentary behavior and low physical activity are needed for promoting physical activity among adolescents. This would allow us to identify which neighborhoods and potential populations need improved environmental policy and intervention programs. To date, no studies have examined geospatial clustering of sedentary behavior, as this present study does, although it is known that many individuals engage in sedentary behavior, particularly among adolescents. Thus, the purpose of this study was to identify geospatial clustering of sedentary behavior and physical activity among Boston adolescents.

Materials and Methods

Study sample

The Boston Youth Survey (BYS) is a biennial survey, sampled among Boston public high school students in 2004, 2006, and 2008. The initial goals of this project were to better understand risky behaviors of Boston youth and subsequently utilize the survey results to promote school- and neighborhood-level violence prevention programs (Harvard T.H. Chan School of Public Health 2017). Data for the present study were extracted from the 2008 BYS Geospatial Dataset. This survey examined a variety of parameters, such as diet and exercise, out-of-school activities, and use of media and technology, among 9th- to 12th-grade public high school students within Boston, Massachusetts (Almeida et al. 2015; Duncan et al. 2016; Tamura et al. 2017). Of all the 32 traditional public high schools in Boston, 22 took part in the 2008 BYS. Four to five classrooms were randomly selected from each of the 22 schools to participate. Approximately 100–125 students from each school were sampled, resulting in 2,725 students enrolled initially and 1,878 completed the survey (response rate = 68.9%). Where students provided their home addresses, we geocoded those addresses to the closest neighborhood street intersection, resulting in 1,292 (68.8%) students (i.e., the actual number of students enrolled with surveys and geocoded home addresses 47.4%). Prior to the survey administration, parents were asked to provide passive consent and students also read the informed assent material. The Human Subject Committee (i.e., the Institutional Review Board) at the Harvard T.H. Chan School of Public Health approved the ethics of the original study protocols.

Sedentary behavior and physical activity

Two items were used for sedentary behavior: 1) “On the average school day, how many hours do you spend watching television?” and 2) “On the average school day, how many hours do you spend playing video or computer games, or using a computer for something other than school work?” Item choices based on number of hours include: none, < 1, 1–2, 3–4, 5 or more. Consistent with the previous study using BYS data (Almeida et al. 2015), three binary variables were created: 1) TV watching 2 vs. > 2 hours/day, 2) video game and computer use 2 vs. > 2 hours/day, and 3) total screen time: 2 vs. > 2 hours/day. Physical activity was assessed with the following item, “In the past 7 days on how many days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard?” Responses ranged from 0 to 7 days. Based on a previous study with these

data (Almeida et al. 2015), a binary variable was created for engaging in physical activity: <5 vs ≥ 5 days in the past week.

Statistical analyses

A Bernoulli spatial scan statistic (M. Kulldorff and Nagarwalla 1995) was used to detect spatial clustering of sedentary behavior and physical activity among Boston adolescents using SaTScan™ software. Analyses were performed at the individual level to maximize spatial heterogeneity (Tamura et al. 2017). The null hypothesis is that no spatial clustering of sedentary behavior and physical activity exists. If rejected, it indicates that participants inside the cluster have a higher probability of reporting sedentary behavior and physical activity, compared to respondents outside the cluster. Prior research shows that larger geographic scale analysis could reduce the statistical power to determine clustering (Ozonoff et al. 2007). In turn, smaller geographic scale permits us to identify the exact location of the cluster, as compared to geopolitical boundaries, such as a county level analysis (Tamura et al. 2014). Therefore, we performed our cluster detection analysis at the respondent level.

SaTScan™ finds the most likely clusters based on a likelihood ratio test statistic. The statistical significance and associated p-value for each cluster is evaluated using Monte Carlo simulations. For each outcome, random simulations are conducted under the null hypothesis in SaTScan™ and the value of the maximum likelihood ratio statistic is compared to that of the observed data. If the null hypothesis is rejected (meaning $\alpha < 0.05$), then the observed maximum likelihood statistic is greater than 95% of the maximum likelihood statistic than that of random simulations. Therefore, a statistically significant spatial cluster of a given outcome shows that respondents within the cluster have a higher probability of reporting the outcome compared to respondents outside the cluster (Martin Kulldorff 2005). Unadjusted tests were performed separately for each dependent variable. SaTScan™ yields a relative risk (RR) for each cluster, a radius of the cluster, observed cases, and expected cases.

