Published in final edited form as:
Prev Med. 2013 February ; 56(2): 145–148. doi:10.1016/j.ypmed.2012.11.019.

Association of the built environment with physical activity and adiposity in rural and urban youth

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Abstract

Objective—To determine if: (1) differences exist for body mass index (BMI) and moderate-to-vigorous physical activity (MVPA) between rural and urban youth, and (2) perceived and objective measures of environmental supports for physical activity differentially correlate with BMI and MVPA in middle school rural and urban youth.

Method—Cross-sectional analyses were performed in spring 2012 on data collected from December 2008 until May 2010 for 284 middle school youth from a rural county and an adjacent urbanized area. Multivariable linear models estimated associations between BMI/MVPA and perceived environmental barriers/supports for physical activity and objectively measured neighborhood spatial variables.

Results—Mean MVPA was significantly lower for rural youth (15.9 minutes/day) compared to urban youth (19.2 minutes/day). No differences were observed between rural and urban youth for BMI or BMI percentile. Significant differences in both perceived and objective correlates for MVPA and BMI percentile were found in multivariable models between rural and urban youth.

Conclusion—Differences observed for correlates of MVPA and BMI across the settings suggest that rurality should be considered when identifying targets for intervention to promote MVPA and prevent adiposity in youth.

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Conflict of Interest statement: The authors declare that there are no conflicts of interest.

Introduction

Previous studies have reported higher physical activity (PA) in rural compared to urban youth (Liu et al., 2008; Loucaides et al., 2004), while others have found no difference (Joens-Matre et al., 2008; Prentice-Dunn and Prentice-Dunn, 2011). Results for overweight/obesity have been more consistent, with most authors concluding that overweight/obesity is more prevalent in rural versus urban/suburban youth (Bruner et al., 2008; Joens-Matre et al., 2008; Lutfiyya et al., 2007). It has been suggested that differences can be partially explained by disparities in the presence of PA environmental supports (Brownson et al., 2004; Moore et al., 2008; Parks et al., 2003). Despite evidence that disparities in environmental supports between rural and urban youth exist (Sandercock et al., 2010), little research has been conducted to examine differences in PA, opportunities for PA, and aspects of the built environment across rural and urban settings (Moore et al., 2010).

The goals of the present investigation were to determine if: (1) differences exist for body mass index (BMI) and moderate-to-vigorous physical activity (MVPA) between rural and urban youth, and (2) perceived and objective measures of environmental supports for PA differentially correlate with BMI and MVPA in middle school rural and urban youth.

Method

Participants

Participants were recruited from three middle schools in the southeastern United States. One school served a rural county (2010 population: 21,362) and two schools served the urban core of an adjacent urban county (2010 population: 168,148). Participants were recruited from December 2008 to May 2010. Of 1773 students enrolled, 481 received parental consent with 441 (25%) assenting to participate in data collection. Of these, 38 either did not return the accelerometer or did not have any recorded wear time, 118 did not provide at least four valid days of monitoring, and one student did not provide a geocodable address, resulting in a final sample of 284. Procedures were approved by the Institutional Review Board (IRB) at East Carolina University. Participants were informed about the study and parental consent/child assent was obtained prior to participation.

Physical Measures

Height and weight were recorded twice and averaged for analysis. BMI and BMI percentile were calculated according to Centers for Disease Control and Prevention growth charts (Kuczmarski et al., 2002). PA was measured using accelerometers (ActiGraph GT1M, Pensacola, FL) affixed on the participant’s right hip which collected data in 30s epochs for seven days (Pate et al., 2006). Counts were converted using thresholds (Evenson et al., 2006b) to determine time spent in sedentary, light, and MVPA. Data were reduced using MeterPlus (Santech, Inc, La Jolla, CA). A day was included in analyses if the monitor was worn for at least eight hours on any four days. Thirty minutes of consecutive zeros were considered indicative of non-wear time (Sirard and Slater, 2009). Counts were standardized to an 8-hour day based upon the proportion of time spent in each activity category.

