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Association of Access to Recreation Facilities and Parks with Adolescent Participation in Organized Sports and Activity Programs

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by

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The thesis of Marisa McCormack is approved, and it is acceptable in quality and form for publication on microfilm and electronically

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TABLE OF CONTENTS

List of Tables

ABSTRACT OF THE THESIS

Association of Access to Recreation Facilities and Parks with Adolescent Participation in Organized Sports and Activity Programs.

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With low rates of adolescents meeting the national guidelines for physical activity, identifying barriers that are preventing them from being physically active is important. One barrier that has been studied is the proximity of park and recreation facility near adolescents' homes and physical activity in adolescents. To further understand the association between proximity of parks or recreation facilities and adolescents' physical activity, this study examined the association of proximity, availability and total count of parks and recreation facilities with adolescent-reported participation in organized sport teams and physical activity classes. Data used were from the TEAN (Teen Environment and Neighborhood) study. To evaluate the associations between the objective and perceived access to parks and recreation facilities with adolescents' participation in organized sports teams and physical activity classes, GIS data and

NEWS-Y parental-reported proximity to parks and recreation facilities were used. Parent's perceptions were related to adolescents' participation in organized sport teams and fitness classes, but GIS-based proximity and total count of accessible facilities were not related to teams and classes participation Parents reporting better availability to parks or recreation facilities might support their adolescents to be physically active in organized sport teams or physical activity classes because they are aware of the programs offered nearby. Based on these results, we recommend (a) creating and evaluating interventions that increase parents' knowledge of available parks and recreation facilities near their home, and (b) changing environments so parks and recreation facilities are available in all neighborhoods.

Chapter 1: Introduction

According to national guidelines, children and adolescents should participate in 60 minutes of moderate to vigorous intensity physical activity (MVPA) each day.[1] Activities that are aerobic, bone-strengthening and muscle-strengthening should be included in the 60 minutes.[2] Moderate to vigorous activities that encompass bone-strengthening, muscle-strengthening and cardio include but are not limited to sports, fitness classes, physical education and biking and walking to and from school.[2] Approximately only 50% of children and 10% of adolescents meet the national guidelines for physical activity guidelines based on objective accelerometer data.[3]

Physical activity is important for youth due to the array of physical, mental and academic benefits that come from being physically active. Physically active youth have been shown to have better bone health, weight status, overall health, cardiorespiratory and muscular fitness.[3,4] Youth with higher cardiorespiratory fitness and muscular fitness are less likely to develop lifestyle-related chronic diseases as an adult, such as diabetes.[4] Outside of the physical health benefits, youth who are physically active have improved mental health outcomes, increased self-esteem and confidence.[2] Children who are physically active tend to have better grades, school attendance, cognitive performance and classroom behaviors.[2-4]

Despite these profound benefits, only 25% of high schoolers were enrolled in physical education courses in the 2017-2018 school year.[5] With the steady decrease in physical education programs in junior high and high school, there is now a shift of adolescents needing to get their physical activity outside of school.[5,6] There are many potential barriers that are preventing youth from being physically active outside of school. Some barriers that have been noted are proximity to recreation facilities/parks, societal norms, transportation, and cost of programs.[6,7,8]

Adolescents who participate in organized sport teams and physical activity classes generally have higher levels of physical activity than adolescents who do not participate.[4] With low rates of adolescents meeting the national guidelines for physical activity, identifying barriers that are preventing them from being physically active is important.

Parks and Physical Activity

Public parks provide a space that can facilitate physical activity for both adolescents and adults. Parks can provide opportunities for individuals to participate in moderate to vigorous activities and provide the flexibility for the individual to choose preferred activities. Several studies have identified which specific built environment factors facilitate physical activity in parks among youth. Proximity to parks, street connectivity and neighborhood walkability are the most common factors studied for park use and physical activity.[7,8,10] Proximity is defined as the distance between two desired locations, whereas connectivity is defined as how easy it is to access locations.[8] Previous studies have supported a conclusion that proximity to parks and recreation facilities is associated with higher physical activity for both children and adolescents.[8] Adolescents who had access to 7 or more parks or recreation facilities in their census block group were 26% more likely to be physically active than those in census block groups with fewer than 7 active areas.[10] Neighborhoods with a greater proportion of parks were associated with more physical activity in children.[11]

Being exposed to greener neighborhoods through parks or green spaces has been associated with a lower body mass index in children ages 3–16 and higher MVPA in children ages 8–14 years.[11,12] Adolescent girls who lived near more parks, particularly near those with amenities that are conducive to walking and with active features, engaged in more non-school MVPA than those with fewer parks.[13] Giles-Corti and colleagues found that access, distance,

attractiveness, and size of public open spaces were all related to their use.[14] Features other than size may be associated with park use, including accessibility, availability, and quality of amenities.[7] In a survey by Scott and Jackson, adolescents reported they would use parks more if they had access to parks closer to home.[15]

Though previous research reported proximity was associated with adolescent physical activity, there is limited research on the difference between perceived proximity to parks and objectively measured proximity to parks in their associations with adolescent physical activity. Understanding the difference between perceived proximity and GIS-measured proximity is important. GIS measures might report parks that are proximate to adolescents, but adolescents may not be aware of the park or may choose to not use it for safety, cleanliness or other personal reasons; therefore, the park might not be used for physical activity even though it is near their home. The same principle might also apply to recreation facility use and participation in organized sport teams or physical activity classes. This study was innovative because the adolescent physical activity outcome measure was specific to participation in organized teams and physical activity classes. There is no current research that uses organized teams or physical activity classes as an outcome for access to parks or recreation facilities.