Subsequently, we tested for clustering with covariate adjustment (i.e., spatial confounding). SaTScan™ limits the geographic distribution of covariate adjustments to 12 categories. Consistent with a previous study on clustering analysis using the 2008 BYS Geospatial Dataset (Tamura et al. 2017), demographic variables were defined as age (older/younger; 18–19 years versus 13–17 years), gender (male/female), and race/ethnicity (Non-Hispanic White, Non-Hispanic Black and Hispanic, Asian/Other) (Tamura et al. 2017). For instance, one of 12 categories is an older-white-male student. An unadjusted cluster detection test and the test adjusted for covariates were performed. If a statistically significant cluster becomes non-significant after covariate adjustments, the cluster is explained by the geographic distribution of the covariates (Tamura et al. 2014). Respondents with missing values for the dependent variables or covariates were excluded to maximize the sample size for each outcome and covariates and statistical power of the tests and to minimize bias using a case-control analysis (Tamura et al. 2017), with a final sample of 1,080 students for TV watching, 1,072 for gaming, 1,065 for total screen time, and 1,108 for physical activity. ArcGIS 10.3 (ESRI, Redlands, CA) was used to visualize the findings.

Results

The average age was 16.3 years ($SD \pm 1.3$) (Table 1). The majority of the students were Black (42%) and Hispanic (32%), followed by White and Asian students. These students were predominantly U.S. born students. Hours spent on TV viewing (mean = 3.3 hours, Interquartile range (IQR) = 1.0) show similar across age, but time spent on gaming (mean = 3.0 hours, IQR = 2.0) and PA days (mean = 2.9 days, IQR = 4.0) decreased as they aged. Male students tend to spend more time gaming (3.2 vs. 2.8 hours, $p < .0001$) and engaged in physical activity on more days (3.6 vs. 2.3 days, $p < .0001$) than female students. Non-Hispanic Black and Hispanic students tend to spend more time watching TV (3.5 and 3.4 hours, respectively) and engaged in physical activity on fewer days (2.9 and 2.9 days, respectively) than did white students (2.78 hours of TV viewing and 3.5 physical activity days). Total screen time, TV watching, game hours and physical activity days appeared to be almost same for both U.S. and foreign born students. Surprisingly, underweight students spent more time on total screen time, TV watching, game hours than obese students did. Sedentary behavior items are moderately correlated (Pearson correlation coefficient $r = 0.27$, $p < .0001$) with each other, but not with physical activity.

Overall, one statistically significant spatial cluster of TV viewing was identified across Boston in unadjusted models. Respondents inside Cluster 1 were more than twice as likely to report watching TV > 2 hours/day, compared to respondents outside the cluster ($RR = 2.06$, $p = 0.0037$, Table 2, Figure 1). Moreover, robustness test was performed by using a Bonferroni correction, specifically comparing average hours of TV viewing for respondents inside Cluster 1 to the respondents outside the clusters and indicated $p < .0001$. There were no statistically significant clusters of TV viewing in the model adjusted for age, gender and race/ethnicity. In addition, there was no significant cluster of gaming, total screen time, or physical activity in the unadjusted models.

We performed sensitivity analyses for clustering of TV viewing adjusting for one covariate at a time, with age (high/low), gender (male/female), and race and ethnic groups (Non-Hispanic White, Non-Hispanic Black, Hispanic, Asian, and Other students). Separately adjusting for age and gender, one statistically significant cluster emerged exactly same location and size as Cluster 1 ($p < 0.05$). These results suggest that the geographic distribution of age and gender did not account for Cluster 1. On the other hand, adjustment for five race and ethnicity groups led to insignificant clusters, indicating that race and ethnic groups may account for the Cluster 1.

Discussion

This study employed a spatial scan statistic to detect high rates of sedentary behavior and physical activity among a population-based sample of Boston adolescents. The findings indicate one area with statistically significant higher rates for TV viewing in the unadjusted model.

Adjusting for covariates (i.e., age, gender, and race/ethnicity) contributed to the disappearance of the identified spatial cluster of TV viewing. This suggests that the

geographic distribution of covariates explained the geographically concentrated participants who had a greater likelihood of reporting TV viewing inside of the identified cluster compared to adolescents outside of the cluster.