Spatial data

Participant's home address was geocoded using digital street and property parcel data. Neighborhoods were estimated as the area bounded by a 0.5 mile network distance. Individual-level variables were constructed to measure network proximity to the nearest public school, restaurant of any type, fast food restaurant, supermarket, and convenience store as the shortest road network distance in miles. A composite distance score was derived which combined the access to these locations, using the first component of a principal components analysis. The score had a skewed distribution with larger values indicating less access to these facilities.

Self-reported data

Participants self-reported their age, sex, race, home address, and perceptions of PA environments. Eighteen questions ascertained respondent perceptions on their access to PA facilities and characteristics of their neighborhood using a yes/don't know/no response format (Evenson et al., 2006a; Mota et al., 2009). An access to Mixed-Use Facilities Sum Score was derived by summing the "yes" responses from a checklist of 14 potential destination which each individual indicates his/her access (Evenson et al., 2007).

Analyses

Analyses were performed using SAS 9.2 and JMP 9 statistical software. Log transformations were used to account for skew in MVPA and BMI percentile. Spearman correlations were computed between environmental perception questions and residual estimates of MVPA and BMI percentile stratified by rural/urban location. The difference between the two correlations were estimated and a 95% bootstrap confidence interval for the difference was calculated (using 1000 bootstrap samples of size n=284).

Regression modeling was applied to the data in stages, stratified by rurality; first using sociodemographic covariates and BMI/MVPA as appropriate, second adding the composite distance score to the model, and third adding variables from the earlier correlation analysis that indicated discrepancies between rural and urban cohorts. The stagewise examination was intended to assess changes in R-Square and regression estimates as we broadened the factors included towards a full model.

Results

Physical characteristics of the counties and demographics of the sample are in Supplementary Tables 1 and 2, respectively. Mean MVPA was significantly lower for rural (15.9 minutes/day) compared to urban youth (19.2 minutes/day) and the Composite Distance Score was significantly higher for rural compared to urban youth. No significant differences were found for BMI or BMI percentile between settings.

Unadjusted Spearman correlations are presented for BMI percentile and MVPA with self-reported environmental perceptions in Table 1. Table 2 shows regression models for MVPA and BMI percentile stratified by location. In the MVPA models, a moderate amount of variance was explained in the rural and urban models (R-square=0.44, 0.30, respectively).

The composite distance score was the only significant predictor of MVPA in the rural sample, with BMI percentile and perceptions of high traffic significant in the urban model. The multivariable model for BMI explained a small amount of variance among rural and urban youth (R-square=0.04, .13, respectively). Only the presence of “loose or scary dogs” was significantly associated with BMI percentile in urban but not rural youth.

Discussion

No differences were observed in the prevalence of BMI between urban and rural youth, but MVPA was higher in urban compared to rural youth in the present sample. These findings are consistent with research showing no difference in BMI between urban/rural youth (Davis et al., 2008) but inconsistent with research showing higher BMI for rural youth (Bruner et al., 2008; Joens-Matre et al., 2008; Liu et al., 2008; Lutfiyya et al., 2007). The findings for MVPA are consistent with previous studies reporting higher PA in urban youth (Davis et al., 2008). The difference between the locations was modest in the current sample (a 3.3 minute difference of MVPA/day).

Many of the differences noted were consistent with the existing literature, such as the negative association between BMI percentile and MVPA in urban youth (Davison et al., 2007). However, other findings are paradoxical and require future investigation. For example, the relationships between presence of loose or scary dogs was significantly different between rural and urban youth, in that presence of dogs was associated with higher BMI in urban but not rural youth. In addition, MPVA was positively associated with perceptions of traffic in urban youth after controlling for distance to destinations, which is contradictory to previous findings (Davison and Lawson, 2006).

Study findings should be considered in light of several limitations. First, we employed a convenience sample that did not include suburban youth. It has been suggested that the urban-rural gradient should be trichotomized which wasn’t possible in the present sample (Sandercock et al., 2010). The absence of a true trichotomization might explain our contradictory findings related to BMI (Sandercock et al., 2010). The current sample was not randomly selected and the relatively low response rate might introduce bias.