Recreation Facilities and Physical Activity

Adolescents spend approximately 40% of their time around their home and in their neighborhood.[16] Across several studies, neighborhood characteristics such as availability/ proximity to recreation facilities, walkability and residential density were shown to be associated with adolescent physical activity.[17,18] Proximity to recreation facilities was associated with more physical activity among adolescents and children for both adolescent self-reported physical activity and parent-reported physical activity for both children and adolescents.[19] More

specifically, adolescents who lived in a neighborhood with high recreation facility availability reported 22 more minutes of physical activity a day compared to neighborhoods with low recreation facility availability.[17] Perceived availability of nearby private and public recreation facilities was associated with higher adolescent physical activity using self-reported measures.[19]

Recreation facilities and programs were associated with more afterschool physical activity in adolescents.[6,17,19] The number of nearby recreation facilities and number of nearby parks correlated positively with adolescent girls' physical activity. The density of parks and recreation facilities was also linked to higher physical activity among girls.[20] There are mixed results on whether there is a difference between the sexes for usage of recreation facilities for physical activity. In a study of San Diego adolescents, girls were more likely to report doing physical activity at commercial facilities then boys.[21] Other studies have shown that boys use recreation facilities more, due to having greater interest in fitness and sports.[20]

An explanation for the consistent association between recreation facility availability and adolescent physical activity could be that with more recreation facilities available adolescents have more choices of where to go and what activities to do. For example, if adolescents can pick between fitness classes and different nearby facilities, they would be more inclined to participate than if they only had one class option they did not like. Recreation facilities can offer a variety of sports, fitness classes, dance classes or walking space. Another benefit of recreation facilities is they have staff who are there to monitor adolescents, organize and supervise activities, and make both adolescents and parents feel safe.[17]

Organized Sport Teams and Physical Activity Classes

McKenzie et al. measured the condition of recreation fields using direct observation. Under 20% of fields had organized physical activity or equipment. The authors noted there is a

need for interventions that promote organized and supervised activities to increase MVPA in youth.[22] Examples of organized activities for adolescents include various sport programs and fitness classes, like dance classes or strength and conditioning classes. Barriers to youth participating in organized teams and fitness classes are costs, accessibility to facilities, accessibility to programs and youth responsibilities for school, home, and work.[23] Only 54 percent of youth participated in a sports team in 2017.[24]

The American Academy of Pediatrics recommends youth sports as a way for adolescents to meet the national physical activity guidelines.[25] Adolescent sport participation is linked to improved mental health outcomes and coping skills. Organized teams provide youth the opportunity to build social and interpersonal skills such as leadership and teamwork.[25] Adolescents who participate in organized team sports get 23% to 60% of their MVPA from sports participation.[26,27] One study showed a higher percent of MVPA on sports participation days than non–sports-participation days.[28]

Although previous research has examined barriers such as accessibility to facilities or programs, they have not specifically investigated the association of access to recreation facilities and parks with adolescents' participation in organized sport teams or physical activity classes. The present study analyzed proximity, total count and availability of recreation facilities or parks in relation to adolescent sport/class participation to address this gap in the research. The implications of this research would provide future avenues of interventions to promote youth physical activity specific to sport participation. Interventions could be tailored and optimized to address physical activity gaps, all in hopes in of increasing the proportion of children and adolescents reaching the national guidelines of 60 minutes of MVPA.

Disparities in youth physical activity

Girls, racial and ethnic minorities, youth from households of low socioeconomic status, youth living in rural areas, and youth with disabilities are less likely to be physically active and play sports.[23] These groups are disproportionally affected by barriers to youth sports, including cost, access, and time.[23] Lower socioeconomic status, female sex, lower education and non-white race/ethnicity have all been associated with lower physical activity in adolescents. To control for these confounders in the current research study will help further understanding of their association to adolescent organized sport team and physical activity class participation.

In previous studies, socioeconomic status (SES) has been associated with several built environment variables.[29] Youth who lived in lower-income neighborhoods did less physical activity, had higher sedentary behavior, and higher rates of obesity than those in high-income neighborhoods.[30] Accessibility can be an especially big barrier for youth from households of low socioeconomic status, as 76 percent of youth from households with incomes of at least 400 percent of the Federal poverty threshold participated in a sports team or lesson after school or on weekends within the last 12 months, compared to 41 percent of youth from households at less than 100 percent of the poverty threshold.[23] Without safe, accessible places to be physically active and methods of transportation to reach them, many youth struggle to be physically active.[31]

The current study adds to the current research that sex, race/ethnicity and household education can be covariates for physical activity in youth. Women have less access to physical activity opportunities compared to men.[32] Only 45 percent of youth from households with less than a high school education participated in sport teams, compared to 73 percent of youth from households with a college degree or higher.[23] Adolescents who were non-Hispanic white were most likely to be physically active than either Hispanic or African American adolescents. The

study suggests that non-Hispanic white adolescents had higher physical activity due to access to more physical activity programs, whereas non-Hispanic blacks reported the lowest physical activity for youth.[32,33] It is important to understand the associations between these covariates and adolescent organized sport teams and physical activity class participation.

Rationale for the Present Study

This study builds upon the prior findings that proximity to parks and recreation facilities were associated with physical activity in adolescents. Physical activity is a broad concept that encompass a variety of specific activities modes of participation, such as individual, team, and group. Sports participation and physical activity classes are shown to be associated with adolescent physical activity by giving a structured space that promotes and encourages various forms of physical activity. Investigating how proximity, availability and total count of parks and recreation facilities can be associated with adolescent participation in organized sport teams or physical activity classes may inform future interventions to increase the number of adolescents reaching 60 minutes of MVPA daily.

