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Association of the home environment with cardiovascular and metabolic biomarkers in youth

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Abstract

Objective—To examine the relationship between the home environment and biomarkers associated with the cardiovascular and metabolic risk in adolescents.

Methods—Three hundred fifty-eight adolescents (185 males, 173 females) living in the Twin Cities Metropolitan Area, Minnesota, between the ages of 10–17 years agreed to participate. Data were collected from August 2006 through March 2008. A fasting blood sample was drawn and assayed for insulin, glucose and lipids. Resting blood pressure, percent body fat (PBF) and body mass index were also measured. The home environment was assessed using a self-report of physical activity (PA) and media inventory (PAMI) completed by the parents. Density of PA and media equipment was calculated by summing the number of items present in the home and dividing by the total number of locations in the home. PA and screen media density were modeled as independent variables.

Results—Our results found that the density of PA equipment was negatively associated with insulin levels, low-density lipoprotein (LDL), total cholesterol, insulin resistance, and PBF. Media density was positively associated with insulin, LDL, total cholesterol, and PBF.

Conclusions—The results of this study suggest that the home environment is associated with metabolic and cardiovascular health in adolescents.

Introduction

Recent studies in adults and adolescents have reported an association between physical inactivity and the development of cardiovascular and metabolic risk factors (Expert Panel 2002; Ekelund et al., 2006). Although a number of risk factors are thought to have a role in the development of cardiovascular and metabolic risk, physical inactivity is considered to be one of the driving factors (Park et al., 2003).

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Little is known about how the physical environment of the home may influence physical activity (PA) and associated metabolic risk factors. Therefore, the purpose of this paper is to examine the relationship between elements of the home environment that may influence levels of PA and the following cardiovascular and metabolic risk factors: insulin, glucose, lipids, insulin resistance, blood pressure [BP], percent body fat [PBF] and body mass index [BMI]. We hypothesize that the availability of PA equipment in the home is inversely related cardiovascular and metabolic risk factors while the availability of media equipment is positively related to these risk factors.

Methods

This research was conducted combining data from two etiologic studies of adolescent obesity in the Twin Cities Metropolitan Area. The conceptual model and overall study design is described elsewhere (Lytle, 2009). Recruitment of this population-based cohort occurred using a variety of methods including recruiting an existing cohort, and recruiting through drivers license registration, a health maintenance organization and advertisements (Heitzler et al., 2010). One parent/child dyad per family was allowed to enroll and dyads were excluded from eligibility if they planned to move from the area in the next three years, had a medical condition that affected their growth, or had difficulty comprehending English. The study was approved by the University of Minnesota Institutional Review Board.

Body composition was assessed using a digital bioelectrical impedance scale (Tanita TBF-300A, Tanita Corporation, Tokyo, Japan). BP was measured using an automated sphygmomanometer (Dinamap 8100, GE Healthcare, Piscataway, NJ) after 5 minutes of seated rest and three measurements of BP were averaged.

Self-report data on demographics were obtained at the initial clinic visit from both adolescents and parents. Pubertal status was assessed in all youth participants by the self-report Pubertal Development Scale (PDS)(Petersen et al., 1988).

During a second clinic visit, 12-hour fasting blood sample was obtained by venipuncture. Plasma samples were measured for glucose and insulin, as well as triglycerides (TG), total cholesterol (CHOL), low-density lipoproteins (LDL) and high-density lipoproteins (HDL). Homeostasis model assessment for insulin resistance (HOMA-IR) was calculated as: (fasting glucose*fasting insulin)/22.5 (Matthews et al., 1985).

At the clinic visit, the parent participant was given the Physical Activity and Media Inventory (PAMI) to be completed at home and returned within two weeks in a self-addressed, postage paid envelope. The PAMI is a self-report inventory of the availability of 42 PA equipment items (e.g., bicycle, football, etc.) and five media equipment items (e.g., TV, computer, etc.) and has been shown to be both reliable and valid (Sirard et al., 2008). Density of PA and media equipment was calculated by summing the number of items present in the home environment and dividing by the total number of locations.