These findings suggest differences in PA between rural and urban youth can be partially explained in differences in proximal destinations for commerce. These findings add to the growing body of literature highlighting meaningful differences between rural and urban settings relevant to MVPA and adiposity in youth.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was supported by grants from the Centers for Disease Control and Prevention (K01-DP001126) and (U48/DP000060, Prevention Research Centers Program). The authors would like to thank Daniel A. Rodrı́guez for his assistance in the planning stage of this project and Kaitlyn Walker for her assistance in the preparation of this manuscript.

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Table 1

Spearman Correlations between Neighborhood Perceptions, BMI Percentile and MVPA in rural and urban children from eastern North Carolina

Spearman Correlations[1]	BMI Percentile					MVPA				
Perceived Environmental Characteristic	Total	Rural	Urban	Difference (U-R)	Difference 95% Bootstrap CI[2]	Total	Rural	Urban	Difference (U-R)	Difference 95% Bootstrap CI[2]
It is safe to walk or jog in my neighborhood.	−0.125	−0.044	−0.205	0.161	(−0.062,0.368)	0.185	0.200	0.145	0.055	(−0.176,0.273)
Walkers and bikers on the streets in my neighborhood can easily be seen by people in their homes.	0.029	−0.005	0.059	−0.064	(−0.294,0.157)	**0.047**	**0.168**	**−0.084**	**0.253**	**(−0.015,−0.494)**
There is a lot of crime in my neighborhood.	0.055	−0.049	0.136	−0.186	(−0.427,0.049)	−0.004	−0.002	−0.019	0.017	(−0.215,0.241)
My neighborhood streets are well lit at night.	−0.019	−0.099	0.076	−0.175	(−0.378,0.047)	0.048	0.023	−0.049	0.072	(−0.167,0.316)
There is so much traffic that it makes it hard to walk in my neighborhood.	0.016	0.023	0.011	0.012	(−0.206,0.233)	**0.135**	**0.049**	**−0.283**	**−0.332**	**(−0.535,−0.097)**
I often see other girls and boys playing outdoors in my neighborhood.	0.008	−0.077	0.099	−0.176	(−0.393,0.031)	0.008	−0.003	0.042	−0.044	(−0.296,0.205)
There are lots of loose or scary dogs in my neighborhood.	**0.112**	**−0.029**	**0.260**	**−0.289**	**(−0.491,−0.07)**	−0.075	−0.129	−0.043	−0.086	(−0.319,0.142)
There are many interesting things to look at while walking in my neighborhood.	−0.038	−0.067	−0.017	−0.049	(−0.275,0.167)	0.024	0.079	−0.043	0.122	(−0.11,0.364)
There are trees along the streets in my neighborhood.	0.040	0.042	0.041	0.001	(−0.222,0.222)	−0.041	−0.076	−0.045	−0.031	(−0.258,0.214)
When walking in my neighborhood, there are a lot of exhaust fumes or other bad smells.	−0.063	−0.085	−0.041	−0.044	(−0.272,0.178)	0.057	0.165	−0.064	0.229	(−0.023,0.445)
There usually is not garbage or litter in my neighborhood.	0.071	0.190	−0.019	0.209	(−0.002,0.43)	0.031	0.052	−0.038	0.091	(−0.129,0.308)
Many stores are within easy walking distance of my home.	0.068	0.032	0.131	−0.099	(−0.318,0.133)	0.140	0.216	0.004	0.212	(−0.008,0.422)
It is hard to get to a facility due to physical barriers in the environment (rivers, highways, roads, etc.)	0.010	0.027	0.027	0.000	(−0.218,0.231)	0.102	0.108	−0.009	0.117	(−0.113,0.326)
There are sidewalks on most of the streets in my neighborhood.	0.003	−0.016	0.052	−0.068	(−0.294,0.14)	0.116	0.081	0.018	0.064	(−0.179,0.282)
There are bicycle or walking trails in my neighborhood.	−0.055	−0.073	−0.045	−0.028	(−0.248,0.173)	−0.053	−0.017	−0.068	0.050	(−0.186,0.288)
At home there is enough sports equipment for use for physical activity.	−0.051	−0.030	−0.080	0.050	(−0.167,0.282)	−0.008	−0.045	−0.014	−0.031	(−0.257,0.208)
There are many places I like to go within easy walking distance from my home.	0.020	−0.063	0.078	−0.141	(−0.356,0.079)	**0.048**	**0.244**	**−0.049**	**0.293**	**(−0.056,−0.524)**
My neighborhood has free or low cost recreation facilities.	0.029	0.008	0.053	−0.045	(−0.274,0.171)	0.044	0.151	−0.058	0.208	(−0.034.0.432)