Understanding where adolescents are physically active can help understand which locations or types of facilities are associated with more physical activity and if there are any associations with areas that could have organized sport teams or physical activity classes. This study will be the first to have a big data set looking at the association of access to parks and recreation facilities using total count, distance to nearest, and availability with organized sport teams and physical activity class participation in adolescents. Past research has looked at physical activity as a whole but has not narrowed it down to look specifically at organized sport teams and physical activity class participation. It is reasonable to expect different correlates of different types of physical activity. To address the lack of research on associations between the

built environment and adolescent sports participation and physical activity classes, which are common but under-studied sources of physical activity, the following study aims were analyzed.

Study Aims

1. To compare the self-reported frequency of adolescents' (ages 12-17) physical activity at recreation facilities, parks and other active areas between the sexes (descriptive aim).
2. To evaluate the associations of objective and perceived access to parks with adolescents' participation in organized sports teams and physical activity classes to determine if greater availability of parks in the participant's local neighborhood is associated with higher adolescent participation in organized sports teams and physical activity classes, adjusted for demographics
3. To evaluate the associations of objective and perceived access to sport facilities/recreation facilities with adolescents' participation in organized sports teams and physical activity classes to determine if greater availability of sport facilities/ recreation centers in the participant's local neighborhood is associated with higher adolescent participation in organized sports teams and physical activity classes, adjusted for demographics
4. To evaluate the associations between the objective and perceived access to composite measures of parks and sport facilities/recreation centers with adolescents' participation in organized sports teams and physical activity classes, adjusted for demographics.

Chapter 2: Methods

Study design

Data used were from the TEAN (Teen Environment and Neighborhood) Study. The study was conducted between 2007–2011 with data collected in the Baltimore, Maryland-Washington, DC and Seattle-King County, Washington metropolitan regions. The primary goal of the TEAN study was to evaluate associations between neighborhood environmental factors and adolescent physical activity.

Target Population and Selection Criteria

Households in the King County-Seattle, WA and Baltimore-Washington, DC regions that had adolescents between the ages of 12 and 16 were the targeted participants, along with one parent/caregiver per household. Adolescent-parent pairs were recruited so there would be approximately equal numbers of pairs recruited into the high/low walkability by high/low income quadrants for both King County-Seattle, WA and Baltimore-Washington, DC regions.

Census block groups were created using the median household income reported on the 2000 Census data and the calculated walkability index for each group based up previous studies by Frank et al., 2010; Sallis et al., 2009. For both sites, the income was reported as deciles from the median income of the site. Based on the deciles block groups were categorized as either high or low income. For low income the first five deciles from the median income were categorized as low-income block groups. The 7th, 8th, and 9th deciles from the median income were categorized as high-income block groups. The 10th decile was removed to improve generalizability.[18] To calculate the walkability index for each block group the normalized values of four macro-built environment measures: 1) net residential density, 2) intersection density, 3) retail floor to land area ratio (FAR) and 4) mixed use were summed. Data was retrieved from the

King County 2006 and Maryland 2003 GIS data measures.[18] The walkability index was categorized as either high or low walkability. The first four deciles from the walkability median were categorized as low walkability.[18] For high walkability the 7th through the 10th deciles from the walkability median were used.[18] The block groups were created by combing the income and walkability index variables to create four study quadrants (lower-walkability/lower-income, lower-walkability/higher-income, higher-walkability/lower-income, higher-walkability/higher-income).[18]

The upper age for adolescents was 16 (although a few were 17 by the time they completed surveys), so most adolescents would complete the surveys before they could independently drive. The lower limit of 12 years was selected to limit the differences across students attending elementary versus secondary schools (i.e., all students were either in middle or high school). The recruitment goal for adolescent demographics was to have approximately equal numbers of adolescents at each age level, approximately equal representation of boys and girls, and have distributions of participants' ethnicity/race similar to distributions in the neighborhoods selected for study.

The exclusion criteria for recruitment for adolescents' participation was based on parents' reports. Adolescents were excluded if they had: (a) any psychological or medical condition that would preclude full participation, (b) any disability or illness that would preclude the adolescent from engaging in at least moderate-intensity physical activity, and (c) any eating disturbance indicative of significant eating disorder psychopathology or a medically prescribed dietary regimen. Inclusion criteria for adolescents were (a) child and parent had to be able to complete surveys in English, but not necessarily as a first language, and (b) adolescent must attend middle or high school or be home-schooled.

Recruitment

Participants were recruited 2008-2010 using eligible block groups with adolescents ages 12-16 living in the King County-Seattle, WA and Baltimore-Washington, DC regions. Block groups were selected using the GIS walkability index and Census 2000 median household income.[18] Eligible households were randomly selected using a purchased list from a marketing company. Potential participants were contacted by mail and called via telephone to recruit adolescent and parent/guardian pairs. Participants who expressed interest in the study were mailed parent consent and adolescent assent forms. Participants received a follow up phone call by a research assistant to answer questions. To limit seasonal bias, data collection was only conducted during the school year (i.e., not during the summer break months) to represent adolescents' habitual daily behavior.

Data Collection Procedures

Once signed consent forms were received for both adolescents and parents, adolescents were mailed an accelerometer and GPS device to wear for 7 days with instructions on how to wear the devices and how to mail them back. Participants were then asked to complete the surveys (both parent and adolescent versions) with the option of completing them either online or by mail.

