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The Influence of Sport Participation on Physical Activity in Youth

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THE INFLUENCE OF SPORT PARTICIPATION ON PHYSICAL ACTIVITY IN YOUTH

by

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ABSTRACT

Youth sport participation has been widely supported as a strategy for promoting physical activity in children and youth. Previous research has identified positive associations between youth sport participation and children's physical activity levels. However, there is a paucity of research regarding characteristics of youth sport that may affect the amount and intensity of physical activity youth attain during sport participation. This dissertation is comprised of three studies, and the overall purpose is to examine how characteristics of youth sport associate with children's physical activity.

In the first study, the relationship between types of sport participation and objectively measured physical activity in a sample of middle school youth was examined. Results indicated that children who participated in sport were more physically active and less sedentary than their non-participant peers. Additionally, children's physical activity level was positively associated with frequency of sport participation.

The purpose of the second study was to describe practice and social contextual factors that associated with children's physical activity levels during their participation in a youth sport program. A direct observational system was used to measure children's physical activity intensity and practice and social contextual factors during practices. Results indicated that practice contexts, such as fitness and game activities, were associated with higher intensities of physical activity.

The third study examined how certain coaching factors relate to children's physical activity levels during their participation in a youth sport program. A direct observational system was used to measure children's physical activity intensity, coaching behaviors, and coach proximity during practices. Coaching experience and training data were assessed via surveys completed by coaches. Results indicated that specific coach behaviors, such as watching children perform practice activities with and without verbal feedback, were associated with higher intensity levels of children's physical activity. In addition, prior coaching experience was positively related to children's physical activity levels. Coaching training did not appear to positively influence children's engagement in physical activity.

Overall, the findings of this dissertation describe the physical activity behaviors and related youth sport characteristics of children participating in youth sport programs. Findings indicated that children's physical activity was directly related to their level of participation in sport. Additionally, characteristics of youth sport including practice context, coaching behaviors, coaching experience, and coach training appear to influence children's physical activity intensity during their participation in youth sport. Collectively, the findings of this dissertation highlight the important role that youth sport programs can play as a setting for physical activity promotion of children and youth.

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CHAPTER 1

INTRODUCTION

It is well documented that physical activity provides important health benefits for persons of all ages. Specifically for children and youth, physical activity has been associated with improved bone health, weight status, cardiorespiratory and muscular fitness, cardiometabolic health, cognition and reduced risk of depression (1). To achieve such benefits, it is recommended that school-aged youth ,ages 6 to 17 years, accumulate at least 60 minutes or more of moderate-to-vigorous physical activity each day (1). However, data suggests that majority of children and youth are inactive (1,2) despite the recommendations and significant public health efforts to increase physical activity levels.

Youth sport participation has been defined as a program that provides a systematic sequence of practices and contests for children and youth (3). With millions of children participating in youth sport programs each year (4), major health organizations have endorsed sport participation as a strategy for promoting physical activity (5–7). Recently, the United States Department of Health and Human Services released the *National Youth Sports Strategy*, promoting sport as a platform to influence youth participation in sport and provide health benefits associated with increased physical activity (5).

Previous research has reported that youth who participate in sport tend to be more physically active, expend more energy, and spend more time in moderate-to-vigorous physical activity than their non-sport participant peers (8–12). However, very few studies have objectively measured participants' physical activity levels during youth sport in the United States. Furthermore, there is a paucity of research examining relationships between characteristics of youth sport and physical activity levels of participants during exposure to youth sport. In addition, youth sport coaches are known to play an influential

role in youth health outcomes as they associate with sport participation (13) but the relationship between coaching characteristics and behaviors, and children's physical activity levels during youth sport has not been extensively examined.

As such, the overarching goal of this dissertation was to advance knowledge and understanding of the relationship between youth sport participation and children's physical activity. The proposed dissertation addressed three purposes:1) to describe the association between sport participation and objectively measured physical activity in a sample of middle school youth; 2) to describe the association between practice and social contextual factors and physical activity levels of children during their participation in a youth sport program and 3) to describe how coaching behaviors, coaching experience, and coach training relate to children's physical activity levels during their participation in a youth sport program. An existing data source was used to address the first aim and a cross-sectional observational protocol was conducted to address the second and third aims.

Study one described the cross-sectional relationship between characteristics of sport participation and physical activity among a sample of middle school youth. Data were drawn from the Evaluation of Activity Surveys in Youth study. Physical activity was measured by accelerometry and characteristics of sport participation were gathered via self-reported survey instrument. First, differences in physical activity levels were compared between sport participants and non-participants. Second, the association between physical activity and frequency of sport participation was examined.

The second study investigated practice and social contextual factors that associate with children's physical activity levels during their participation in a youth sport

program. To achieve the aim of this study, a cross-sectional study design was used, and youth soccer teams were recruited from local YMCA programs. Children's physical activity intensity and practice and social contextual factors were assessed using a direct observational system during team practices. First, the associations between physical activity intensity and practice and social contexts were examined. Next, the extent to which the sex-composition of the team mediated the relationship between children's physical activity intensity and practice and social contextual factors was examined.

Lastly, the third study examined how coaching behaviors, coaching experience, and coach training relate to children's physical activity levels during their participation in a youth sport program. Children's physical activity and coaching behaviors were assessed using the direct observational system employed in study two. Coaching experience and training were assessed from information gathered from a coach survey. First, the associations between coaching behaviors and children's intensity of physical activity during their participation in a youth sport program were examined. Second, the extent to which the sex-composition of the team mediated the relationship between children's physical activity intensity and coaching behaviors was examined. Third, the associations between coaching experience and coach training, and team-level physical activity during practices were examined.

The findings presented in these three studies address gaps in the literature and expand our understanding of the relationship between youth sport participation and children's physical activity. Together, the results of this dissertation highlight the importance of examining the role youth sport can play in influencing children's physical

activity and can help to inform potential intervention strategies within the youth sport setting.

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CHAPTER 2

MANUSCRIPT ONE: THE RELATIONSHIP BETWEEN SPORT PARTICIPATION AND PHYSICAL ACTIVITY IN MIDDLE SCHOOL YOUTH[1]

[1] Shull, ER, Pate, RR, […] To be submitted to *Medicine & Science in Sports and Exercise.*

Abstract

Purpose. The purpose of this study was: 1) to compare physical activity levels between children who report sport participation and those who are not sport participants, and 2) to determine if physical activity is associated with frequency of sport participation. **Methods.** Sport participation characteristics and accelerometer-measured physical activity and sedentary behavior were assessed in 246 children (126 males, 120 females) enrolled in middle school (mean age of 12 years). **Results.** Sport participants had higher light (14.6 vs. 13.3 min/h, $p = .004$), moderate-to-vigorous (3.2 vs. 2.4 min/h, $p = .0004$), vigorous (0.4 vs. 0.2 min/h, $p = .003$), total physical activity (17.8 vs. 15.8 min/h, $p = .0002$) and lower sedentary behavior (42.2 vs. 44.2 min/hr, $p = .0002$) compared to non-participants. Frequency of sport participation was positively related to children's light physical activity ($\beta = 0.2 \pm 0.1$, $p = .001$), moderate-to-vigorous physical activity ($\beta = 0.2 \pm 0.02$, $p < .0001$), vigorous physical activity ($\beta = 0.04 \pm 0.01$, $p < .0001$) and total physical activity ($\beta = 0.3 \pm 0.1$, $p < .0001$) and negatively related to children's sedentary behavior ($\beta = - 0.3 \pm 0.1$, $p < .0001$). Sport type-specific analysis revealed that children who reported participating in organized non-school sport ($p < .0001$) and non-organized sport ($p < .025$) had higher levels of total physical activity compared to non-participants. **Conclusion.** Children who participated in sport were more physically active and less sedentary than their non-participant peers. Additionally, children's physical activity level was positively associated with frequency of sport participation.

Introduction

It is well established that physical activity provides numerous health benefits for youth including improvements in cardiorespiratory and muscular fitness, cardiometabolic health, bone health, weight status, cognitive function and reduced risk of depression (1,2). The Physical Activity Guidelines for Americans recommend that children and adolescents accumulate 60 minutes of moderate-to-vigorous physical activity each day (2), however, a majority of youth fail to meet this guideline (3). The United States Department of Health and Human Services recently released the *National Youth Sports Strategy*, promoting sport as a platform to influence youth participation in sport and provide health benefits associated with increased physical activity (4).

Results from existing cross-sectional research have reported that youth sport participants tend to be more physically active and spend more time in moderate-to-vigorous physical activity their non-sport participant peers (5–9). However, factors including individual-level characteristics (e.g., age, sex, race/ethnicity, etc.), frequency of participation, and type of sport participated in (e.g., school vs. non-school, organized vs. non-organized sport programs) may affect the amount and intensity of physical activity attained during sport participation. Examining these factors could provide important information to guide the development of effective strategies to enhance physical activity during youth sport.

The existing literature is limited by a lack of studies which include both an objective measure of physical activity and examination of factors including demographic-level participant characteristics, frequency of participation, and type of sport participated

in. Additionally, much of the existing literature regarding physical activity and youth sport has focused on a specific type of sport or setting. Although this information is important, a more extensive examination of one's sport experience would be valuable, as one's ability to participate in sport and be physically active may be influenced by a variety of factors. The present study aimed to address these gaps by examining the contribution of demographic-level characteristics, frequency of participation, and types of sport program with objectively measured physical activity in a sample of youth.

The overarching goal of this study was to examine the cross-sectional relationship between objectively-measured physical activity and characteristics of sport participation in a sample of middle school children. The specific purposes of this study were: 1) to compare physical activity levels between children who report sport participation and those who are not sport participants and 2) to determine if physical activity is associated with frequency of sport participation.

