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The Relationship of Living Environment with Behavioral and Fitness Outcomes by Sex: an Exploratory Study in College-aged Students

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ABSTRACT

International Journal of Exercise Science 10(3): 330-339, 2017. Although physical activity (PA) is associated with several health benefits, there is a marked decline during college years, which is an influential period for the development of health behaviors. This study examined the relationship of neighborhood and living environment with behavioral (PA and sedentary behavior) and fitness outcomes by sex. Participants were college students that participated in a fitness assessment, followed by a survey that measured self-reported exercise and perception of one's environment (sidewalks, crime, traffic, access to PA resources in their neighborhood and/or apartment complex). Pearson correlations examined the relationship between behavioral (moderate and vigorous PA, sedentary behavior, active travel) and fitness outcomes (VO2max, percent body fat, body mass index, push-ups, curl-ups, blood lipids and glucose) with environmental measures separately by sex. Among participants (n=444; female=211, male n=234) environment was significantly related to PA and fitness, with noted differences by sex. For males, seeing others exercising in the neighborhood and in their apartment complex, using neighborhood bike lanes, crime and the number of PA resources at their apartment complex were associated with behavioral and fitness outcomes. Among females, sidewalks in the neighborhood, seeing others exercising, using neighborhood bike lanes and number of PA apartment complex resources were significantly correlated with fitness and behavioral outcomes. These findings suggest a possible relationship between students' objectively measured fitness and their environment for PA. Future implications include the development of policies to create student housing that supports physical activity and expansion of campus wellness initiatives to off-campus locations.

KEY WORDS: Built environment, physical fitness, youth

INTRODUCTION

Physical activity (PA), which is defined as any bodily movement that requires energy expenditure, is associated with health benefits including weight loss, enhanced cognitive processing, decreased symptoms of depression, reduced risk of cancer, type 2 diabetes, metabolic syndrome, and cardiovascular disease (15). Current guidelines suggest that adults

ages 18-64 years should do at least 150 minutes a week of moderate-intensity (3-6 METS), or 75 minutes of vigorous-intensity aerobic activity (>6 METS) per week (15). METS stands for Metabolic Equivalents and is defined as the ratio of a person's working metabolic rate relative to their resting metabolic rate. However, despite these guidelines, research shows a large decline in PA during the transitional period from high school to college (8, 14). While once considered a life stage for optimal health, this age group is now emerging as one with increasing risk for chronic disease (11).

Without parental guidance and structure of high school physical education or sports programs, many individuals tend towards sedentary behavior (5,6). Since approximately one third of young adults (ages 18-24 years old) attend college in the United States, it is important to examine the trend occurring in this group (10). For the sake of this study, the focus will be on college students that live off-campus since we are asking about students' neighborhoods and campus is not a representative environment. While there is substantial research examining the psychosocial influences related to the decline in PA in this age group, there is little research that examines the effect of the built or social environment on PA.

Previous studies have shown evidence on the connection between the environment and PA based on individuals' perceptions of their surroundings (2). Positive environmental influences on PA include the presence of recreational facilities, sidewalks, and agreeable traffic patterns (12). However, further examination of the relationship of the environment with health is difficult as the majority of the research in this area lacks health and fitness related outcomes. As there is also a discrepancy in PA patterns by sex, it is important to consider these differences when evaluating health markers. Women are often less active than men (18), and environmental differences in correlates of PA exist as well. The majority of evidence points to a lower rate of participation in sports and leisurely PA at a young age that continues over the course of a woman's life. Although convenience is thought to be an important factor in both sexes, men tend to prefer an aesthetically pleasing space while women tend to prefer safety in their exercise environment (7, 16, 17). Accordingly, the purpose of this study is to examine the relationship between the environment and objectively measured fitness and health markers by sex in a sample of college students.

METHODS

Participants

Participants (n=466) were students that were administered a fitness assessment as part of their course requirements, and were then invited to take part in a survey. This data was obtained between September 2014 and April 2015. All students provided their informed consent and tests were administered by trained technicians. This study was approved by the Institutional Review Board at The Pennsylvania State University.