The finding of sedentary behavior clusters among Boston adolescents cannot be compared to other studies as no other study investigated spatial clusters of sedentary behavior among adolescents in an urban city, such as Boston. However there are a few studies which examined spatial clusters of physical activity, one for active transportation among adults in California (Huang et al. 2009), and the other for physical activity among older women from three states (Tamura et al. 2014).

To the best of our knowledge, the current study is the first to detect for spatial clusters of sedentary behavior among adolescents in Boston. After adjusting for covariates, cluster 1 became insignificant, indicating that the identified spatial pattern (i.e., cluster 1) would be due to the spatial distribution of demographic characteristics inside cluster 1. The spatial variations of age and gender were not different inside and outside of the cluster 1. In contrast, race/ethnicity did vary, with greater numbers of Non-Hispanic Black (n=12) and Hispanic (n=14) students residing in Cluster 1 compared to outside the cluster (chi-square test $p<0001$). This may account for the disappearance of the cluster's significance after covariate adjustment, because Non-Hispanic Black and Hispanic children tend to spend more time in sedentary behavior compared to white children. Among 28 students in the Cluster 1, 25 students reported that they spent time on TV watching > 2 hours/day. Clearly, Non-Hispanic Black and Hispanic students inside the Cluster 1 spent more time watching TV compared to students outside the Cluster 1.

Previously, one study found that neighborhood characteristics (e.g., street connectivity and shorter block lengths) were related to geospatial clusters of greater active transportation (Huang et al. 2009). Consequently, although spatial variation of race/ethnicity appeared to account for the observed variation in sedentary behavior, these demographic characteristics may be associated with other variables such as crime rates in a neighborhood or density of parks around the participants' residences that may contribute to the cluster. Further assessment of socioeconomic factors (e.g., household income, parent educational attainment), social networks (e.g., social norms promoting being physically active) and environmental factors that are highly correlated with physical activity and sedentary behavior is needed to better understand why a cluster appeared in this study.

There are limitations that need to be addressed. The findings from this study may not be generalizable to low socio-economic adolescents in other U.S. urban cities. Additionally the sample could potentially be biased since the response rate was low. Thus, participating students may be more health conscientious than ones who did not participate. Self-reported sedentary behavior and physical activity measures are limited by inaccurate reporting (recall bias and social desirability) (Prince et al. 2008). The guidelines for sedentary behavior differed from the current American Academy of Pediatrics recommendations that parents limit any screen time for children aged 6+ years (American Academy of Pediatrics 2016). However, our sample is generally older (range: 13–19 years). Restricting screen time may not be feasible given their age groups. Thus, we followed the previous study of sedentary

time > 2 hours/day (Almeida et al. 2015). Additionally, physical activity outcome differs from the current PA guideline for children of at least 60 minutes of moderate-to-vigorous intensity physical activity (Physical Activity Guidelines Advisory Committee 2008). A limitation related to SaTScan is that the number of categories for covariate adjustments is limited to 12. This restricts the number of adjustments these analyses could include to age, gender, and race/ethnicity. Finally, an actual clustering of sedentary behavior and physical activity might not appear as a circular cluster. The Flexible Scan Statistics developed by Tango and Takahashi can be utilized to better understand geospatial clustering of sedentary behavior and physical activity among this sample of adolescents in Boston (Tango and Takahashi 2005).

Conclusions

The prevalence of sedentary behavior and physical inactivity among adolescents has been gradually increased over the past decade. Specifically, disproportionately more Black and Hispanic children engage in such behaviors compared to the counterparts. This study contributes to the sparse literature applying spatial clustering methods to sedentary behavior and physical activity. Findings suggest that TV watching is spatially clustered among Boston adolescents. Such findings may serve to inform public health policy-makers by identifying specific locations in Boston that could provide opportunities for policy intervention. The application of spatial clustering approaches can yield insights on neighborhood environments where sedentary behavior and physical activity clusters are observed. Findings may inform the development of geographically oriented population-based policies and environmental interventions to reduce sedentary behavior and promote physical activity among adolescents in the U.S.