Methods

Data for the present study were drawn from the Evaluation of Activity Surveys in Youth (EASY) study, which developed a valid and reliable physical activity self-report instrument for youth, using a mixed methods qualitative/quantitative sequential research design (10). Details regarding the overall study protocol are reported elsewhere (10). Prior to the study, written informed parent consent and child assent were obtained. The University of South Carolina's institutional review board approved all protocols. The present analyses included data on a total of 246 children (120 females, 126 males) enrolled in middle school, with a mean age of 12.0 ± 0.9 years.

Measures

Children's physical activity was measured by accelerometry (ActiGraph GT1M and GT3X models; Pensacola, FL), a valid tool used to objectively measure children's physical activity levels (11). Children were instructed to wear the accelerometer on the right hip for seven consecutive days during waking hours (except for water-based activities). Data were collected and stored in 30-second epochs and any period of ≥ 60 minutes of consecutive zero counts was defined as non-wear time. Children had to have worn the accelerometer for at least eight hours on at least three days to be included in the analyses. Average minutes per hour spent in sedentary, light, moderate-to-vigorous, vigorous, and total physical activity were calculated for each participant using age-specific cutpoints (12).

Sport participation information was assessed using data from the EASY instrument (10), completed by children in 6th, 7th and 8th grades. Children were asked about activities completed in the past week (0-7 days). The following questions specifically asked about three types of sport and were used in the present study's analysis: 1) "In the past week (7 days) did you play on an organized school sports team?"; 2) "In the past week (7 days) did you play on an organized, non-school sports team?"; and 3) "In the past week (7 days) did you play non-organized sports?". If a child reported yes, he/she then reported the number of days, in the last 7, that he/she had participated in the activity. In this manuscript the term 'type' will be used to refer to three forms of sport participation including: organized school sport, non-organized school sport, and non-organized sport. Table 2.1 provides operational definitions of the sport participation type variables and categories that are defined in this study.

Children demographic information including their age, sex, race/ethnicity, and eligibility for free and reduced lunch were reported. Children's free and reduced lunch eligibility was coded as 'yes or 'no' to use as an indicator of child's socio-economic status. Additionally, children's height and weight were measured, and body mass index (BMI) percentiles were calculated to provide an indicator of weight status.

Data Analyses

All analyses were performed using SAS 9.4 Statistical software (SAS Institute, Cary, NC). Statistical significance was set at $p < .05$. Descriptive statistics were calculated to describe the sample characteristics including demographic, anthropometric, physical activity, and sport participation characteristics. Additional descriptive statistics were calculated to describe children's frequency of participation in sport (days/week) and children's physical activity (min/h) in each type of sport. All models adjusted for children's age, sex, socioeconomic status, race/ethnicity, and BMI percentile.

An adjusted ANOVA was used to compare physical activity levels between sport participants and non-participants. Children were classified as a sport "participant" if they reported ≥ 1 day(s) per week of participation in any type of sport or "non-participant" if they responded "no" to the sport-related questions from the EASY instrument. Additionally, an adjusted ANOVA model was conducted to examine sport type differences in total physical activity between non-participants and all sport participants, controlling for type of sport. These data are presented as Least Squares Means; therefore the means were adjusted for the average value of the specified covariates in the adjusted model.

Lastly, an adjusted multiple linear regression analysis was conducted to determine whether physical activity was associated with frequency of sport participation. To do so, a variable named 'frequency of sport participation' was created for each child and was analyzed as the independent variable. The self-reported days per week (0-7 days) of participation for all three sport-related questions from the EASY instrument were summed to form the frequency of sport participation variable for each child.

Results

Characteristics of study participants are summarized in Table 2.2. The sample consisted of 51% males, and mean age was 12 years. The racial and ethnic composition was diverse and approximately 40% of the sample received free or reduced lunch. Just over 70% of the sample reported participating in sports during the previous week.

Descriptive information regarding the frequency of sport participation and physical activity levels among study participants is presented in Table 2.3. Frequency of sport participation ranged from 3.4 days/week among children participating in non-organized sport to 3.8 days/week among children who participated organized school sport. Over half of the sample reported participating in non-organized sport (n=140). Children who participated in organized non-school sport had the highest levels of physical activity across all intensities. For children who participated in a combination of sport types, the combination of organized non-school and non-organized sports was most common.

ANOVA was used to compare physical activity levels between sport participants and non-participants. Results of this analysis are presented in Table 2.4. Sport

participants had significantly higher light, moderate-to-vigorous, vigorous, and total physical activity compared to non-participants. Non-participants had significantly higher sedentary behavior compared to sport participants.

Sport type-specific differences in total physical activity between all sport participants and non-participants were investigated. This model controlled for type of sport and child-level variables and results are presented in Table 2.5. Significant differences in total physical activity were found for both organized non-school sport and non-organized sport participants compared to non-participants. There was an estimated mean difference of 2.1 min/h in total physical activity between organized non-school sport participants non-participants.

Results of the linear regression analyses assessing the frequency of sport participation and children's physical activity levels are summarized in Table 2.6. Frequency of sport participation was significantly positively related to children's light physical activity, moderate-to-vigorous physical activity, vigorous physical activity, total physical activity and significantly negatively related to children's sedentary behavior.

Discussion

Across the globe, millions of children engage in youth sports. In the United States alone, approximately 70% of children ages 6-12 years old participate in a sport (13). Thus, youth sport serves as an important institution that reaches a large population of youth. As there is a pressing need to find ways to increase physical activity levels among American children, youth sport has the potential to play a crucial role in doing so. The main finding of our study was that children's physical activity was directly related to

their level of participation in sport during the previous week. Children who participated in any type of sport were consistently more active and less sedentary compared to children who did not participate in sport. Additionally, our findings revealed that the greater the frequency of participation in sport, the higher the level of physical activity and the lesser time spent in sedentary behavior among children.

Our findings are consistent with the existing literature in which studies have reported that youth sport participants tend to be more physically active and spend less time in sedentary behavior compared to their non-participant peers (14). However, many of the existing studies have focused their examination on one specific sport (e.g., soccer), type of sport (e.g., interscholastic), or sex of child; and have been limited by self-reported physical activity or a physical activity measure that was only gathered during the duration of a single sport practice or event (14). Additionally, the measure of sport participation has varied in previous studies (14). For example, some studies have compared children's participation in sport during the previous year to physical activity measured at a single time point, which may not align with the timing of the child's reported participation in a sport. In the present study, children's objectively-measured physical activity and reported sport participation data were measured for the same seven-day period. This information provides valuable insight into the children's behaviors and can be used to draw more accurate and timely conclusions about their concurrent activity and sport participation.

Very few studies have examined the relationship between frequency of sport participation and physical activity in youth (7,15–17) and none have done so using an objective measure of physical activity in a sample of American children. Our findings address this gap and reveal that the more frequent children participated in sport the more

physically active they were. Specifically, frequency of sport participation was consistently and positively related to children's physical activity across several different intensities including light, moderate-to-vigorous, vigorous, and total physical activity. Additionally, frequency of sport participation was found to be negatively related to children's time spent in sedentary behavior. These findings support the hypothesis that encouraging, and offering opportunities for, children to participate in sport more frequently may be part of an effective approach to help children meet the national physical activity guideline of 60 minutes of moderate-to-vigorous physical activity per day (2).

Our findings indicate that the type of sport in which children participate influences their physical activity level. In particular, we found that children who participated in organized non-school sport and non-organized sport attained greater levels of total physical activity compared to their non-participant peers. This finding suggests that sport programs outside of organized school sports, such as community/club leagues, and recreation/play such as 'pick-up' games, may provide a meaningful avenue for children to be physically active. Existing studies have explored the relationship between physical activity and youth sport participation in school and/or non-school programs, yet very few have made comparisons between those programs (7,18,19), and none have examined the issue among a sample of American children. The findings of the present study align with previous findings from Silva and colleagues (2013) and Mandic and colleagues (2012), in which participation in sport outside of the school setting (e.g. club sport) had stronger associations with children meeting physical activity recommendations (19) and reported time spent in physical activity (7) compared to school sport. Overall,

our study builds upon previous research by examining children's physical activity levels across different types of sport, which few studies have previously addressed (14). Understanding how different types of sport may contribute to children's physical activity can influence how and which sports should be promoted to youth. It would be of great interest for future research to employ experimental study designs to examine the effects of increasing sport participation opportunities across different types of sport, in relation to physical activity levels among children, to further understanding on this topic.

To our knowledge, this was the first study to examine the relationship between objectively-measured physical activity and sport participation characteristics, such as, children's frequency of participation and the comparison of different types of sport, between participants and non-participants, in a sample of American middle school children. A major strength of this study was the use of a device-based measurement of physical activity and sedentary behavior, including the analysis of various intensities of physical activity. Another important strength of this study was that children's objectively-measured physical activity and reported sport participation data were gathered across a span of the same week. As previously discussed, this information allows us to better understand children's activity and sport participation behaviors in a time period that aligns for both measures. However, several potential limitations to the present study should be acknowledged. Youth sport participation was self-reported with the potential issue of recall bias. Additionally, the present study was conducted in one area in the Southeastern United States and may limit the generalizability of the results. Lastly, the present study did not include other known correlates that may influence physical activity (e.g., social support, self-efficacy, etc.), which would be of interest for future research.

This study examined relationships between objectively-measured physical activity and youth sport participation by examining sport type and sport frequency in a sample of American middle school children. Children who participated in sport were more physically active and less sedentary than their non-participant peers. Our results also suggested that the type of sport children participate in may be meaningful in the amount of physical activity children attain, specifically organized non-school and non-organized sports. Efforts to promote physical activity and reduce sedentary behavior should include an emphasis on sport participation, and more specifically, increased frequency of participation as well as opportunities for organized non-school and non-organized sport participation among children. It would be of interest to further examine the influence of children's participation across different sports in larger and more diverse samples and observe longitudinal trends to better understand the relationship between children's physical activity and youth sport participation.