Protocol

Upon completing their fitness assessments, participants completed an electronic survey (Qualtrics, Provo, UT) that was linked with their fitness outcomes with an identifying number.

Body composition - Height and weight were measured to calculate body mass index (BMI). A BMI above 25kg/m^2 places in an individual in an overweight category, while a BMI above 30kg/m^2 places in an individual in an obese category. Body fat percentage was calculated via bioelectrical impedance analysis (Omron BF306, Omron Global, Lake Forest, IL).

Aerobic Fitness - VO_2 max, defined as maximal oxygen uptake, was used to measure aerobic fitness using YMCA Submaximal Cycle Ergometer test (14) while wearing a heart rate monitor. Workrate and heartrate were used to produce an estimate of maximal oxygen consumption by the direct heart rate plotting method.

Muscular Endurance - Muscular endurance was measured via two tests: a one-minute maximum repetition push-up test and a modified curl-up test (maximum of 75 curl-ups) (14).

Cholesterol: Total cholesterol and fasting plasma glucose (FPG) were both measured with a commercially available analyzer (Cholestech LDX, Alere, Waltham, MA). Forty microliters of blood were collected via finger stick and injected into a Cholestech LDX lipid profile with glucose cassette. The normative value for total cholesterol is below 200 mg/dL, while the normative value for FPG is below 100 mg/DL.

Demographics - Students self-reported their age, sex, and race/ethnicity. Individuals also indicated if they were employed, their place (e.g., on or off-campus) and type of residence (e.g., house, apartment building, etc.).

Behavioral outcomes - The Global Physical Activity Questionnaire (GPAQ) was used to determine minutes of moderate and vigorous PA (1). Moderate forms of PA included any activities that cause a small increase in breathing or heart rate, such as brisk walking, cycling, swimming, and playing volleyball. Vigorous forms of PA included any activities that cause a large increase in breathing or heart rate, such as running and playing football. The GPAQ was also used to assess sedentary behavior separately on weekdays and weekends (hours/day). Other information collected includes the summed number of walking and biking trips/week to campus (active travel; AT).

Environmental variables - Five items from the Neighborhood Environment Walkability Scale (3) was used to assess perceptions of sidewalks, traffic, crime and seeing others active in their neighborhood. These items included estimated distance to the nearest park, neighborhood sidewalk maintenance, perceived crime in the neighborhood during the day and at night and perceived neighborhood traffic.

Using a 5-point Likert scale (1=not at all to 5=very much) individuals who reported living in an apartment complex were asked if they felt their apartment provides them with PA resources and if they believe others are active in their apartment complex. Individuals reported (yes/no) if their apartment complex offered resources for PA (e.g. weight room, cardio equipment, pool, etc.), which was summed (range 0-12).

Statistical Analysis
Descriptive statistics and frequencies described the sample. T-tests and Chi-square analyses examined the differences between sexes. Pearson correlations were used to examine the relationship between fitness and behavioral outcomes with environmental outcomes separately by sex. All analyses were run using SPSS 22.0 (IBM, Armonk, NY). Significance levels were set at $p<.05$.

RESULTS

Characteristics of the participants are found in Table 1. The final study included 466 participants (n=234 males, n=211 females). The majority of the sample was Non-Hispanic White (n=369, 78%) and lived off-campus (n=380, 83%). Males) had higher BMI values (25.61±3.76 kg/m^2 vs. 24.19±4.14 kg/m^2; t=3.53, p<.001), VO2max (37.70±8.92 ml/kg/min vs 36.01±7.25 ml/kg/min; t=2.02, p=.04), push-ups (25.34±12.91 vs. 21.81±25.45; t=3.12, p=.002), curl-ups (60.14± 27.91 vs. 37.74±16.56; t=9.39, p<.001) and lower percent body fat (16.03±4.92 vs. 26.47±6.39; t=18.10, p<.001) compared with females. Females reported less minutes a week of vigorous PA (134.94±145.09 vs. 182.62±162.71; t=3.20, p=.001) and AT trips (9.04±6.31 vs. 10.47±5.79; t=2.39, p=.02) compared with males.