Measures:

Self-reported places for physical activity. For the descriptive aim 1, adolescents were asked 15 items on "How often are you physically active in/at the following locations?" The survey included 1) indoor recreation or exercise facility; 2) beach, lake, river or creek; 3) bike/hiking/walking trails, paths; 4) basketball court; 5) other playing fields; 6) indoor swimming pool; 7) small public park; 8) large public park; 9) public open space that isn't a park; 10)

friend's house or relative's house; 11) School grounds (during non-school hours); 12) outdoor swimming pool; 13) ski or other winter area; 14) skatepark; 15) parking lot. Adolescents were asked to report how often they were active at these locations using a 6-point scale: 0 representing never, 1 representing once a month or less, 2 representing once every other week, 3 representing once a week, 4 representing 2 or 3 times per week, or 5 representing 4 or more times per week. Item test-retest reliabilities ranged from about .40 to .70.[34]

Table 1: Description of Predictor Measures for GIS Measures and NEWS-Y Measures

Predictor Measures	Definition
GIS Measures:	
Parks	
Distance to Nearest Park in km	distance to the nearest park from participant's home
Total Park Count	total count of parks within the 1 km street network buffer from the participant's home
Recreation Facility	
Distance to Nearest Recreation Facility in km	distance to the nearest recreation facility from participants home
Total Recreation Facility Count	total count of recreation facilities within the 1 km street network buffer from the participant's home
Combined Parks and Recreation Facilities	
Distance to Nearest Park or Private Recreation Facility in km	distance to the nearest park OR sport/recreation facility from participant's home. The closer facility (park or recreation facility) was chosen.
Average Distance to Nearest Park and Recreation Facility	average distance to the nearest park and sport/recreation facility from participant's home.
Total Count of Parks and Recreation Facilities	total count of parks and sport/recreation facilities within the 1-km street network buffer from the participant's home.
NEWS-Y Measures: Proximity was assessed on a 5-point scale of walking time from home: 1) representing 1-5 minutes, (2) representing 6-10 minutes, (3) representing 11-20 minutes, (4) representing 21-30 minutes and (5) representing 31+ minutes.	
Parks	
Walking Time Score to Nearest Park	'Nearest park' variable was measured by taking the self-reported walking-time codes for the nearest small park OR large park (lower code = fewer 'minutes to walk there' = shorter distance).
Availability of Large and Small Parks	self-reported response codes were reversed for the small and large parks and the sum was taken (higher score = better availability/access). The reversed proximity response codes were: (1) representing 31+ minutes to walk there, (2) representing 21-30 minutes, (3) representing 11-20 minutes, (4) representing 6-10 minutes and (5) representing 1-5 minutes to walk there.
Recreation Facility	
Walking Time Score to Nearest Recreation Facility	Nearest recreation facility variable was measured by taking the self-reported walking time code for the nearest recreation facility. Selected facilities were indoor recreation or exercise facility, basketball court, playing fields, and school recreation facilities. (lower code = fewer 'minutes to walk there' = shorter distance).
Availability of Recreation Facilities	self-reported response codes were reversed for the recreation facilities and the sum was taken (higher score = better availability/access). Selected facilities were indoor recreation or exercise facility, basketball court, playing fields, and school recreation facilities. The reversed proximity scale was: (1) representing 31+ minutes, (2) representing 21-30 minutes, (3) representing 11-20 minutes, (4) representing 6-10 minutes and (5) representing 1-5 minutes.
Combined Parks and Recreation Facilities	
Sum of Walking Time Score to Nearest Park and Recreation Facility	The combined variable was computed by taking the sum of the walking time code for nearest park and nearest recreation facility variables described above.
Total Availability of Parks and Recreation Facilities	The combined variable for availability was computed as the sum of the reversed self-reported walking time code for both park items (large and small) and all four recreation facilities (indoor recreation or exercise facility, basketball court, playing fields, and school recreation facilities).

Proximity/availability of parks and recreation facilities: Availability of recreation facilities and public parks was measured using geographic information systems (GIS). The GIS measures were created by 1) geocoding participants' residential addresses, 2) creating the 1 kilometer (km) street network buffer around each resident's location, and 3) linking recreation facilities and parks to the participant's buffer.[8] The completion of these three steps allowed identification of the number of parks and recreation facilities in the buffer around each participant's home as well as distances to the nearest park and recreation facility. Arcview 3.2 (ESRI, Redlands, CA) software was used to geocode participant addresses, create 1-kilometer buffers, and compute network-based distances. Seven built environment predictors were created in GIS (See Table 1 and 2).

Parental Perceived Access to Recreation Facilities and Parks: Using the parent-reported Neighborhood Environment Walkability Scale for Youth (NEWS-Y), perceived proximity to parks and recreation facilities was measured.[19] Proximity was indicated by estimating walking time from home to the various places using a 5-point scale:(1) representing 1-5 minutes , (2) representing 6-10 minutes, (3) representing 11-20 minutes, (4) representing 21-30 minutes and (5) representing 31+ minutes. Proximity to both large and small parks was estimated. The selected recreation facilities used in analyses were indoor recreation or exercise facility, basketball court, playing fields, and school recreation facilities. These facilities were chosen because they are places associated with organized sport teams or physical activity classes and can be located at publicly accessible recreation facilities, whether fees were required or not. Swimming pools were not included because they could have been in someone's backyard rather than in an accessible recreation facility. Although the parents completed the survey, the NEWS-Y built environment scales have previously been shown to be generally comparable between

parents and adolescents (intraclass correlation coefficients [ICCs] ranged from .72 to .93). These measures overall showed good test–retest reliability (ICC) = .67, and Cronbach α coefficient = .83.[19] A summary of variables created from NEWS-Y is shown in Table 1 and 2.

Outcome Measure:

Self-reported participation in organized sport teams or physical activity classes. Adolescents were asked to report "In the past year, how many sports teams or physical activity classes have you participated in outside of school?" Total number of organized sport teams or fitness classes was reported 0, 1, 2, 3, 4 or more.