Table 2.1. Definitions of sport type variables and categories.

Sport type variables	
Organized school sport	Children who reported ≥ 1 day(s) per week of participation in an organized school sport.
Non-organized school sport	Children who reported ≥ 1 day(s) per week of participation in a non-organized school sport.
Non-organized sport	Children who reported ≥ 1 day(s) per week of participation in a non-organized sport.
Categories of sport type variables	
All children who reported each type of sport	All children in the sample who reported ≥ 1 day(s) per week of participation in a sport program regardless of if they reported only one type of sport, or more than one type of sport.
Combinations of sport participation; children who reported >1 type of sport	Children who reported ≥ 1 day(s) per week of participation in one or more type(s) of sport. Any combination of organized school, non-organized school, and/or non-organized sport.
Children who reported only 1 type of sport	Children who reported ≥ 1 day(s) per week of participation in only one type of sport. Either organized school sport only, non-organized school sport only, or non-organized sport only.

Table 2.2. Descriptive characteristics of the total sample (N=246).

	N	% or Mean (SD)
Demographic Characteristics		
Age (yr)	246	12.0 ± 0.9
Sex		
Males	126	51.2%
Females	120	48.8%
Race/Ethnicity		
White	116	47.2%
Black	92	37.4%
Hispanic	15	6.1%
Other	23	9.4%
Free/Reduced Lunch Status		
Yes	99	40.2%
No	147	59.8%
Anthropometric Characteristics		
Height (cm)	246	156.0 ± 8.7
Weight (kg)	246	51.4 ± 15.1
Body Mass Index %	246	65.4 ± 28.5
Physical Activity		
Sedentary (min/h)	246	42.5 ± 4.2
Light (min/h)	246	14.4 ± 3.2
Moderate-to-vigorous (min/h)	246	3.1 ± 1.8
Vigorous (min/h)	246	0.4 ± 0.4
Total (min/h)	246	17.5 ± 4.2
Sport Participation		
Non-Participant	69	28.1%
Participant	177	72.0%

Table 2.3. Frequency of participation in sport (days/week) and physical activity (min/h) among children, N=246.

Type of sport	N	Frequency of participation Mean (SD)	Physical activity Mean (SD)				
			Sedentary	Light	MVPA	Vigorous	Total
All children who reported each type of sport							
Organized School	27	3.8 (1.8)	41.4 (3.6)	15.3 (3.4)	3.4 (1.1)	0.4 (0.3)	18.6 (3.6)
Organized Non-school	97	3.6 (2.0)	40.1 (4.4)	16.0 (3.6)	4.1 (1.7)	0.6 (0.4)	19.9 (4.4)
Non-organized	140	3.4 (2.2)	41.1 (3.6)	15.4 (3.1)	3.6 (1.2)	0.4 (0.4)	18.9 (3.6)
Combinations of sport participation; Children who reported >1 type of sport							
Organized School & Organized Non-school	3	7.7 (3.2)	38.9 (5.5)	17.1 (4.6)	4.0 (1.1)	0.6 (0.3)	21.1 (5.5)
Organized School & Non-organized	9	6.4 (3.3)	41.6 (2.7)	15.5 (2.4)	3.0 (1.0)	0.2 (0.2)	18.4 (2.7)
Organized Non-school & Non-organized	61	7.1 (3.5)	40.7 (4.1)	15.3 (2.9)	4.0 (2.0)	0.6 (0.6)	19.3 (4.1)
All three	7	11.1 (4.5)	39.4 (3.7)	16.3 (4.0)	4.4 (1.2)	0.6 (0.4)	20.6 (3.7)
Children who reported only 1 type of sport							
Organized School only	8	3.4 (1.4)	45.7 (2.3)	12.2 (2.6)	2.2 (1.1)	0.2 (0.3)	14.3 (2.3)
Organized Non-school only	26	3.4 (2.1)	41.4 (4.4)	15.3 (2.9)	4.0 (2.3)	0.4 (0.4)	18.6 (4.4)
Non-organized only	63	3.6 (2.1)	42.6 (3.9)	14.4 (3.0)	3.0 (1.6)	0.3 (0.3)	17.4 (4.0)
Children who did not report participating in any type of sport							
Non-participants	69	-	44.6 (3.8)	13.2 (3.2)	2.2 (1.1)	0.2 (0.2)	15.4 (3.8)

MVPA = moderate-to-vigorous physical activity

Table 2.4. *Adjusted ANOVA results examining differences in physical activity between and sport participants and non-participants, presented as Least Squares Means (Standard Error).

Physical activity	Sport participant (n=177)	Non-participant (n=69)	*p-value*
Sedentary (min/h)	42.2 (0.4)	44.2 (0.5)	0.0002
Light (min/h)	14.6 (0.3)	13.3 (0.4)	0.004
Moderate-to-vigorous (min/h)	3.2 (0.1)	2.5 (0.2)	0.0004
Vigorous (min/h)	0.4 (0.04)	0.2 (0.1)	0.003
Total (min/h)	17.8 (0.4)	15.8 (0.5)	0.0002

*Adjusted for age, sex, race/ethnicity, socioeconomic status, and body mass index percentile

Table 2.5. *Adjusted ANOVA results examining sport type differences in total physical activity (min/h) between all sport participants and non-participants, controlling for type of sport and child-level variables.

	Sport participant			Non-participant			β (SE)	*p-value*
Type of sport	N	LS Means (SE)	CI	N	LS Means (SE)	95% CI		
Organized School	27	18.2 (0.7)	[16.8, 19.6]	69	17.3 (0.3)	[16.7, 18.0]	0.9 (0.7)	0.2217
Organized Non-school	97	18.8 (0.5)	[17.8, 19.8]	69	16.7 (0.5)	[15.8, 17.6]	2.1 (0.5)	<.0001
Non-organized	140	18.3 (0.5)	[18.3, 17.3]	69	17.2 (0.5)	[16.2, 18.2]	1.1 (0.5)	0.025

*Adjusted for type of sport, age, sex, race/ethnicity, socioeconomic status, and body mass index percentile; LS Means = Least Squares Means; SE = standard error; CI = confidence interval for β

Table 2.6. *Adjusted multiple linear regression results assessing physical activity and frequency of sport participation (# of days in the past week).

	β	CI	SE	*p-value*
Sedentary (min/h)	-0.3	-0.45 – -0.21	0.1	<.0001
Light (min/h)	0.2	0.07 – 0.27	0.1	0.001
Moderate-to-vigorous (min/h)	0.2	0.11 – 0.21	0.02	<.0001
Vigorous (min/h)	0.04	0.03 – 0.05	0.01	<.0001
Total (min/h)	0.3	0.21 – 0.45	0.1	<.0001

Adjusted for age, sex, race/ethnicity, socioeconomic status, and body mass index percentile; CI = confidence interval

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CHAPTER 3

MANUSCRIPT TWO: CHILDREN'S PHYSICAL ACTIVITY BEHAVIORS ACROSS PRACTICE AND SOCIAL CONTEXTS IN THE YOUTH SPORT SETTING[2]

[2] Shull, ER, Pate, RR, […]. To be submitted to the *Journal of Science and Medicine in Sport.*

Abstract

Objectives. The purpose of this study was to identify practice and social contextual factors that associate with physical activity levels of children during their participation in a youth sport program. **Methods.** A sample of 27 youth soccer teams serving children ages 6-11 years participated in this study. Physical activity intensity and practice and social contextual factors were directly observed and recorded by momentary time-sampling procedures using the Observational System for Recording Physical Activity in Children—Youth Sport version. Each team was observed for one regularly scheduled practice during which approximately 6 children were each observed for 20 thirty-second observation blocks. Each 30-s observation included 10-s of observation and 20-s for recording. In total, children were observed for 3,102 intervals. Children's physical activity intensity across practice and social contexts was described. Multilevel logistic regression analyses were conducted to describe associations between physical activity intensity and practice and social contexts. Interaction terms were introduced into the models to determine if the associations differed across girls-only, boys-only, and coed teams. **Results.** A total of 158 children across the 27 teams were observed. Children were more likely to engage in moderate or vigorous physical activity while performing fitness (Odds Ratio [OR], 9.9, 95% CI = 5.34-18.04), game (OR, 4.0, 95% CI = 2.88-5.66), warm-up (OR, 2.8, 95% CI=1.85-4.11), and drill (OR, 1.9, 95% CI=1.41-2.67) activities compared to tactic/instructional activities. The associations between physical activity intensity levels and practice and social contexts did not differ across girls-only, boys-only, and coed teams. **Conclusions.** Specific practice contexts, such as fitness and full team game activities, were associated with higher intensity levels of physical activity

during children's participation in youth sport. Incorporating more fitness and game activities into youth sport practices could benefit children by increasing their time spent in higher intensity physical activity.

Introduction

For decades, youth sport has been thought to provide numerous social and psychological developmental benefits for those participating.[1] In addition, youth sport has been widely promoted as a way for participants to attain the health benefits associated with physical activity, including improvements in cardiorespiratory and muscular fitness, cardiometabolic health, bone health, weight status, cognitive function and reduced risk of depression among others.[2,3] In 2019, the United States Department of Health and Human Services highlighted these benefits of sport participation and regular physical activity within the *National Youth Sports Strategy.*[4]

Although it is often assumed that youth who engage in sport are active, very few studies have objectively examined participants' physical activity during sport. [5–9] Furthermore, the contextual factors associated with physical activity in the youth sport setting, such as practice and social contexts, have been relatively unexplored. Practice contextual factors refer to activities performed by participants during a practice session, such as, warming up, drills, and scrimmages or game-like activities. Social contextual factors refer to the social interactions of the participants as they perform practice activities, such as being paired with others for a group activities or being solitary. These contextual factors may play a role in influencing the amount and intensity of physical activity achieved by youth participating in sport.