Among the males there were a number of significant correlations between environmental variables and fitness and behavioral outcomes as shown in Table 2. Seeing others in the neighborhood exercise was positively associated with push-ups (r=0.13, p=0.04) and negatively associated with cholesterol (r=-0.19, p=0.03). Perceiving that one's apartment complex provides them with resources to be active was negatively associated with AT trips (r=-0.16, p=0.02) and sedentary time on the weekend (r=-0.17, p=0.04. The number of reported resources at their apartment complex was negatively associated with curl-ups (r=0.15, p=0.02) and AT trips (r=-0.32, p<0.001) and positively associated with cholesterol (r==0.22, p=0.03).

Correlations between the environmental variables and fitness and behavioral outcomes are shown in Table 3. Reporting sidewalks in the neighborhood was negatively associated with weekday sitting time (r=-0.14, p=0.04). Seeing others exercise in the neighborhood was positively associated with push-ups (r=0.13, p=0.02) and negatively associated with total cholesterol (r=-0.19, p=0.04) and sit time during the week (r=-0.14, p=0.03) and on the weekend (r=-0.15, p=0.03). Fasting plasma glucose was positively associated with traffic (r=0.28, p=0.05), crime in the neighborhood during the day (r=0.21, p=0.04), using bike routes in the neighborhood (r=0.28, p=0.02) and perceiving that others are active in their apartment complex (r=0.25, p=0.05). The number of resources at their apartment complex was negatively associated with curl-ups (r=-0.22, p=0.03) and number of AT trips (r=-0.30, p<0.001). Perceiving that others are active at their apartment complex was positively associated with curl-ups (r=0.15, p=0.02), moderate (r=0.17, p=0.02) and vigorous PA (r=0.20, p=0.03) and negatively associated with total cholesterol (r=-0.19, p=0.05).

Table 1. Characteristics of the sample (n=466).

	Males (n=234)		Females (n=211)	
	Mean (SD)	n (%)	Mean (SD)	n (%)
Demographics				
Race				
% Non-Hispanic White		191 (78.9)		158 (75.2)
% Non-Hispanic Black		6 (2.5)		5 (2.4)
% Hispanic		19 (7.9)		15 (7.1)
% Asian American/Pacific Islander		19 (7.9)		20 (9.5)
% Other		7 (2.9)		12 (5.8)
Age (years)	21.38 (1.43)		21.16 (1.07)	
Grade Point Average	3.28 (0.41)**		3.40 (0.44)	
Employment Status				
% employed full or part time				100 (47.8)
Residence location				
% residing off campus		210 (86.8)		159 (77.2)
Perceived walked time to campus (minutes)	15.51 (17.47)		14.92 (17.31)	
Type of residence				
House		62 (30.2)		40 (25.2)
Apartment Building		61 (29.8)		53 (33.3)
Apartment Complex (multiple buildings)		82 (40.0)		66 (41.5)
Typical location of Exercise				
% On campus		118 (48.5)**		94 (44.5)
Fitness Outcomes				
BMI (kg/m^2)	25.61 (3.76)***		24.19 (4.14)	
% Body fat	16.03 (4.92)***		26.47 (6.39)	
VO_2 max (ml/kg/min)	37.70 (8.92)*		36.01 (7.25)	
Curl ups	60.14 (27.91)***		37.74 (16.56)	
Push ups	25.34 (12.91)***		21.81 (25.45)	
Total Cholesterol	162.73 (31.99)		167.10 (25.41)	
FPG	88.29 (6.18)		87.56 (8.84)	
Behavioral Outcomes				
Moderate PA (min/wk)	144.22 (135.75)		155.41 (145.83)	
Vigorous PA (min/wk)	182.62 (162.71)***		134.94 (145.09)	
AT trips/week	10.47 (5.79)*		9.04 (6.31)	
Sit time weekday (hours)	5.07 (2.11)		4.95 (1.99)	
Sit time weekend (hours)	5.34 (2.64)		5.42 (2.29)	