Covariates

Covariates included adolescent's self-reported age, sex (male/female), race/ethnicity (recoded as white/non-Hispanic or nonwhite/Hispanic). Household covariates included highest household education (recoded as some college or less/college degree or more), and parent marital status (recoded as living with partner/married or other). Socioeconomic status was based on census block group data and categorized by county-level median split (recorded as low income/high median household income of block group).[29] Study site was coded (Seattle/King County or Maryland/Washington, DC regions). Census block group number was included as a random effect in all models to adjust for geographic clustering of participants in the recruitment procedures.

Statistical analysis

Data were analyzed using the IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, N.Y., USA). Independent t-tests were computed to compare the self-reported frequency of physical activity at each of the selected locations by sex. Mixed regression analyses were conducted to evaluate associations between the adolescent-reported number of organized sport

and fitness classes outcome measure with (a) the GIS-based built environment measures of parks and recreation facilities measures, and (b) the parent-reported perceived proximity and availability measures for parks and recreation facilities. All models were adjusted for study design and demographic covariates and adjusted for participant clustering as a random effect. A total of 13 mixed regression models were completed. Because all models included the same covariates, with similar associations of covariates with the outcome, results for covariates were estimated in a separate model and are only presented once, in Table 3. Associations of the 13 separate models of associations of parks and recreation facilities with adolescent teams and activity classes participation have been aggregated and presented in Table 4.

Chapter 3: Results

Table 2 Descriptive Statistics for Participants' Number of Sport Teams and Physical Activity Classes, Demographic Covariates, and Independent Variables

	Mean (SD) or %	Minimum	Maximum
Number of Sport Teams and Physical Activity Classes	1.52 (1.37)	0	4
Demographic Covariates			
Adolescent Age	14.1 (1.40)	12	17
Income			
High Income	50.1		
Low Income	49.1		
Site			
Baltimore, MD	52.3		
Seattle, King County	47.7		
Sex			
Boys	49.6		
Girls	50.4		
Race/Ethnicity			
Nonwhite	33.4		
White/Non-Hispanic	65.8		
Marital Status			
Not Married or Living with Partner	15.9		
Married or Living with Partner	83.4		
Household Education			
Some College or Less	24.5		
College Degree or More	74.9		
Independent Variables			
GIS Variables			
Distance to Nearest Park in km	.888 (.869)	0	8.10
Total Park Count	1.46 (1.65)	0	9
Distance to Nearest Recreation Facility in km	.934 (.977)	.003	14.10
Total Recreation Facility Count	3.01 (4.81)	0	62
Distance to Nearest Park or Private Recreation Facility in km	.603 (.610)	0	8.10
Average Distance to Nearest Park and Recreation Facility	.911 (.781)	.034	10.90
Total Count of Parks and Recreation Facilities	4.46 (5.60)	0	66
NEWS-Y Variables			
Walking Time Score to Nearest Park (Large or Small) *	2.36 (1.34)	1	5
Availability of Large and Small Parks **	6.03 (2.37)	2	10
Walking Time Score to Nearest Recreation Facility*	1.99 (1.08)	1	5
Availability of Recreation Facilities**	12.36 (4.00)	4	20
Sum of Walking Time Score to Nearest Park and Recreation Facility*	4.34 (2.13)	2	10
Availability of both Parks and Recreation Facilities**	18.39 (5.79)	6	30

**Self-reported walking-time code:(1) representing 1-5 minutes , (2) representing 6-10 minutes, (3) representing 11-20 minutes, (4) representing 21-30 minutes and (5) representing 31+ minutes.*

*** Represents the total availability score based on the sum of walking-time codes: (1) 31+ minutes, (2) 21-30 minutes, (3) 11-20 minutes, (4) 6-10 minutes and (5) 1-5 minutes.*

Participants

A total of 928 adolescent-parent pairs completed both adolescent and parent surveys, of which 485 and 443 were completed by Baltimore and Seattle families, respectively. Adolescent demographics were 468 (50.4%) girls and 460 (49.6%) boys; 66.3% were non-Hispanic white and 33.7% were nonwhite. The average age was 14.1 (SD = 1.4) years of age with a range from 12-17 years.

Parental demographics were 731 (79.1%) women and 193 (20.9%) men; 74% non-Hispanic white and 26% nonwhite; and their average age was 47.2 (SD = 6.7) years, with a range from 22 – 71 years. Most parents had completed a college degree or higher (64%), and 84% were married or living with a partner. Mean household income was reported as approximately $77,500 per year.

Covariate Results:

More adolescents participated in organized sport teams and physical activity classes in the Baltimore site than Seattle site (t=-2.91, p=.004). Adolescents with a household education of a college degree or more were more likely than less educated households to participate in organized sport teams and physical activity (t=-2.71, p=.007). Adolescents older in age were less likely to participate in organized sport teams and physical activity classes (t=-5.561, p=<.001). There were not significant associations for neighborhood income, adolescents' sex or race/ethnicity, or parent's marital status with adolescent participation in organized sport teams or physical activity classes (t=-1.62, p=.106; t=.591, p=.555; t=-.964, p=.335; t=-1.06, p=.291). (See Table 3).

Table 3: Summary of Mixed Regression Model Results for Association of Study Design and Demographic Covariates Explaining Adolescent Participation in Organized Teams and Classes.