Direct observation can provide important information regarding children's physical activity within practice and social contexts in the youth sport setting. However, in the current literature, direct observational studies have varied drastically by design, observational tool, type of sport, and age and sex of participants observed. Furthermore, to our knowledge, no study has used direct observation to examine associations between practice and social contextual factors and physical activity across sex-specific (girls-only, boys-only) and combined (girls and boys, i.e., coed) sport teams. Understanding how physically active children are during specific sport contexts can reveal potential physical activity intervention opportunities within the youth sport setting.

The Observational System for Recording Activity in Children – Youth Sport (OSRAC:YS) was created to provide objective measures of physical activity and the contextual factors in the youth sport setting.[5] The overarching goal of this study was to identify practice and social contextual factors that associate with children's physical activity levels during their participation in youth sport programs using the OSRAC:YS direct observational method. The purposes of this study were: 1) to describe practice and social contextual factors as observed in a youth sport program; 2) to describe associations between practice and social contextual factors and children's intensity of physical activity during their participation in a youth sport program and 3) to determine if associations between practice and social contextual factors and children's intensity of physical activity differ across girls-only, boys-only, and coed teams.

Methods

Study Design & Participants

A cross-sectional study design was used to examine practice and social contextual factors and physical activity of youth sport participants using the OSRAC:YS observational system. Sport teams were recruited from YMCA organized youth soccer programs in three South Carolina cities. Eligible programs included registered girls-only, boys-only and coed teams, serving youth ages 6-11 years old. From the eligible programs, an equal amount of girls-only, boys-only and coed teams were randomly selected to partake in the study. The random selection occurred by first identifying of all eligible participating teams, with assistance from the program directors. Then, all eligible teams were stratified by type of team (i.e., girls-only, boys-only and coed). Lastly, 27 total teams, 9 teams of each type, were randomly selected. Prior to the study, informed consent was obtained from the coaches of each team. Because there was no contact with parents, and children were observed anonymously, informed consent was not solicited from parents or children. The University of South Carolina's institutional review board approved all study protocols.

Measures

The OSRAC:YS was used to simultaneously measure children's intensity of physical activity and the contextual factors of the youth sport setting. The OSRAC:YS consists of 5 observational categories: 1) physical activity level, 2) practice context, 3) social context, 4) coach behavior, and 5) coach proximity. Briefly, a single focal child and the coach of the team are observed continuously during a 10-min observation period. This includes 20 observation cycles consisting of a 10-s observation period followed by

20-s recording period. During each 10-s observation interval, a single code for each OSRAC:YS category is identified and recorded. Physical activity level is coded as the highest level observed for 3 or more seconds of the 10-s observation interval. For each contextual category, a single code is recorded based on its occurrence with a standard of 3-s established as the baseline. The OSRAC:YS has been found to be strongly correlated with accelerometer-based estimates of moderate-to-vigorous physical activity ($r = 0.73$, $p<.001$) and has been found to be reliable measure of contextual factors of youth sport practices, demonstrating moderate to strong agreement between observers (Kappa coefficients of 0.67 to 0.93).[5] For the purpose of this study, the analysis focused on practice and social context categories.

Physical Activity

Children's physical activity intensity levels were coded as part of the OSCRAC:YS procedure, using The Children's Activity Rating Scale (CARS).[10] The CARS instrument comprised 5 levels of activity. Level 1 was stationary/motionless, level 2 was stationary/movement of trunk or limbs, level 3 was slow/easy movement, level 4 was moderate movement, and level 5 was fast movement. These ratings have been shown to be representative of sedentary (1-2), low-intensity (3), moderate-intensity (4), and vigorous-intensity (5) physical activity.[10]

Contextual Factors

Practice Context. Practice context codes from the OSRAC:YS were used to describe the type of practice activity.[5] These include: 1) warm-up, 2) drills, 3) tactic/instruction, 4) fitness, 5) game, 6) cooldown, and 7) transition. Warm-up was classified as any activity performed at a low- to moderate-intensity aerobic activity,

typically including stretching, at the beginning of the practice. Drills included activities that focused on a specific soccer component. Tactic/instruction activities that focused on learning soccer rules or skill development. Fitness was classified as activities performed at moderate- to high-intensity physical activity levels that aimed at improving participants' physical fitness (e.g., running laps or sprints). Game included full team activities in which all players of the team were involved, either working together or opposing other players (e.g., scrimmages). Cool-down was classified as activities occurring at the end of the practice session, with a focus on reducing the intensity of the activity (e.g., stretching). Lastly, transition was classified as a change between two practice contexts that did not include activities associated with the soccer activity (e.g., water break).

Social Context. The social context category of OSRAC:YS described the social structure, including the interaction of the focal child with other children that was influenced by the practice context.[5] Social context included four codes: 1) Solitary, 2) 1 vs 1, 3) greater than 2 but less than full team, referred to as 'group', and 4) full team.

Procedures

Researchers attended one practice per team (27 practices total) over the course of the fall 2020 youth soccer season to directly observe physical activity and contextual factors of the youth sport setting using the OSRAC-YS. Prior to each observed practice, youth soccer participants were randomly assigned to 10-min observation blocks. At the beginning of each practice, researchers identified the coach and the first single focal child to be observed continuously during a single 10-min observation period. Prerecorded audio cues to "observe" and "record" prompted researchers through the observation

cycles and the OSRAC:YS codes were recorded on a tablet using MOOSES™ observational software. At the completion of the 10-min observation block, an automated alarm signaled the end of the session. The process was repeated with a new focal child until the end of practice. A 60-min practice equated to six 10-min observation intervals.

Observer Training and Reliability. Two researchers completed training and demonstrated reliability using the OSRAC:YS. Training included informal observations, memorizing codes, definitions, and protocol, debriefing sessions, and *in situ* observations, prior to data collection. To demonstrate reliability, the primary researcher was accompanied by the second trained researcher for over 20% observation sessions (n=6) for inter-rater reliability assessment. The researchers simultaneously but independently, observed the same focal child during these sessions using split headphones and auditory prompts. Percent agreement for each of the 5 OSRAC:YS categories were calculated for inter-rater reliability sessions using the following equation: [#agreements / (#agreements + #disagreements)] x 100. Cohen's kappa was calculated for all inter-rater reliability assessments. Percent agreements and kappa values for each session were averaged to provide overall mean percent agreement and kappa values. A percent agreement of >80% was determined for all observed categories, suggesting a strong agreement between observers.

Data Analyses

All analyses were performed using SAS 9.4 Statistical software (SAS Institute, Cary, NC). Statistical significance was set at $p < .05$. Physical activity levels were aggregated into four levels of intensity. These consisted of the following intensities: sedentary (levels 1 and 2), light (LPA; level 3), moderate or vigorous (MVPA; levels 4

and 5), and light, moderate or vigorous (LMVPA; levels 3, 4, and 5) representing all levels of activity. Descriptive statistics were calculated to describe the number and percentage of intervals observed as sedentary, LPA, MVPA, and LMVPA across the OSRAC-YS categories of practice and social contexts.

Multilevel logistic regression analyses were conducted to examine the associations between observed intervals in physical activity intensities and contextual factors during youth sport practices. Two separate logistic regression models using PROC GLIMMIX were conducted for physical activity variables of MVPA and LMVPA. The physical activity intensity levels were dichotomized as MVPA and non-MVPA; and LMVPA and non-LMVPA for the analyses. Practice and social contextual factors were entered into the model as independent variables. Observation intervals were used as the unit of analysis. Intervals nested within children, and children nested within team were included as random effects. All models controlled for time of sport season, corresponding to the observation week.

Lastly, an interaction term was introduced to the multilevel logistic regression models to determine if the associations between practice and social contextual factors and intervals observed in physical activity intensities differ across girls-only, boys-only, and coed teams.

Results

Characteristics of participating teams and children are summarized in Table 3.1. A total of 27 teams consisting of nine girls-only, nine boys-only and nine coed teams were observed. Approximately six randomly selected children per team were observed at each practice, equating to 158 children (77 girls, 81 boys). In total, children were

observed for 3,102 coding intervals. The physical activity levels coded using the OSCRAC:YS are presented in Table 3.2. The most frequently observed physical activity code was slow easy (31%) and the least observed physical activity code was moderate (12%). Once aggregated into four levels of intensity used for analyses, approximately 67% of observed intervals were rated as LMVPA, followed by MVPA (36%), sedentary (33%), and LPA (31%).

Practice and social contextual factors of the youth sport programs and intervals of physical activity are presented in Table 3.3. The most frequently occurring practice contexts observed were drills (33.8%), followed by games (20.7%), transitions (14.3%), tactic/instruction (14%), warm-up (9.8%), fitness (2.5%), and lastly, cooldown (0.6%). The proportion of observed intervals in MVPA was greatest during fitness activities (66%) and games (50%). Regarding the social context category, full team activities were by far the most frequently observed (76.3%), as compared to the solitary, 1v1, or group categories.

A series of multilevel logistic regression analyses were calculated to examine associations between practice and social contextual factors and MVPA and LMVPA. Results are presented in Tables 3.4 and 3.5. Youth sport participants were significantly more likely to engage in MVPA while performing fitness (OR=9.9, CI = 5.34-18.04), game (OR=4.0, CI =2.88-5.66), warm-up (OR=2.8, CI = 1.85-4.11), and drill (OR=1.9, CI = 1.41-2.67) activities compared to tactic/instructional activities. Similarly, sport participants had higher odds (OR=7.5, CI = 3.79-14.75) of engaging in LMVPA when performing fitness activities in comparison to tactical/instructional activities. There were

no significant differences in the odds of performing MVPA or LMVPA between the social contextual categories.