Statistical Analysis

Descriptive statistics were calculated and tested for differences ($p<0.05$) by gender using a t-test. In the multivariate analysis, PA and media equipment density were modeled as independent variables for each biologic measure separately, adjusting for home–level and individual-level covariates. Adjusted models were tested for interaction by gender and stratified if $p<0.05$. All models used PROC GENMOD in SAS version 9.1 [SAS Institute, Cary, NC], accounting for clustering at the school level and age, gender, pubertal status, number of people living in the home, study sample, and variables associated with socioeconomic status at the individual level. All categorical variables were compared by a chi-square test and are reported as percentage.

Results

The sample included 723 student-parent dyads and 50.6% (n=366) consented for the optional blood draw. There were no statistical ($p<0.05$) differences in pubertal status, gender, age or BMI between those who opted for the blood draw and those who did not. Eight participants were dropped due to missing data on one or more variables. A total of 358 adolescents were included in this analysis. Table 1 describes the characteristics of the analysis sample, stratified by gender. As expected, females were further along the pubertal development scale than males. The parents of male participants reported a higher density of PA and media equipment than parents of female participants. Females had significantly higher levels of insulin, HDL, and CHOL, but lower systolic BP

Adjusted models estimating the association between PA equipment density, media density and biomarkers were analyzed (Table 2). PA equipment density was negatively associated with insulin, LDL, CHOL, HOMA-IR, and PBF. Media equipment density was positively associated with LDL, CHOL and PDF. Significant gender interactions were present in several of the relationships including the relationship between PA equipment density and insulin ($\beta=-0.43$, $p=0.05$), with male subjects showing a significant negative association between insulin levels and PA equipment density ($\beta=-0.33$, $p=0.03$). The association between HOMA-IR and PA equipment density also significantly differed by gender ($\beta=-0.10$, $p=0.03$), again with males showing a significant negative association ($\beta= -0.08$, $p=0.02$). The only significant interaction between gender and media equipment density was in the slope for TG ($\beta=-35.41$, $p=0.05$) with females showing a significant, positive association ($\beta=32.5$, $p=0.02$).

Discussion

To our knowledge, this is one of the first studies to examine the relationships between elements of the home environment and biomarkers related to cardiovascular and metabolic diseases. Even though the access to PA and media equipment and biological markers are quite distal in the pathway for disease, we observed a number of significant relationships in the expected direction. As the PA equipment density increased there was a significant decrease in insulin, LDL, CHOL, HOMA-IR and PBF. Our data also show significant and positive relationships between screen media density and LDL, CHOL, and PBF. Recent studies in adolescents (Ekelund et al., 2006; Wake, Hesketh, Waters, 2003; Mark, Janssen, 2008) have reported that increased media usage is associated with obesity and other cardiovascular risk factors. The present study adds to the current literature by using a measure of PA and media equipment in the home as well as by examining their associations with biomarkers. Of interest in the present study is the gender difference regarding the association between PA and media equipment density and biologic markers. Males had strong, negative associations with PA equipment density, insulin and HOMA-IR, while females had strong, positive associations with media equipment density and TG.

The current study has limitations. This is a cross-sectional study so causality cannot be determined, and an assessment of behavior as a link between equipment density and biomarkers was not evaluated. In the present study we only evaluated five types of media and recently a number of newer media items are available for this age group. In addition, PA and media equipment density does not necessarily correspond to physical activity or media usage. Finally, this sample is a middle-class sample from a Minnesota community, so the findings may not be generalizable to other communities.

Conclusion

Our results suggest a role for the home environment in metabolic and cardiovascular health of adolescents, and suggest that boys and girls may respond differently to the home environment. Additional research on biological and physiological biomarkers and the home environment with larger and more generalizable samples is necessary to determine the role of the home environment on disease risk. Finally, additional studies are needed on physical activity and media usage and cardiovascular and metabolic health in adolescents.

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Table 1

Sample characteristics for total sample and by gender, TREC IDEA[1] and ECHO[2]