References

- Almeida J, Duncan DT, Sonnevile KR. Obesogenic Behaviors among Adolescents: The Role of Generation and Time in the United States. *Ethnicity & Disease*. 2015; 25(1):58–64. [PubMed: 25812253]
- American Academy of Pediatrics. American Academy of Pediatrics Announces New Recommendations for Children's Media Use. 2016. <https://www.aap.org/en-us/about-the-aap/aap-press-room/pages/american-academy-of-pediatrics-announces-new-recommendations-for-childrens-media-use.aspx>
- Booth FW, Roberts CK, Laye MJ. Lack of exercise is a major cause of chronic diseases. *Compr Physiol*. 2012; 2(2):1143–1211. DOI: 10.1002/cphy.c110025 [PubMed: 23798298]
- Centers for Disease Control and Prevention. Guidelines for Investigating Clusters of Health Events. *MMWR, Morb Mortal Wkly Rep*. 1990; 39:1–16. [PubMed: 2294395]
- Ding D, Sallis JF, Kerr J, Lee S, Rosenberg DE. Neighborhood environment and physical activity among youth a review. *Am J Prev Med*. 2011; 41(4):442–455. DOI: 10.1016/j.amepre.2011.06.036 [PubMed: 21961474]
- Duncan DT, Rienti M Jr, Kulldorff M, Aldstadt J, Castro MC, Frounfelker R, et al. Local spatial clustering in youths' use of tobacco, alcohol, and marijuana in Boston. *Am J Drug Alcohol Abuse*. 2016; :1–10. DOI: 10.3109/00952990.2016.1151522
- Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007; 56(11):2655–2667. DOI: 10.2337/db07-0882 [PubMed: 17827399]

- Harvard TH, Chan School of Public Health. Harvard Youth Violence Prevention Center. Jun 23, 2017 <https://www.hsph.harvard.edu/hyvpn/research/>
- Huang L, Stinchcomb DG, Pickle LW, Dill J, Berrigan D. Identifying clusters of active transportation using spatial scan statistics. *Am J Prev Med*. 2009; 37(2):157–166. doi:S0749-3797(09)00303-1 [pii] 10.1016/j.amepre.2009.04.021. [PubMed: 19589451]
- Kann L, Kinchen S, Shanklin SL, Flint KH, Kawkins J, Harris WA, et al. Youth risk behavior surveillance—United States, 2013. *MMWR Suppl*. 2014; 63(4):1–168.
- Kim Y, Umeda M, Lochbaum M, Stegemeier S. Physical Activity, Screen-Based Sedentary Behavior, and Sleep Duration in Adolescents: Youth Risk Behavior Survey, 2011–2013. *Prev Chronic Dis*. 2016; 13:E131.doi: 10.5888/pcd13.160245 [PubMed: 27634781]
- Kulldorff M. SaTScan™: Software for the spatial, temporal, and space-time scan statistics. 2005. <http://www.satscan.org/>. Accessed June 24 2016
- Kulldorff M, Nagarwalla N. Spatial disease clusters: detection and inference. *Stat Med*. 1995; 14(8): 799–810. [PubMed: 7644860]
- Lou D. Sedentary behaviors and youth: Current trends and the impact on health. San Diego, CA: Active Living Research; 2014.
- Ozonoff A, Jeffery C, Manjourides J, White LF, Pagano M. Effect of spatial resolution on cluster detection: a simulation study. *Int J Health Geogr*. 2007; 6:52.doi: 10.1186/1476-072X-6-52 [PubMed: 18042281]
- Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report. Washington, DC: U.S. Department of Health and Human Services; 2008. 2008
- Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *Int J Behav Nutr Phys Act*. 2008; 5:56. doi:1479-5868-5-56 [pii] 10.1186/1479-5868-5-56. [PubMed: 18990237]
- Tamura K, Duncan DT, Athens JK, Bragg MA, Rienti M Jr, Aldstadt J, et al. Geospatial clustering in sugar-sweetened beverage consumption among Boston youth. *Int J Food Sci Nutr*. 2017; :1–10. DOI: 10.1080/09637486.2016.1276519
- Tamura K, Puett RC, Hart JE, Starnes HA, Laden F, Troped PJ. Spatial clustering of physical activity and obesity in relation to built environment factors among older women in three U.S. states. *BMC Public Health*. 2014; 14:1322.doi: 10.1186/1471-2458-14-1322 [PubMed: 25539978]
- Tango T, Takahashi K. A flexibly shaped spatial scan statistic for detecting clusters. *Int J Health Geogr*. 2005; 4:11. doi:1476-072X-4-11 [pii] 10.1186/1476-072X-4-11. [PubMed: 15904524]
- Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, et al. Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project process and outcome. *Int J Behav Nutr Phys Act*. 2017; 14(1):75.doi: 10.1186/s12966-017-0525-8 [PubMed: 28599680]
- Waller LA, Gotway CA. *Applied Spatial Statistics for Public Health Data*. New Jersey: John Wiley & Sons, Inc; 2004.