Given the observed association between intervals observed in physical activity intensities and practice contextual factors, interaction terms were introduced into the multilevel logistic regression logistic regression models to determine whether the relationship varied across girls-only, boys-only, and coed teams. No significant interactions were found.

Discussion

Participation in youth sport has been broadly endorsed as a way for children to achieve health benefits related to physical activity[4] and it is estimated that 60 million children participate in the United States alone.[11] As such, youth sport is a wide-reaching institution that can provide opportunities to promote children's physical activity. A better understanding of how physically active children are during different practice contexts could identify specific areas to target and increase physical activity within the youth sport setting. The present study used a direct observational system to identify practice and social contextual factors that relate to children's physical activity intensities during their participation in youth sport. The main finding of this study was that practice contexts including fitness, full-team games, warm-up and drill activities were associated with higher physical activity intensity in children during their participation in youth sport practices, regardless of sex composition.

Very few studies have examined the relationship between children's physical activity intensities and contextual factors in the youth sport setting and none have done so in a sample including girls, boys and coed sport teams.[5,6,8,9] Our findings address this gap

and revealed that children were about ten times more likely to engage in MVPA during fitness activities and four times more likely to engage in MVPA during full-team game activities when compared to engagement in tactical and instructional practice activities. Our findings are similar to those of Cohen and colleagues,[5] who used the OSRAC:YS in a sample of youth soccer participants (N=29, 5-10 years old). They reported that children's moderate-to-vigorous physical activity was higher during drills, fitness, and game activities. Another study conducted by Schlechter and colleagues[9] examined 5-11 year-olds' physical activity during flag football using a combination of two observational systems, the OSRAC:YS and the System for Observing Fitness Instruction Time. They reported higher percentages of time spent in moderate-to-vigorous physical activity during free-play, gameplay, and warm-up compared to fitness segments, however, it is important to note that they observed a different sport and used a combination of observational systems that differ from the present study. Collectively, it is clear that specific practice activities, especially fitness and game activities, are associated with higher intensities of children's physical activity in the youth sport setting and should be emphasized by coaches when structuring and planning practices.

In the present study, we found that children engaged in MVPA for 36% of the total intervals observed during practices. This finding is consistent with previous studies that have examined children's physical activity during youth sport practices and have reported that children spent around one-third of practice time engaged in moderate-to-vigorous physical activity.[5,6,8,9] The observation that children are not engaged in MVPA for roughly two-thirds of the time observed during practices indicates that there is a lot of room for improvement for increasing children's time spent in health-enhancing levels of

physical activity. In the present study, fitness and game practice activities were associated with children's engagement in MVPA. As such, it would be beneficial for children to spend more time engaging in these activities during practices. Strategies should be implemented to promote fitness and game activities during youth sport practices, as they have potential to increase children's engagement in moderate and vigorous intensities of physical activity.

Our results indicated that social contexts, such as children performing activities while solitary, 1v1, in a group, or as a full team, were not associated with children's physical activity intensity during their participation in youth sport practices. This finding is consistent with Schlechter et al.[9] who studied and observed the same social interaction categories among children in flag football practices. On the contrary, Cohen et al.[5] found children's moderate-to-vigorous physical activity to be higher during small group and individual practice activities. The differences in findings could be attributed to the lack of variability of social context intervals observed in the present study. For example, most of the social context observations were of the full team in both the present study (80%) and Schlechter et al. (93%) compared to Cohen et al. (36%). It is well known that children's physical activity can be influenced by a number of interpersonal factors [12] including social interactions, and it has been suggested social influences are related to improved quality of one's youth sport experience.[13] As such, future research should continue to examine the role of social influences on children's physical activity achieved during youth sport in larger samples and across different types of sport. Additionally, it would be beneficial for future studies to employ experimental study designs in testing the effects of

social contexts on children's physical activity levels during their participation in youth sport practices.

This study had several notable strengths. To our knowledge, this study was the first to investigate the associations between contextual factors of the youth sport setting and children's physical activity intensities in a sample of girls, boys, and coed teams. The inclusion of all three types of teams added diversity to the study sample and improved the generalizability of the findings compared to previous studies that only examined girls-only or boys-only teams. Another strength of this study was the use of the OSRAC:YS,[5] as it was developed specifically to assess physical activity of youth sport participants and contextual factors of the youth sport setting. Direct observation offered simultaneous recording of important youth sport practice and social contexts, in which physical activity behaviors occurred, which wearable device-based measures or self-reported measures cannot. Lastly, random selection procedures were used to select the participating teams in the present study as well as the children observed at each practice, providing an unbiased approach to gather data and improve the generalizability of the findings. However, this study also had several limitations. These included observation of a single sport within one United States state. Future studies should employ similar methods across different types of sport and geographic regions. Additionally, only one practice per team was observed over the course of the season. However, the time of season in which the team was observed was accounted for in the analyses.

Conclusion

In summary this study identified practice contextual factors that associate with children's physical activity intensities during their participation in a youth sport program.

Children were most likely to be physically active while engaging in fitness and full-team game practice activities. Given the substantial number of children that participate in youth sport, it would be important to incorporate more fitness and game activities into practice sessions. Increasing children's engagement in MVPA in the youth sport setting is a strategy that could help increase the number of children meeting the recommended physical activity guidelines.[3] The findings of this study can help guide youth sport program directors and coaches in planning their practices for maximal engagement in health-enhancing levels of physical activity of youth sport participants.

Table 3.1. Characteristics of participating teams (N=27) and children (N=158).

	Total
Children, n	158
Sex, n, (%)	
Girls	77 (48.7%)
Boys	81 (51.3%)
Teams, n	27
Sex composition of team, n	
Coed	9
Girls-only	9
Boys-only	9
Age group composition of team (years), n	
6/7	11
8/9	8
10/11	8

Table 3.2. Observed physical activity level from the OSRAC:YS, presented as the number of observed intervals.

Observed Codes	Number of Intervals	% of Intervals
Physical Activity Level		
Stationary/No Movement	385	12.4
Stationary Limb Movement	639	20.6
Slow Easy	971	31.3
Moderate	361	11.6
Fast	746	24.1
Total Observed Intervals	3,102	

Table 3.3. Number of intervals observed across physical activity intensities stratified by contextual factors.

Observed Codes	Observed Intervals	Sedentary	LPA	MVPA	LMVPA
Total Observed Intervals	3,102	1024	971	1107	2078
Practice Context					
Warm-up	319	14	85	120	205
Drills	1094	379	344	371	715
Tactic/Instruction	453	208	129	116	245
Fitness	80	16	11	53	64
Game	672	126	211	335	546
Cooldown	21	11	7	3	10
Transition	463	170	184	109	293
Social Context					
Solitary	104	39	35	30	65
1 v 1	237	98	55	84	139
Group	288	99	77	112	189
Full Team	2473	788	804	881	1685

LPA = light physical activity, MVPA = moderate or vigorous physical activity, LMVPA = light, moderate or vigorous physical activities.

Table 3.4. Logistic regression analyses indicating the odds of children achieving moderate or vigorous physical activity by contextual factors during their participation in youth sport.

Observed Codes	OR	95% CI
Practice Context		
Warm-up	2.76	1.85-4.11*
Drills	1.94	1.41-2.67*
Fitness	9.86	5.34-18.04*
Game	4.04	2.88-5.66*
Cooldown	0.49	0.13-1.85
Transition	1.10	0.78-1.56
Tactic/Instruction	Ref	
Social Context		
Solitary	0.91	0.50-1.68
Group	0.95	0.57-1.59
Full Team	0.78	0.53-1.13
1 v 1	Ref	

*$p < .0001$. Models were controlled for time of sport season (week). OR = odds ratio, CI = confidence interval.

Table 3.5. Logistic regression analyses indicating the odds of children achieving light, moderate or vigorous physical activities by contextual factors during their participation in youth sport.

Observed Codes	OR	95% CI
Practice Context		
Warm-up	2.41	1.61-3.60*
Drills	2.28	1.67-3.11*
Fitness	7.47	3.79-14.75*
Game	5.39	3.76-7.72*
Cooldown	0.73	0.25-2.10
Transition	1.96	1.42-2.70*
Tactic/Instruction	Ref	
Social Context		
Solitary	1.36	0.73-2.53
Group	0.96	0.55-1.67
Full Team	1.20	0.78-1.75
1 v 1	Ref	

*$p < .0001$. Models were controlled for time of sport season (week). OR = odds ratio, CI = confidence interval.

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CHAPTER 4

MANUSCRIPT THREE: THE INFLUENCE OF COACHING BEHAVIORS, EXPERIENCE, AND TRAINING ON CHILDREN'S PHYSICAL ACTIVITY LEVELS DURING YOUTH SPORT[3]

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Abstract

Purpose. The purpose of this study was to examine how coaching behaviors, coaching experience, and coach training relate to physical activity levels of children during their participation in a youth sport program. **Methods.** Youth soccer teams (N=27) serving children ages 6-11 years were directly observed during one practice. Team coaches reported prior coaching experience, training, and demographic characteristics. At each observation physical activity intensity and coaching behaviors were recorded by momentary time-sampling procedures consisting of 30-s intervals (10-s observation, 20-s recording). The head coach and approximately 6 children per team were each observed for 10-min observation blocks consisting of 20 thirty-second intervals. Multilevel logistic regression were conducted to describe the associations between coaching behaviors and intensity of children's physical activity. Interaction terms were added into the models to determine if the associations differed across girls-only, boys-only, and coed teams. ANOVAs were used to describe associations between coaching experience, coach training and team physical activity level. **Results.** Children were more likely to engage in moderate or vigorous physical activity when coaches were watching without verbal feedback (Odds Ratio [OR], 3.2, 95% CI = 1.70-5.83) or watching with verbal feedback (OR, 2.1, 95% CI = 1.27-3.59), compared to when the coach was disengaged. The associations between coaching behavior factors and children's physical activity intensity did not differ across girls-only, boys-only and coed teams. In addition, the number of prior seasons coached was positively related to team physical activity levels. **Conclusion.** Coach behaviors, such as watching youth participants perform activities with or without feedback, were associated with higher intensity levels of children's physical activity

during youth sport. Additionally, prior coaching experience was positively related to team physical activity levels. These findings can be used to inform coaching strategies to promote increased children's physical activity during youth sport practices.