	Total (n=358)		Males (n=185)		Females (n=173)		
Variable	%		%		%		p-value
% Receive free/reduced cost lunch	8.1		8.1		8.1		1.0
% College education[3]	79.9		81.1		78.6		0.56
% White	88.6		88.7		88.4		1.0
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p-value**
Student age (yrs)	14.7	1.8	14.7	1.8	14.8	1.8	0.53
Pubertal Status	2.9	0.7	2.6	0.7	3.2	0.6	<0.0001
Total # people in house	4.4	1.2	4.4	1.3	4.3	1.2	0.78
PA equipment density	5.2	2.8	5.7	3.1	4.7	2.4	<0.0001
Media equipment density	0.7	0.3	0.8	0.3	0.7	0.3	0.01
Insulin (pmol/L))	60.0	40.3	55.5	42.5	64.9	37.2	0.03
HOMA-IR[4]	1.7	1.2	1.6	1.3	1.8	1.1	0.08
Glucose (mmol/L)	4.4	0.4	4.5	0.4	4.4	0.4	0.10
High-density lipoprotein cholesterol (mmol/L)	1.3	0.3	1.2	0.3	1.4	0.3	<0.0001
Low-density lipoprotein cholesterol (mmol/L)	2.2	0.6	2.2	0.6	2.3	0.6	0.21
Total lipoprotein cholesterol (mmol/L)	3.9	0.8	3.9	0.8	4.0	0.7	<0.0001
Triglycerides (mmol/L)	0.9	0.5	0.9	47.8	0.5	0.4	0.95
Systolic blood pressure (mm Hg)	114.9	9.6	116.5	9.8	113.2	9.1	<0.0001
Diastolic blood pressure (mm Hg)	54.6	7.5	54.0	6.7	55.2	8.2	0.11
Percent body fat (%)	20.9	10.3	15.6	9.1	26.4	8.5	<0.0001
Body mass index percentiles	60.3	28.2	60.1	29.6	60.6	26.7	0.87

[1] Transdisciplinary Research in Energetics and Cancer: The Identifying Determinants of Eating and Activity (TREC IDEA). Data collected from November 2006 to May 2007 in adolescents from the Minneapolis/St. Paul Metropolitan Area.

[2] Etiology of Childhood Obesity: A Longitudinal Study (ECHO). Data collected from September 2007 to May 2008 in adolescents from the Minneapolis/St. Paul Metropolitan Area.

[3] Assessed by asking the question: "Among all of the adults in your home, what is the highest level of education completed?"

[4] Homeostasis model assessment for insulin resistance (HOMA-IR)

Table 2

Adjusted generalized estimating equation models between biologic measures and the physical activity equipment and media equipment density of the home environment, TREC IDEA[1] and ECHO[2].

	PA equipment density			Media density		
Dependent Variable	**Coef**	**SE**	**p**	**Coef**	**SE**	**p**
Insulin[3]	**−0.24**	**0.11**	**0.03**	2.11	1.13	0.06
HOMA-IR[3,4]	**−0.05**	**0.02**	**0.02**	0.44	0.24	0.07
Glucose	−0.18	0.16	0.26	0.14	1.50	0.93
High-density lipoprotein cholesterol	−0.15	0.21	0.48	−0.58	2.08	0.78
Low-density lipoprotein cholesterol	**−1.62**	**0.51**	**<0.01**	**11.58**	**4.76**	**0.02**
Triglycerides [3]	−0.46	0.81	0.57	12.60	8.80	0.15
Total lipoprotein cholesterol	**−1.86**	**0.58**	**<0.01**	**13.58**	**5.72**	**0.02**
Systolic blood pressure	0.07	0.19	0.70	1.40	1.70	0.41
Diastolic blood pressure	0.03	0.14	0.84	0.97	1.43	0.50
Percent Body Fat	**−0.59**	**0.18**	**<0.01**	**3.92**	**1.55**	**0.01**
Body mass index percentiles	−0.78	0.57	0.18	7.14	5.07	0.16

Adjusted models include density of media and density of physical activity equipment adjusted for age, gender, pubertal status, number of people living in the home, receive free or reduced cost lunch (yes vs. no), highest household education (college graduate vs. not) and study sample.

[1]Transdisciplinary Research in Energetics and Cancer: The Identifying Determinants of Eating and Activity (TREC IDEA). Data collected from November 2006 to May 2007 in adolescents from the Minneapolis/ St. Paul Metropolitan Area.

[2]Etiology of Childhood Obesity: A Longitudinal Study (ECHO). Data collected from September 2007 to May 2008 in adolescents from the Minneapolis/St. Paul Metropolitan Area.

[3]Indicate models with significant interaction by gender, $p<0.05$.

[4]Homeostasis model assessment for insulin resistance (HOMA-IR)

Note: Generalized estimating equations were used to account for clustering at the school level.