Note: * p<.05, ** p<.01, *** p<.001 differences between groups

Table 2. Pearson correlations (r) between environmental variables and fitness and behavioral outcomes for males (n=234)

	sidewalks in the neighborhood	Traffic	crime during the day	Crime at night	seeing others in the neighborhood exercise	apartment provides me with PA resources	others are active in my apartment complex	# of resources at apartment complex
Fitness Outcomes								
BMI (kg/m²)	0.01	-0.06	0.03	-0.06	-0.05	0.04	0.06	0.02
% Body fat	-0.02	-0.01	0.07	-0.05	0.03	0.04	0.02	0.02
VO_2 max (ml/kg/min)	0.04	0.07	0.09	0.04	0.06	-0.05	-0.1	-0.03
Curl ups	-0.05	0.04	0.04	0.06	-0.07	-0.05	0.15*	-0.16*
Push ups	0.08	0.04	0.05	-0.06	0.13*	0.01	0.01	0.02
Total Cholesterol	-0.06	0.18	-0.02	0.04	-0.19**	0.1	0.19*	0.22*
FPG	0.17	-0.08	-0.09	-0.02	0.03	-0.07	0.1	0.06
Behavioral Outcomes								
Moderate PA (min/wk)	0.06	-0.04	-0.05	0.02	0.12*	0.01	0.07	0.05
Vigorous PA (min/wk)	0.01	-0.02	0.01	0.05	-0.01	0.1	0.07	0.03
AT trips/week	-0.08	0.1	-0.06	0.01	0.21**	-0.16*	-0.03	-0.32***
Sit time weekday (hours)	0.01	0.02	-0.1	0.15*	-0.05	-0.11	-0.07	0.04
Sit time weekend (hours)	-0.04	0.06	-0.18 **	0.13*	-0.01	-0.17*	-0.1	-0.07

Note: PA: Physical activity, AT: active travel, BMI: Body Mass Index, * p<.05, ** p<.01, *** p<.001

Table 3. Pearson correlations (r) between environmental variables and fitness and behavioral outcomes for females (n=211)

	sidewalks in the neighborhood	Traffic	crime during the day	Crime at night	seeing others in the neighborhood exercise	apartment provides me with PA resources	others are active in my apartment complex	# of resources at apartment complex
Fitness Outcomes								
BMI (kg/m^2)	0.01	-0.06	0.03	-0.06	-0.05	0.04	0.06	0.02
% Body fat	-0.02	-0.01	0.07	-0.05	0.03	0.04	0.02	0.02
VO_2 max (ml/kg/min)	0.04	0.07	0.09	0.04	0.06	-0.05	-0.1	-0.03
Curl ups	-0.05	0.04	0.04	0.06	-0.07	-0.05	0.15*	-0.16*
Push ups	0.08	0.04	0.05	-0.06	0.13*	0.01	0.01	0.02
Total Cholesterol	-0.01	0.18	-0.02	0.04	-0.19*	0.1	-0.19*	0.22*
FPG	0.09	0.28*	0.21*	-0.16	0.08	-0.02	0.25*	-0.02
Behavioral Outcomes								
Moderate PA (min/wk)	0.01	-0.02	-0.02	-0.04	-0.05	0.13	0.17*	-0.01
Vigorous PA (min/wk)	0.03	0.01	-0.1	-0.09	-0.04	0.19*	0.20**	0.02
AT trips/week	-0.01	0.12	-0.04	0.12	-0.01	-0.20*	0.01	-0.30***
Sit time weekday (hours)	-0.14*	-0.08	-0.12	0.05	-0.14*	-0.15	-0.12	0.06
Sit time weekend (hours)	-0.05	-0.05	0.05	0.04	-0.15*	-0.15	0.05	-0.01

Note: PA: Physical activity, AT: active travel, BMI: Body Mass Index, * p<.05, ** p<.01, *** p<.001

DISCUSSION

This study examined the relationship between one's living environment, level of PA, and related fitness and health indicators. Despite the known benefits of exercise, there is often a sharp decline in this behavior during this life stage (8); approximately 40 to 50% of students are considered physically inactive, and this rate of inactivity increases as students become upperclassmen and move off-campus (14).