		95% Confidence Interval			
Covariates	Estimates (Std.Error)	Lower Bound	Upper Bound	T-Value	P-Value
Neighborhood Income (0=Low income; 1=High income (REF))	-.151 (.093)	-.334	.032	-1.62	.106
Site (1=Seattle; 2=Baltimore region (REF))	-.262 (.090)	-.429	-.085	-2.91	.004
Adolescent Age	-.174 (.031)	-.236	-.113	-5.56	(<.001)
Adolescent Sex (M=0; F=1(REF))	.052 (.088)	-.120	.224	.591	.555
Adolescent Race/Ethnicity (0= Nonwhite; 1=non-Hispanic, white (REF))	-.092 (.095)	-.278	.095	-.964	.335
Household Marital Status (0=not married/living with partner; 1=married/living with partner (REF))	-.131 (.124)	-.373	.112	-1.06	.291
Household Education (.00=some college or less; 1.00=college degree or more (REF))	-.292 (.108)	-.503	-.080	-2.71	.007

REF specifies the reference group to which the other group(s) were compared.

GIS Measures Results:

Parks: There was no association between total count of parks from the adolescent's home and adolescent participation in organized teams and classes (t=.401, p=.689). There was no association between distance to nearest park in km from the adolescent's home and adolescent participation in organized teams and classes (t=-.608, p=.544).

Private Recreation Facilities: There was a significant positive association between GIS-measured distance from home to nearest private recreation facility and participation in organized teams and classes, with greater distance associated with more participation in teams/classes (b=.091, t=1.99, p=.047). There was no association between total count of private recreation facilities from the adolescent's home and adolescent participation in organized teams and classes (t=1.09, p=.277).

Combined Parks and Private Recreation Facilities: There was no association between the GIS distance to nearest park or recreation facility in km from the adolescent's home on adolescent participation in organized teams and classes (t=.552, p=.581). There was no association between the GIS average distance to nearest park and recreation facility from the

adolescent's home on adolescent participation in organized teams and classes (t=.912, p=.363). There was no association between the total count of parks and recreation facilities from the adolescent's home on adolescent participation in organized teams and classes (t=1.06, p=.292).

NEWS-Y Measures Results:

Parks: There was no association between adolescent participation in organized teams and classes and parental self-reported walking time score to nearest park (large or small) (t=-1.30, p=.195). There was a significant positive association between adolescent participation in organized teams and classes and parent-reported availability of large and small parks combined, with greater parent-perceived availability associated with higher adolescent participation in teams/classes (b=.050, t=2.66, p=.008).

Recreation Facilities: There was no significant association between adolescent participation in organized teams and classes and parental self-reported walking time score to nearest recreation facility (t=-1.79, p=.074). There was a significant positive association between adolescent participation in organized teams and classes and parent-reported availability of recreation facilities, with greater parent-perceived availability associated with higher adolescent participation in teams/classes (b=.038, t=3.46, p=.001)

Combined Parks and Recreation Facilities: There was no significant association between adolescent participation in organized teams and classes and parental self-reported sum of walking time score to nearest park and recreation facility (t=-1.72, p=.086). There was a significant positive association between adolescent participation in organized teams and classes and parent-reported total availability of parks and recreation facilities, with greater parent-perceived availability of parks and recreation facilities associated with higher adolescent participation in teams/classes (b=.027, t=3.49, p=.001)

Table 4: Summary of Mixed Regression Model Results Explaining Adolescent Participation in Organized Teams and Classes from GIS-Based and NEWS-Y Measures of Parks and Recreation Facilities. Each row presents results of a separate model, all of which were adjusted for all the study design and demographic variables in Table 3.

		95% Confidence Interval			
Independent Variable	Estimates (Std.Error)	Lower Bound	Upper Bound	T-Value	P-Value
GIS Variables:					
Distance to Nearest Park in km	-.031 (.052)	-.133	.070	-.608	.544
Total Count of Parks	.011 (.027)	-.042	.064	.401	.689
Distance to Nearest Private Recreation Facility in km	.091 (.046)	.001	.181	1.99	.047
Total Count of Private Recreation Facilities	.010 (.009)	-.008	.029	1.09	.277
Distance to Nearest Park or Recreation Facility in km	.041 (.074)	-.104	.186	.552	.581
Average Distance to Nearest Park and Recreation Facility	.053 (.058)	-.061	.167	.912	.363
Total Count of Parks and Recreation Facilities	.009 (.008)	-.007	.024	1.06	.292
NEWS-Y Variables:					
Walking Time Score to Nearest Park (Large or Small)	-.043 (.033)	-.108	.022	-1.30	.195
Availability of Large and Small Parks	.050 (.019)	.013	.087	2.66	.008
Walking Time Score to Nearest Recreation Facility	-.073 (.041)	-.153	.007	-1.79	.074
Availability of Recreation Facilities	.038 (.011)	.016	.060	3.46	.001
Sum of Walking Time Score to Nearest Park and Recreation Facility	-.036 (.021)	-.076	.005	-1.72	.086
Total Availability of Parks and Recreation Facilities	.027 (.008)	.012	.042	3.49	.001

Note: Covariates were adjusted for all models were: neighborhood income, site, adolescent age, adolescent sex, adolescent race/ethnicity, household marital status and household education. To adjust for participant clustering per recruitment methods, census block group was included as a random effect in all models.

Places Where Adolescents are Physically Active, by Sex

The five most frequent places for physical activity for boys were friend's house or relative's house, other playing fields, basketball court, school grounds and outdoor swimming pool (Frequencies were 2.27, 2.15, 1.89, 1.82 & 1.73 respectively). Girls' most frequent places for physical activity were outdoor swimming pool, friend's house or relative's house, other playing fields, school grounds and bike/hiking/walking trails/paths (Frequencies were 2.05, 1.96, 1.67, 1.61 & 1.41 respectively). (see Table 5)

Table 5 shows the means (SD) separately for boys and girls of the adolescent-reported frequency of use of each facility type for physical activity. There were no significant differences for reported frequency of adolescent use for physical activity at several locations: Indoor

recreation or exercise facility, beach/lake/river or creek, Bike/Hiking/Walking Trails/Paths, other playing fields, indoor swimming pool, school grounds and outdoor swimming pool. Boys were significantly more likely to use the following facilities for physical activity: Basketball courts (p=<.001), small parks (p=.046), large parks (p=<.001), public open spaces (p=.<.001), ski or other winter areas (p=.<.001), and skateparks (p=<.001). Girls were significantly more likely to use a friend's house or relative's house for physical activity (p=.041).