Introduction

Regular engagement in physical activity is known to be associated with favorable health outcomes for children and youth, and it is recommended that school-aged youth accumulate at least 60 minutes a day of moderate-to-vigorous physical activity (1). Despite public health efforts to promote physical activity in young people, data suggest that majority of children and youth in the United States are not meeting the recommended levels of physical activity (1,2). With millions of children involved in youth sport programs each year (3), sport participation has been endorsed as a strategy for promoting physical activity in children and youth (4–6).

Within the youth sport setting, coaches are known to play a fundamental role in developing participants' skills and performance outcomes (7). Coaches are also recognized as an important influence in fostering positive youth development through youth sport participation, which includes the development of personal, social and physical skills of youth sport participants (8–10). A main responsibility of youth sport coaches is to plan and facilitate the structure and activities that occur during practices. As such, youth sport coaches have the ability to influence sport participants' physical activity levels through those practice activities. Previous research has suggested that coaching behavior may be related to children's physical activity levels (11–13), however, very few studies have examined this topic and further investigation is needed to better

understand the potential influence coaching behaviors may have on children's physical activity outcomes in the youth sport setting.

Coach-related factors including coach training and coaching experience have also been hypothesized by researchers to have an influence on children's youth sport experiences. It has been documented that through coach training and education, coaches have the potential to create sport environments that foster positive development (14,15) and psychosocial outcomes (16,17) of youth participating in sport. Overall, the existing literature has supported coach training as a way to shape behaviors of coaches and subsequently influence children during their participation in sport programs (16,18). However, little is known about how coach training and coaching experience relate to children's physical activity behaviors.

While youth sport coaches are positioned to influence physical activity levels of youth sport participants, there is a paucity of research examining coaching behaviors, coaching experience, and coach training, as they relate to children's physical activity levels during their participation in a youth sport program. Thus, the overarching goal of this study was to examine how coaching behaviors, experience, and training relate to children's physical activity levels during their participation in a youth sport program. The purposes of this study were: 1) to describe selected coaching behaviors and intensity of children's physical activity as observed during youth sport practices; 2) to describe the associations between selected coaching behaviors and intensity of children's physical activity during their participation in a youth sport program; 3) to determine if the associations between coaching behaviors and children's intensity of physical activity

differ across girls-only, boys-only and co-ed teams; and 4) to describe the associations between coaching experience, coach training, and team physical activity level.

Methods

Study Design & Participants

A cross-sectional study design was used to examine coaching behaviors, coaching experience, coach training, and physical activity of children during their participation in a youth sport program. Organized youth soccer teams were recruited from YMCA programs in three South Carolina cities. Eligible programs included registered girls-only, boys-only and coed teams, serving youth ages 6-11 years old. With assistance from program directors all eligible programs were identified. Random selection was used to select an equal amount of girls-only, boys-only and coed teams from the eligible programs. A total of 27 teams consisting of nine girls-only, boys-only and coed teams participated in the study. Informed consent was obtained from the coaches of each team prior to the study. All study protocols were approved by the University of South Carolina's institutional review board.

Measures

Children's intensity of physical activity and selected coaching behaviors in the youth sport setting were measured using direct observation via the Observational System for Recording Activity in Children – Youth Sport (OSRAC:YS) (11). The OSRAC:YS has been found to be a reliable tool for measuring children's physical activity and contextual factors of the youth sport practice environment (11) and consists of five observational categories. The categories are as follows: 1) physical activity level, 2) practice context, 3) social context, 4) coach behavior, and 5) coach proximity. Similar to

other direct observational systems, the OSRAC:YS utilizes momentary time-sampling procedures to record the activity of a single focal child and the team coach. The focal child and the coach of the team are observed continuously during a 10-min observation period. This includes 20 observation cycles consisting of a 10-s observation period followed by 20-s recording period. During each 10-s observation interval, a single code for each OSRAC:YS category is identified and recorded. Physical activity level is coded as the highest level observed for 3 or more seconds of the 10-s observation interval. For each contextual category, a single code is recorded based on its occurrence with a standard of 3-s established as the baseline. The OSRAC:YS has been found to be strongly correlated with accelerometer-based estimates of moderate-to-vigorous physical activity ($r = 0.73$, $p<.001$) (11). For the purpose of this study, the analysis focused on coach behavior and coach proximity categories.

Physical Activity. Children's physical activity intensity levels and team physical activity levels were used as measures in the present study. Children's physical activity intensity levels were coded using The Children's Activity Rating Scale (CARS) (19) as part of the OSCRAC:YS procedure. A measure of team physical activity was calculated by averaging children's CARS physical activity scores from each team, reflecting the overall activity level of children observed at each team practice. The CARS instrument included 5 levels of activity. Level 1 was stationary/motionless, level 2 was stationary/movement of trunk or limbs, level 3 was slow/easy movement, level 4 was moderate movement, and level 5 was fast movement. The ratings from CARS have been shown to be representative of sedentary, low-intensity, moderate-intensity, and vigorous-intensity physical activity (19).

Coaching Behavior. Coach behavior codes from the OSRAC:YS were used to describe the actions of the coach and included: 1) watching with feedback, 2) watching without feedback, 3) demonstration, 4) management/instruction, and 5) disengaged/off task (11). Watching with or without feedback was classified as a coach watching the participants perform an activity or task and then either providing feedback or not. Demonstration was coded when a skill was demonstrated by the coach or the coach participated in a practice activity with the aim of demonstrating that skill to the participants. An example of a demonstration code would be the coach playing with the team during a scrimmage. Management and instruction was coded when a coach was setting up practice activities, providing instructions to the team about such activities, or having general team discussions, such as preparation for an upcoming practice or game. Lastly, a coach was referred to as disengaged and off task if he/she appeared to be uninvolved or removed from the practice activity.

Coaching Proximity. Coach proximity codes from the OSRAC:YS were used to describe the location of the coach in relation to the focal child being observed (11). Coaching proximity was recorded as one of two codes: 1) proximal or 2) distal. The coach was be considered proximal or distal depending on if the coach is inside or outside of the practice field. The sidelines of the practice field were used as the boundary for practice field. Any time the coach was within the sidelines of the practice field he/she was considered proximal and if outside the sidelines he/she was conserved distal.

Coach Characteristics. Coaches completed a brief coaching survey prior to each team's observational visit. Survey items included questions regarding past coaching experience, past coach training, and demographic information. Coaching experience was

defined as the number of seasons having coached youth soccer prior to the current season. This was reported on a scale of 0-5+ seasons and then collapsed into three categories including: 0, 3-4, and 5+ seasons. No coaches reported a response of 1-2 seasons therefore there is no category for 1-2 seasons. 5+ seasons indicates that the coach had previously coached 5 or more seasons of youth soccer prior to the current season. Coach training was defined by the number of reported training methods undertaken by the coach including in-person or online training provided by the YMCA or another organization; national certifications or programs; a college degree related to coaching; or informal training, such as reading coaching books. Coach training was categorized as follows: 1) little to no training; 2) moderately trained; and 3) highly trained. The category 'little to no training' was defined as a coach indicating no prior training or the undertaking of one type of prior informal training method. The category 'moderately trained' was defined as the coach indicating undertaking two types of prior training. Lastly, the category 'highly training' was defined as the coach indicating undertaking three or more types of prior training.

Procedures

Over the course of a single youth soccer season, researchers attended one practice per team (N=27) to measure selected coaching behaviors and intensity of children's physical activity using the OSRAC-YS. The coach of each participating team received a coach survey prior to their observation. At each practice the OSRAC:YS was administered using procedures previously employed by Cohen and colleagues (11). Researchers were positioned on the sideline of the soccer field with a clear view of the practice. A single head coach was identified and was observed for the entire practice.

Youth soccer participants were randomly assigned to 10-min observation blocks prior to the start of each practice. At the beginning of each practice, researchers identified the coach and the first single focal child to be observed continuously during a single 10-min observation period. Prerecorded audio cues to "observe" and "record" prompted researchers through the observation cycles. The OSRAC:YS codes were recorded on a tablet using MOOSES™ observational software. At the completion of the 10-min observation block, an automated alarm signaled the end of the session. The process was repeated with a new focal child until the end of practice. A 60-min practice equated to six 10-min observation intervals.

Observer Training and Reliability. Two researchers completed training and demonstrated reliability using the OSRAC:YS. Training included informal observations, memorizing codes, definitions, and protocol, debriefing sessions, and *in situ* observations, prior to data collection. To assess inter-rater reliability the primary researcher was accompanied by the second trained researcher for over 20% observation sessions (n=6) where the coach and focal child were concurrently observed. Percent agreement for each of the 5 OSRAC:YS categories were calculated for inter-rater reliability sessions using the following equation: [#agreements / (#agreements + #disagreements)] x 100. Cohen's kappa was calculated for all inter-rater reliability assessments. Percent agreements and kappa values for each session were averaged to provide overall mean percent agreement and kappa values. A percent agreement of >80% was determined for all observed categories, suggesting a strong agreement between observers.