[1] Spearman correlations calculated between continuous outcomes and ordinal survey responses. Estimates are listed for combined sample and stratified estimates for rural and urban environments.

[2] Intervals come from 1000 bootstrap samples and show the 2.5th and 97.5th percentiles.

Coefficients in bold represent significant urban/rural differences at the $p < .05$ significance level.

Table 2

Stagewise Regression Results Stratified by Region

	Outcome - BMI Percentile		Region - Rural				Outcome - BMI Percentile		Region - Urban			
	R-Square = 0.03		R-Square = 0.034		R-Square = 0.036		R-Square = 0.094		R-Square = 0.079		R-Square = 0.131	
Term	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**
Intercept	**87.81**	**24.40**	**65.09**	**28.40**	**62.35**	**29.18**	**83.29**	**30.34**	**83.63**	**32.65**	**113.68**	**34.01**
Gender (Male)	1.66	2.68	4.35	3.18	4.23	3.21	2.88	2.42	2.24	2.71	2.27	2.65
Age	−0.39	1.97	1.51	2.26	1.43	2.27	0.08	2.39	−0.17	2.53	−0.4	2.47
Race (White)	−3.10	2.51	−1.16	2.58	−1.18	2.6	**−6.41**	**2.23**	**−5.23**	**2.54**	−3.74	2.55
MVPA	−0.31	0.19	−0.27	0.20	−0.27	0.2	**−0.43**	**0.19**	−0.38	0.21	−0.33	0.21
Composite Distance Score			−0.05	1.53	−0.04	1.54			−1.51	6.06	−0.51	5.93
Dogs[a]					−1.94	4.36					**13.69**	**5.42**

	Outcome - MVPA		Region - Rural				Outcome - MVPA		Region - Urban			
	R-Square = 0.335		R-Square = 0.411		R-Square = 0.44		R-Square = 0.217		R-Square = 0.26		R-Square = 0.30	
Term	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**	**Estimate**	**Std Error**
Intercept	12.87	11.75	16.21	14.54	7.04	13.72	**54.43**	**12.73**	**56.33**	**14.11**	**54.47**	**12.19**
Gender (Male)	**7.43**	**1.05**	**9.16**	**1.31**	**7.11**	**1.05**	**5.24**	**0.96**	**5.83**	**1.09**	**4.36**	**0.87**
Age	1.15	0.90	1.10	1.13	0.95	0.9	−1.94	1.02	−2.07	1.12	−1.48	0.9
Race (White)	−1.59	1.16	−0.75	1.30	−0.51	1.03	0.06	1.00	−0.09	1.17	0.04	1
BMI Percentile	−0.07	0.04	−0.07	0.05	−0.05	0.04	**−0.08**	**0.04**	−0.08	0.04	**−0.07**	**0.03**
Composite Distance Score			**−1.84**	**0.74**	**−1.20**	**0.61**			0.32	2.72	0.91	2.22
Easily Visible[a]					−0.07	1.49					0.26	1.52
High Traffic[a]					−4.19	3.08					**4.78**	**2.12**
Places of Interest Near Home					−2.58	1.48					−0.47	1.29

Regression parameter estimates and standard errors. Items in bold indicate parameter estimates that are significantly different than zero, alpha = 0.05.

[a] Coded “Agree” = 3, “Neither” = 2, “Disagree” = 1