Table 5: Means, Standard Deviations (SD), and Independent T-Test Results for the Reported Frequency With Which Places Were Used for Physical Activity Among Adolescents, by Sex.

Places for Physical Activity	Girls Mean (SD)	Boys Mean (SD)	T-Score (p-value)
Indoor Recreation or Exercise Facility	1.37 (1.73)	1.47 (1.74)	.880 (.424)
Beach, Lake, River or Creek	.880 (1.10)	.930 (1.14)	.652 (.704)
Bike, Hiking, Walking Trails, Paths	1.41 (1.42)	1.55 (1.46)	1.48 (.158)
Basketball Court	1.01 (1.46)	1.89 (1.79)	8.16 (<.001)
Other Playing Fields (like football, softball, tennis)	1.67 (1.78)	2.15 (1.80)	4.08 (.369)
Indoor Swimming Pool	.790 (1.26)	.790 (1.18)	.063 (.245)
Small Public Park	1.35 (1.38)	1.45 (1.48)	1.04 (.046)
Large Public Park	1.13 (1.33)	1.38 (1.53)	2.63 (<.001)
Public Open Spaces (like plaza, square, or undeveloped land)	.750 (1.16)	1.16 (1.54)	4.64 (<.001)
Friend's House or Relative's House	1.96 (1.50)	2.27 (1.56)	3.12 (.041)
School Grounds (during non-school hours)	1.61 (1.81)	1.82 (1.77)	1.83 (.800)
Outdoor Swimming Pool (during warmer months)	2.05 (1.84)	1.73 (1.74)	(-2.73) (.058)
Ski or Other Winter Areas (during colder months)	.720 (1.11)	1.07 (1.38)	4.33 (<.001)
Skatepark	.180 (.72)	.530 (1.22)	5.21 (<.001)
Parking Lot	.500 (1.07)	.990 (1.52)	5.63 (<.001)

Note: Frequency response options were: 0 representing never, 1 representing once a month or less, 2 representing once every other week, 3 representing once a week, 4 representing 2 or 3 times per week, or 5 representing 4 or more times per week.

Chapter 4: Discussion

Results showed a marked difference between perceived and objective measures of proximity and availability of parks and adolescent participation in physical activity, with significant associations found only for perceived availability and proximity. The parental self-reported NEWS-Y measures of availability of large and small parks, availability of recreation facilities, and total availability of parks and recreation facilities had a positive association with adolescent-reported participation in organized sport teams or physical activity classes. The implication of this finding is that adolescent who have better availability of parks and recreation facilities are more likely to participate in organized sport team and physical activity classes adolescents.

The significant measures for perceived availability indicate better access to multiple facilities and choice. Having the perceived availability to multiple parks could give the option to be physically active in different areas and allow for the choice of safer areas. In the case of organized sport teams or physical activity classes, availability of multiple parks and recreation facilities could be associated with the availability of different sports or classes, so adolescents can make choices based on their wants/needs. Although not a causal relationship, the results support the idea of perceived access is positively associated with adolescence participation rather than the measured GIS distance to nearest and total count measures.

An explanation for the positive association between parental perceived measures of availability for these areas and adolescent-reported participation in organized sport teams or physical activity classes could be attributed the knowledge gap of these areas near their homes or the perceived quality of these areas by parents. The study showed the average total count of

parks and recreation facilities near an adolescent's home was 4.46, and parents may only know about one or two of the parks and recreation facilities near them. Parents may feel limited in their options to choose places for their adolescent to be active due to their limited knowledge of areas around them.

Parents perceived quality of parks and recreation facilities could also be associated with adolescents' participation in organized teams and physical activity classes. If they felt that a park or recreation facility met their standards of quality, they would be more likely to allow their adolescents to participate. A flaw in the GIS measure is that it does not account for the quality or perceptions of the parks and recreation facilities; it only measures proximity or presence of parks and recreation facilities. This interpretation was supported by a Cohen et al., 2007 study that showed quality of park amenities was associated with park use. In addition to the perceived quality of parks and recreation facilities, the GIS measure may capture all parks and recreation facilities, including some that could be unknown to parents and their children. This could contribute to the gap in knowledge of available parks and recreation facilities from the parental side. For the corresponding GIS measures of total count of parks, total count of private recreation facilities and total count of parks and private recreation facilities there was not significantly associated with adolescent participation in organized sport teams or physical activity classes.

Similar to previous studies, the present study supported that proximity to recreation facilities was associated with physical activity.[8,18,19] The GIS measure for distance to nearest private recreation facility in km measured the distance to the nearest recreation facility from each participant's home. The results support that the more proximal the recreation facility was, the more adolescents participated in organized sport teams or physical activity classes. Ensuring recreation facilities are near all neighborhoods could influence adolescent sport or physical

activity participation. This is important for building new neighborhoods or revamping old neighborhoods that might have unused space in order to foster adolescents to be more physically active through sports.

Demographics:

Factors such as age, household education and site location were associated with adolescent's participation in organized sport teams or physical activity classes. The older the reported age, the fewer organized sport teams and physical activity classes reported by adolescents. This is similar to previous studies that show as children get older, they are less physically active.[2] Even when there are close recreation facilities and parental reports of high counts of available parks and recreation facilities, as children get older, they are less physically active. Creating interventions that can promote older adolescents to be physically active at the available parks and recreation facilities would be important for improving activity levels.