Since this life stage is influential in the development of healthy behaviors (11), these findings can be used to inform approaches to discourage sedentary time and support healthy lifelong habits. The implications of this study are important in the future design of student apartment complexes and creating active living initiatives across college campuses.
The current study showed that perception of others' physical activity was significantly related to students' engagement in PA. For males, seeing or perceiving others exercising, either in their neighborhood or apartment complex was associated with a greater number of push-ups and lower total cholesterol as well as greater active travel. Among females, seeing/perceiving that others were active, was positively associated with curl-ups, moderate and vigorous PA and negatively associated with total cholesterol. This finding is supported by previous research that has shown people are more likely to engage in behaviors when others close to them are also participating. This may occur because it provides an exercise opportunity for onlookers, as well as a chance to interact with others. It also creates the thought process that this behavior is desirable and normal, so individuals feel more inclined to participate (4).

Another significant relationship with PA was the support of their physical environment, most notably the resources available at their apartment complex. Perceiving that one's apartment complex provides them with adequate resources was negatively associated with weekend sitting time for males and greater vigorous PA for females. For females, the number of reported sidewalks was negatively associated with weekday sit time. This is consistent with earlier findings that availability and proximity to recreation facilities have been associated with greater physical activity (12), and that under these circumstances, individuals are nearly two times more likely to meet PA guidelines. In both sexes, greater perception of PA-supportive resources was negatively associated with AT trips, suggesting individuals are active through means other than transport. This could be related to the perception of what type of exercise is needed for desired benefits; students may not believe that transportation related walking and biking are sufficient for their preferred outcomes. Further research should investigate this relationship.

These findings provide some significant implications for the college student housing market, in addition to universities and student health/wellness programs. Current trends point to the importance of balancing affordability with available amenities as the demand for off-campus housing grows (9,13). As large real estate developers create student housing opportunities with extensive amenities, touting the improved quality of life, better safety, and spacious living quarters, healthy living could possibly be a selling point.[11] This may include increased sidewalks, bike lanes, enhanced lighting to increase the perception of a safe environment, and

other on-site amenities that facilitate PA. Our findings suggested that both the physical and built environment of apartment complexes were related to behavioral and health/fitness outcomes. This can possibly open an opportunity to bridge on-campus health and fitness related programming with off-campus living to help combat the decline in activity typically seen as students' progress through their college career (14). It is unclear if this relationship between living environment and behavioral and health outcomes would extend past college age into young and middle aged adulthood, however it warrants additional research.

Although this study yielded a number of interesting findings, there were some limitations. Among the most significant limitations was the use of a self-reported PA measure. This is subject to recall and reporting bias and also resulted in a large range of reported activity levels. In future studies, the use of accelerometers would help minimize the subjectivity of self-report and retrospective recall. Compared to previous work, this study had a fairly robust sample, though relative to larger epidemiological studies it was limited; therein, a larger sample size would also help decrease the variability in outcomes. In addition, further research could help determine a causal relationship in whether active individuals move to apartment complexes that support this lifestyle, or whether this type of apartment complex fosters active individuals. There should also be further research done on variables included in the present study but not found to have a correlation, such as the relationship between VO_2 max and living environment. It would be beneficial to determine whether VO_2 max has a higher correlation with other variables.

Despite the limitations, these findings provide insight for the design of future college-student living areas and campuses. The results from the present study offer a foundation for further study of PA in this population. These findings can inform the development of new student housing communities and can also serve as a basis for creating campus-wide PA promotion strategies for college administrators looking to address the decline in activity associated with this life stage. With the use of sex-specific variables, these interventions can be specifically tailored to the correct target audience for greatest adherence. Addressing these factors related to inactivity can help with the formation of healthy lifelong behaviors and lead to improved health and well-being.

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