Figure 1. Spatial clusters of high rates of TV viewing among Boston adolescents. Cluster 1 is statistically significant, while other two clusters are not statistically significant.

Table 1

Student's characteristics, 2008 Boston Youth Survey Geospatial Dataset (N=1,056)

	N (%) ^a	Total screen time (SD)	TV viewing hours (SD)	Game Hours (SD)	PA Days (SD)
Age					
14	83 (7.86)	6.40 (1.93)	3.29 (1.24)	3.11 (1.31)	3.15 (2.27)
15	207 (19.60)	6.68 (1.98)	3.48 (1.11)	3.20 (1.34)	3.03 (2.44)
16	285 (26.99)	6.56 (1.96)	3.48 (1.16)	3.08 (1.31)	3.00 (2.39)
17	300 (28.41)	5.96 (2.01)	3.14 (1.20)	2.82 (1.37)	2.79 (2.35)
18	181 (17.14)	6.02 (2.8)	3.27 (1.19)	2.75 (1.35)	2.57 (2.23)
Gender					
Female	599 (56.72)	6.11 (2.05)	3.29 (1.19)	2.82 (1.38)	2.34 (2.24)
Male	457 (43.28)	6.57 (1.95)	3.39 (1.17)	3.18 (1.28)	3.60 (2.31)
Race/Ethnicity					
White	116 (10.98)	5.74 (1.80)	2.78 (1.05)	2.96 (1.16)	3.53 (2.29)
Black	447 (42.33)	6.46 (2.08)	3.52 (1.15)	2.94 (1.40)	2.94 (2.40)
Hispanic	338 (32.01)	6.46 (1.99)	3.41 (1.20)	3.04 (1.33)	2.86 (2.34)
Asian	78 (7.39)	5.83 (1.92)	2.73 (1.18)	3.10 (1.41)	1.19 (2.01)
Other	77 (7.29)	6.14 (2.01)	3.36 (1.06)	2.78 (1.35)	2.69 (2.26)
Nativity status[*]					
US Born	782 (74.55)	6.28 (2.00)	3.33 (1.17)	2.95 (1.35)	2.94 (2.37)
Foreign Born	267 (25.45)	6.37 (2.05)	3.33 (1.21)	3.04 (1.34)	2.73 (2.34)
Weight-status[*]					
Underweight	40 (4.10)	6.97 (2.17)	3.57 (1.38)	3.40 (1.19)	2.20 (2.23)
Normal	605 (62.05)	6.18 (1.92)	3.22 (1.17)	2.96 (1.32)	2.98 (2.38)
Overweight	174 (17.85)	6.11 (2.14)	3.37 (1.17)	2.74 (1.43)	2.80 (2.23)
Obese	156 (16.00)	6.71 (2.03)	3.58 (1.08)	3.12 (1.32)	3.17 (2.33)

Note: Total sample is based on when sedentary behaviors, physical activity, age, gender, and race/ethnicity are not missing.

^{*} Nativity status and weight-status are missing with 7 and 81 students, respectively.

Table 2

Cluster characteristics of sedentary behavior and PA

Cluster ID	Radius in km	Observed cases	Expected cases	Relative risk	p-value
TV viewing – unadjusted model					
1	0.62	25	12.50	2.06	0.004
2	2.4	146	119.16	1.32	0.404
3	0.19	6	2.68	2.26	0.99
TV viewing - adjusted model *					
1	0.62				0.333
2	2.08				0.907
Playing video or computer games - unadjusted model					
1	3.46	150	124.42	1.33	0.82
Total sedentary time - unadjusted model					
1	0.62	26	16.77	1.57	0.211
2	2.35	186	160.55	1.22	0.43
PA - unadjusted model					
1	0.57	16	7.20	2.29	0.481
2	1.62	8	2.77	2.94	0.712
3	0.14	4	1.11	3.64	0.942

Note:

* Models adjusted for age, gender, and race/ethnicity. Covariate adjusted models only show radius and p-value of the cluster.