As children get older, sport programs become more competitive. Competitive sport programs can discourage youth from participating if they are not motivated by competition or not skilled enough to compete at high level. Interventions that can encourage non-competitive sport programs for all youth even as they get older can encourage more sports participation in older youth.

This study supports prior research that living in households with a college degree, or more was associated with greater adolescent participation in organized sport teams and physical activity classes.[24,31] Households with a college degree or more could be associated with higher incomes and/or more free time to be physically active.[36] This could explain the association between household education and adolescent participation in organized teams and physical activity classes. Lastly, individuals who have a college degree or more have been associated with

engaging in positive health behaviors, such as exercising.[36] Thus, active parents could be role models for active lifestyle and support their adolescents to participate in sports or physical activity classes to ensure their children are physically active.

Income was not associated with adolescent participation in organized teams or physical activity classes for any of the independent variables measured. This is opposite of previous studies that showed income as a barrier to adolescents' participation in sports or physical activity.[29,30] Although we did not survey this in this current study, money spent on physical activity classes or sports participation could have varied between low-income and high-income households. Low-income households could report being active in classes or sports that are not as costly. Physical activity class or sport team's assistance funds or sliding-scale fees could have also helped low-income adolescents participate in sports or physical activity classes.

In previous research, there were significant differences between sex for physical activity and sport participation.[20,23,36] Sex was not associated with participation in organized sport teams or physical activity classes for adolescents for this study. Although we did not include organized team or physical activity class type into the survey, similarities in sex could be associated to equal opportunities to participate in organized sport teams. There could also be equal opportunities to participate in non-gender specific organized teams or physical activity classes.

The locations that had the highest frequency of use for boys and girls were friend's or relative's house, playing fields, basketball court, outdoor swimming pool and school grounds. Playing fields, basketball court and outdoor swimming pool could be can also places that youth could participate in organized sport teams and physical activity classes. Due to the overlap of these places, adolescents may choose to be active in these areas because there is a structured activity for them to do, or could be associated with their favorite sport. To increase adolescent

participation in organized teams and physical activity classes, campaigns should be tailored to include existing local structured physical spaces where youth already participate physical activity in. Programs can also use these areas to create flyers and advertisement of available organized sport teams and physical activity classes that are offered in the area to promote in areas where adolescents are active and are more likely to see them.

For both boys and girls being active at a friend's or relatives house was the most common, this could be due to having peer support to be active whereas other areas may not have the same level of peer support to be active. In previous research, girls may be limited to physical activity due to safety concerns or sex roles for physical activity.[32] Due to safety concerns parents may not let their daughters be physically active in areas that might be unsafe such as parking lots or public open spaces. Due to this safety concern, going to a friend's or relatives can provide security for girls and could be more likely they are physically active there. Boys were more likely to use playing fields than girls, this is similar to Grow et al.,2008 who found adolescent reported using playing fields as one of their most frequent places of physical activity.[34]

Limitations:

When using the self-reported places of physical activity survey, the frequency of adolescent physical activity is reported by the average of the categorical measure versus the days they are physically active. Using the average of the categorical measure can make it difficult to ascertain the actual frequency of adolescents being active at the selected locations because it represents a range of frequencies versus actual number of days and can lead to a under or over representation of use. The GIS measures do not account for the type of recreation facility or which recreation facility that draw more adolescent sport participation or physical activity use was also not measured or specified. This would be important for future research to determine

which type or features of a facility improve adolescent physical activity in sports or fitness classes.

This study used cross-sectional observational data. Thus, only associations can be interpreted, and we are not able to infer causality. Another limitation was the measures did not identify specific sports or physical activity classes. This information could have been used to identify select sports or specific classes that could have influenced adolescent participation. Finally, sports and physical activity classes were combined in a single item though they are very different modes of providing physical activity. Future studies should assess sports team and activity classes separately.

Future Research

Future studies should investigate the potential of using sport wearables for tracking physical activity in organized sport teams and physical activity classes for adolescents. For this study, self-reported surveys were used to report if they were participating in organized teams or physical activity classes but did not report how active they were during practices or classes. Using wearables that can track which sport they are participating in and log how active they are could better understand the connection between moderate to vigorous activity and sports. Wearables are also more accurate than self-reports.[39]

Previous research has shown that parent's access to a vehicle is associated with physical activity in youth. (reference) Understanding if this association carries over to organized sport teams or physical activity classes could be useful for creating programs that can encourage adolescent to be more active by having transportation that get this to practice or class.

Conclusion:

The top frequently used places for physical activity for both girls and boys were also areas that can have organized sport programs and physical activity classes. Playing fields, basketball court and outdoor swimming pool could be also places that youth could participate in organized sport teams and physical activity classes. These areas can offer structured physical activity that can encourage youth to be active and choose between various activities.

Parental Perceived availability of multiple parks and recreation facilities was associated with adolescent participation in organized sport teams and physical activity classes rather than perceived proximity to single facilities and GIS measures. The perceived availability of multiple parks and recreation facilities near their home can give parents choices of organized sport teams and physical activity classes that best fit the needs and wants of the adolescent.

Future research should include which specific activities and programs park and recreation facilities offer that provide popular activity choices and encourage adolescent participation in organized sport teams and physical activity. There should also be an intervention trial that increase parents' knowledge of available parks and recreation facilities near their home.

Age, household education and site covariates were associated with adolescent participation in organized sport teams and physical activity classes across all models. Thus, the present study supports targeting older adolescents or low education households with interventions to increase adolescent participation in organized sport teams and physical activity classes.

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