Data Analyses

All statistical analyses were conducted using SAS (Version 9.4; SAS Institute, Cary, NC) and statistical significance was set at $p < .05$. To represent the measure of children's physical activity intensity levels, CARS scores were aggregated into four intensity levels including: sedentary (levels 1 and 2), light (LPA; level 3), moderate or vigorous (MVPA; levels 4 and 5), and light, moderate or vigorous (LMVPA; levels 3, 4, and 5) representing all levels of activity. Descriptive statistics were calculated to describe the number and percentage of intervals observed as sedentary, LPA, MVPA, and LMVPA across the OSRAC-YS categories of coach behavior and coach proximity were calculated. To represent the measure of team physical activity level, the mean CARS physical activity score for each team were calculated to reflect the overall activity level of children observed at each team practice.

Multilevel logistic regression analyses were conducted to examine the associations between coaching behaviors and intensity of children's physical activity during youth sport practices. Two separate logistic regression models using PROC GLIMMIX were conducted for physical activity intensity variables of MVPA and LMVPA. The physical activity intensity levels were dichotomized as MVPA and non-MVPA; and LMVPA and non-LMVPA for the analyses. Coach behavior and proximity factors were entered into the model as independent variables. Observation intervals were used as the unit of analysis. Intervals nested within children, and children nested within team were included as random effects. All models controlled for time of sport season. An interaction term was introduced to the multilevel logistic regression models to determine

if the associations between coach behaviors and intervals observed in children's physical activity intensities differ across girls-only, boys-only, and coed teams.

ANOVAs were used to examine the associations between coaching experience, coach training and children's physical activity levels grouped by team units. The dependent variable, physical activity, was analyzed using the mean CARS physical activity score of each team to reflect the overall activity level of children observed at each practice. The independent variables were coaching experience and coach training. Models were adjusted for time of sport season, coach age, sex, race/ethnicity and education level and team sex and age group composition.

Results

Characteristics of participating teams and children are summarized in Table 4.1. A total of 158 children (51% boys) across 27 teams were observed. Teams consisted of nine girls-only, nine boys-only and nine coed teams. Characteristics of coaches from the coach survey are presented in Table 4.2. Most coaches were male (81.5%), of white racial composition (93%), and the average coach age was 40 years. Over half of the coaches had coached five or more seasons prior to the present study.

The number of intervals observed across physical activity intensity categories by coach behavior and coach proximity factors are presented in Table 4.3. In total, children were observed for 3,102 coding intervals. The most frequently occurring coach behaviors observed were watching and providing verbal feedback (55%) and management and instruction (33%). The proportion of observed intervals in MVPA was greatest when the coach was watching without verbal feedback (56%) and the proportion of observed intervals in sedentary was the greatest when the coach was managing and providing

instruction (46%). Regarding coach proximity, the coach was almost always observed as being proximal (98%) as compared to the coach being distal in relation to the focal child being observed.

Multilevel logistic regression analyses were calculated to examine associations between coach behavior and coach proximity factors and MVPA and LMVPA. Results are presented in Tables 4.4 and 4.5. Children were significantly more likely to engage in MVPA when coaches were watching without verbal feedback (OR=3.2), watching with verbal feedback (OR=2.1), and providing management/instruction (OR=0.4) activities compared to when the coach was disengaged. Similarly, children had the highest odds (OR=2.1) of engaging in LMVPA when coaches were watching without verbal feedback in comparison to when the coach was disengaged. There were no significant differences in the odds of children performing MVPA or LMVPA between coach proximity factors.

Given the observed association between intervals observed in children's physical activity intensities and coach behavior factors, interaction terms were entered into the multilevel logistic regression models to determine whether the relationship varied across girls-only, boys-only, and coed teams. No significant interactions were found.

Results of ANOVAs to examine the associations between coaching experience, coach training and physical activity level of children grouped by team units are presented in Table 4.6. Significant differences in team physical activity levels were observed between both coaching experience ($p < .0001$) and coach training ($p < .0001$) variables. Teams with coaches having more experience had significantly greater physical activity levels compared to teams with coaches having less experience. Specifically, teams with coaches who had previously coached 3-4 and 5 or more seasons had greater physical

activity levels compared to teams with coaches who had no prior seasons coached. The findings for the associations between coach training and team physical activity level were counterintuitive. Teams with coaches having little to no training were more physically active compared to teams with coaches who had more training.

Discussion

An important feature of youth sport is its potential to provide participants with opportunities to engage in physical activity. Because coaches are considered to be key leaders in the youth sport setting, it essential to understand how coaching behaviors, experience, and training relate to physical activity levels of participating children. The key finding of present study was that coaching behaviors, including watching participants perform activities with or without feedback, were associated with higher physical activity intensities of children during their participation in youth sport practices, regardless of the sex composition of the teams. Additionally, coaching experience was identified as being positively related to children's physical activity at the team level. Collectively, these findings can be used to educate coaches on how to structure practices to optimize children's engagement in physical activity.

Very few previous studies have directly observed coaching behaviors and children's physical activity in the youth sport setting (11,13,20,21). The present study identified specific coaching behaviors that were positively associated with children's engagement in physical activity during practices. These behaviors included watching children perform activities with or without feedback and providing management and instruction. Cohen and colleagues examined physical activity levels of children across coaching behaviors in a sample of youth soccer participants using the OSRAC:YS and

accelerometry (11,21). They found a significant relationship between directly observed MVPA and coaching behaviors, and reported that higher levels of MVPA occurred during times when coaches were watching practice activities with or without verbal feedback, and lower levels of physical activity when coaches were demonstrating skills, providing instructions, or were disengaged (11,21). These findings align with those of the present study, in which children were observed to have higher engagement in physical activity when coaches were watching practice activities and lower engagement when coaches were observed providing management and instruction or were disengaged during practices. A study by Guagliano and colleagues used the System for Observing Fitness Instruction Time to record coach behaviors and practice contexts during youth sport programs in a sample of Australian youth (13). Their results indicated that coaches spent the largest portion of practice time in knowledge delivery, which is similar to the variable management and instruction in the present study. However, they did not conduct analyses to examine the associations of coaching behaviors and children's physical activity. Collectively, these findings identify coaching behaviors that frequently occur during practice time and can positively influence children's physical activity during youth sports. This information can be used by managers of youth sport programs to maximize physical activity opportunities for participating children. For instance, coaches should be encouraged to maximize the occurrence of watching participants perform practice activities with and without feedback during youth sport practices, since these behaviors were identified as being associated with greater engagement in physical activity.

A notable finding of the present study was that coaching experience was found to be significantly associated with children's observed physical activity levels at the team

level. Teams with coaches having greater experience, especially those with five or more prior seasons coached, had higher team physical activity levels compared to teams with coaches having less experience. To our knowledge, only two other studies have examined the influence of coaching experience on children's physical activity during their participation in youth sport (21,22). Cohen and colleagues examined the relationship between coaching experience, coach efficacy, and physical activity levels of children participating in girls and boys youth soccer teams (N=30) (21). Coach experience was reported and grouped by year(s) of coaching experience. No significant associations between coaching experience and children's moderate-to-vigorous physical activity were identified in their study. Another study by Schlechter and colleagues examined the relationship between coaching experience, coach training, and physical activity levels of children participating in boys flag football teams. Coach experience was reported from 14 team coaches and was dichotomously categorized as either having coached at least once prior to the current season or not. They also indicated no significant difference in time spent in moderate-to-vigorous physical activity between experienced and inexperienced coaches or between trained and untrained coaches. Although the aforementioned studies reported no significant associations between coaching experience and children's physical activity, the present study revealed that greater coaching experience was related to greater engagement of children's physical activity observed across teams. As there is a paucity of research surrounding this topic, future research should examine the effect of coaching experience in larger and more diverse samples of coaches and youth sport programs.

We also observed that coach training does not appear to positively influence children's engagement in physical activity at the team level. Specifically, teams with

coaches having little to no training were more physically active compared to teams with coaches who had more training. One potential explanation for this counterintuitive finding is that the promotion of physical activity may not be consistently incorporated into coach training programs. The content of training programs offered to youth sport coaches varies by organization but typically includes components on ethics and philosophy, concussion management, injury and safety prevention, physical conditioning, sport skills and tactics, and effective motivational techniques (23,24). Prominent youth sport organizations, such as the National Alliance of Youth Sport, have established coaching standards that are recommended to enhance participants' experiences in youth sport programs (25). In addition, The USA Hockey Association created the American Development Model which includes recommended principles to promote developmentally-appropriate participant development, health and safety, and sustained physical activity throughout the lifespan for youth sport participants (26). Although these standards and models exist, there is currently no single governing body in the American youth sport system to ensure that these standards are met by coaches and youth sport programs or are included in coach training programs, posing an issue. Even though the standards may not be imposed, it would be important for coach training programs to include education on the promotion physical activity and strategies to incorporate physical activity into practices. An example of this is illustrated in a study by Guagliano and colleagues employed a randomized controlled trial, aimed at determining the short-term efficacy of a coach training intervention on girls physical activity during a basketball program (16,20). The coach training in the intervention group focused on strategies coaches could implement to increase moderate-to-vigorous physical activity

during a girls basketball program (16,20). Their findings indicated that youth participants in the intervention group spent a significantly higher portion of practice time in moderate-to-vigorous physical activity compared to the control group (16). These findings demonstrate that coach training that includes strategies for physical activity promotion can be effective in influencing children's physical activity. Overall, more experimental studies are needed in larger and more diverse samples before firm conclusions can be drawn on the influence coach training background on children's physical activity levels.

There are limitations to consider when interpreting the results of the present study. Our study was conducted in three cities in one United States state and only one sport was observed. In addition, female coaches may be underrepresented in the study sample, though, in the youth sport setting male coaches are often more prevalent than female coaches (27). Lastly, only one practice per team was observed. However, this study had several strengths. Our sample was diverse and included girls, boys, and coed youth sport teams. The generalizability of our findings is improved by using the inclusion of all three types of teams as well as the use of random selection to select participating teams and children observed during practices. Another notable strength of the present study was the use of direct observation via the OSRAC:YS, allowing simultaneous recording of coaching behaviors and children's physical activity intensities during youth sport practices, which other physical activity measures such as self-report or wearable devices cannot.

In summary, the present study found that coaching behaviors and coaching experience were positively associated with children's physical activity intensities during

their participation in youth sport, regardless of the sex composition of team. Our findings suggest that coaches should watch participants perform activities with or without feedback during practices. Additionally, we observed that teams with more experienced coaches, but not necessarily more educated, had higher levels of physical activity. As such, sport program directors should place an emphasis on retaining experienced coaches. The findings from the present study can be used to inform education of coaches on how to structure practices to optimize children's engagement in physical activity. Future research should examine the influence of coaches on children's physical activity during youth sport by addressing these issues in larger samples and across a variety of sports.

Table 4.1. Characteristics of participating teams (N=27) and children (N=158).

	Total
Children, n	158
Sex, n, (%)	
Girls	77 (48.7%)
Boys	81 (51.3%)
Teams, n	27
Sex composition of team, n	
Coed	9
Girls-only	9
Boys-only	9
Age group composition of team (years), n	
6/7	11
8/9	8
10/11	8

Table 4.2. Characteristics of coaches (N=27).

	N	% or Mean (SD)
Demographic Characteristics		
Age (yr)	27	40.4 (8.1)
Sex		
Male	22	81.5%
Female	5	18.5%
Race/ethnicity		
White	25	92.6%
Black	1	3.7%
Other	1	3.7%
Educational level		
Some college or associates degree	5	18.5%
Graduated college	12	44.4%
≥ Master's degree	10	37.0%
Coaching Experience		
Seasons coached		3.4 (2.1)
0	7	25.9%
3-4	6	22.2%
5+	14	51.9%
Coach Training		
Little to no prior training	10	37.0%
Moderately trained	9	33.3%
Highly trained	8	29.6%

Table 4.3. Number of intervals observed across physical activity intensities stratified by coach behavior and proximity factors.

Observed Codes	Observed Intervals	Sedentary	LPA	MVPA	LMVPA
Total Observed Intervals	3,102	1024	971	1107	2078
Coach Behavior					
Watching with Verbal Feedback	1718	444	495	780	1274
Watching without Verbal Feedback	151	32	35	84	119
Demonstration	131	53	30	48	78
Management/Instruction	1022	468	385	169	554
Disengaged	80	27	27	26	53
Coach Proximity					
Proximal	3038	1002	951	1085	2036
Distal	64	22	20	22	42

LPA = light physical activity, MVPA = moderate or vigorous physical activity, LMVPA = light, moderate or vigorous physical activities.

Table 4.4. Logistic regression analyses indicating the odds of children engaging in moderate or vigorous physical activity by coaching factors during their participation in youth sport.

Observed Codes	OR	95% CI
Coach Behavior		
Watching with Verbal Feedback	2.14	1.27-3.59*
Watching without Verbal Feedback	3.15	1.70-5.83*
Demonstration	1.29	0.68-2.45
Management/Instruction	0.36	0.21-0.61*
Disengaged	Ref	
Coach Proximity		
Proximal	1.20	0.68-2.12
Distal	Ref	

*$p < .05$. Models adjusted for time of sport season. OR = odds ratio, CI = confidence interval. Ref = reference variable.

Table 4.5. Logistic regression analyses indicating the odds of children engaging in light, moderate or vigorous physical activities by coaching factors during their participation in youth sport.

Observed Codes	OR	95% CI
Coach Behavior		
Watching with Verbal Feedback	1.76	1.05-2.98*
Watching without Verbal Feedback	2.13	1.10-4.10*
Demonstration	0.76	0.40-1.44
Management/Instruction	0.55	0.32-0.92*
Disengaged	Ref	
Coach Proximity		
Proximal	1.23	0.68-2.20
Distal	Ref	

*$p < .05$. Models adjusted for time of sport season. OR = odds ratio, CI = confidence interval. Ref = reference variable.

Table 4.6. Results of ANOVA examining associations between coaching experience, coach training, and team physical activity level.

	Team physical activity (Mean CARS score*)	
	Least Squares Means (Standard Error)	p-value
Coaching Experience		<.0001[a, b, c]
0, no prior seasons coached	2.79 (0.02)	
3-4 seasons coached	2.96 (0.02)	
5+ seasons coached	3.04 (0.01)	
Coach Training		<.0001[d, e, f]
Little to no prior training	3.12 (0.02)	
Moderately trained	2.99 (0.02)	
Highly trained	3.04 (0.02)	

[a] 0, no prior seasons coached and 3-4 seasons coached differ.
[b] 0, no prior seasons coached and 5+ seasons coached differ.
[c] 3-4 seasons coached and 5+ seasons coached differ.
[d] Little to no prior training and moderately trained differ.
[e] Little to no prior training and highly trained differ.
[f] Moderately trained and highly trained differ.
*CARS score range is from 1-5.
Models adjusted for time of sport season, coach age, sex, race/ethnicity and education level, and team sex and age composition.

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CHAPTER 5

OVERALL DISCUSSION

Significance

The health effects of physical activity are well-documented among adults and youth (1,2). In children and youth, physical activity is associated with important health benefits including improvements in cardiorespiratory and muscular fitness, cardiometabolic health, bone health, weight status, cognitive function and reduced risk of depression (2,3). Despite this evidence, data suggests that the majority of children and youth are not meeting the recommended physical activity guidelines (2,4) and effective strategies for increasing children's physical activity are greatly needed. In the United States, an estimated 44 million children and adolescents participate in youth sport programs. Thus, youth sport represents a far-reaching institution with the ability to provide physical activity to a large population of youth (5). As such, major health organizations have looked to youth sport participation as a strategy for promoting physical activity in children and youth (6–8).

Existing research has reported that youth sport participants tend to be more physically active, expend more energy, and spend more time in moderate-to-vigorous physical activity than their non-sport participant peers (9–13). However, very few studies have objectively measured participants' physical activity levels during youth sport in the United States. Additionally, there is a lack of research examining relationships between characteristics of youth sport and physical activity levels of children during their participation in youth sport. This includes a paucity of research investigating the influence of coaching characteristics and behaviors on children's physical activity levels during youth sport. This is important to consider as youth sport coaches are known to

play a fundamental role in influencing children's development and overall experience during their participation in youth sport (14–17).

Currently, there are major gaps in the literature regarding the influence of youth sport participation on physical activity behaviors in children and youth. It is clear that youth sport provides an opportunity for children to engage in physical activity, however, very little research has examined characteristics of the youth sport setting and how those characteristics relate to children's physical activity. In order to develop effective methods to increase physical activity during sport programs, it is necessary to identify factors that associate with children's physical activity in the youth sport setting. Thus, this dissertation is significant because it addressed gaps in the literature and provides important information that advances our understanding of the influence of youth sport participation on children's physical activity behaviors.

Purpose

The overall purpose of this dissertation was to advance knowledge and understanding of the relationship between youth sport participation and children's physical activity. The dissertation is comprised of three studies. The purpose of the first study was to describe the association between sport participation and objectively measured physical activity in a sample of middle school youth. The second study described the association between practice and social contextual factors and physical activity levels of children during their participation in a youth sport program. Finally, the third study described how coaching behaviors, coaching experience, and coach training

relate to children's physical activity levels during their participation in a youth sport program.

Design and Methods

Cross-sectional study designs were employed in all three studies included in this dissertation. The first study used data from the Evaluation of Activity Surveys in Youth (EASY) study, which developed a valid and reliable physical activity self-report instrument for youth. The outcome variable of interest was physical activity, which included sedentary, light, moderate-to-vigorous, vigorous, and total physical activity intensity levels. Physical activity was measured via accelerometry and characteristics of sport participation were gathered via self-reported survey instrument. To examine differences in physical activity levels between sport participants and non-participants ANOVA were conducted. Multiple linear regression analyses were used to investigate the association between physical activity and frequency of sport participation.

In the second and third studies, youth soccer teams were recruited from local YMCA programs in three southeastern cities. Children's physical activity intensity and practice and social contextual factors were assessed using a direct observational system during team practices. Coaching characteristics were obtained from a coach survey completed by coaches. The outcome variable of interest in both studies was children's physical activity intensity. In the second study, logistic regression analyses were employed to examine associations between practice and social contexts and physical activity intensity observed during youth sport practices. In the third study, logistic regression analyses were employed to examine associations between coach behaviors and

children's physical activity intensity as observed during youth sport practices. Additionally, ANOVAs were conducted to describe associations between coaching experience, coach training and children's physical activity at the team level. In both studies, an interaction term was introduced into the logistic regression models to determine if the associations differed across girls-only, boys-only and coed teams.

Major Findings

Overall, the findings of this dissertation support existence of a positive relationship between youth sport participation and physical activity in children and youth. This dissertation highlighted specific characteristics of youth sport that are related to children's physical activity such as the frequency of participation, type of sport, and coaching characteristics, as well as practice contexts and coaching behaviors that occur during practices. In the first study, results indicated that children who participated in sport were more physically active and less sedentary than their non-participant peers. Sport type-specific analysis revealed that children who reported participating in organized non-school sport and non-organized sport had higher levels of physical activity compared to non-participants. Additionally, children's physical activity level was positively associated with frequency of sport participation.

The second study observed significant positive associations between children's physical activity intensity and practice contexts during youth sport practices. For example, children were more likely to engage in higher intensity levels of physical activity while performing fitness and full team game activities. The social contexts observed, such as children performing an activity alone, 1v1, in a group, or as a full team,

were not significantly associated with children's physical activity. This could be attributed to the lack of variability of social context intervals observed as most were of the full-team. Additionally, the sex-composition of the team did not influence the relationships identified.

In the third study, significant positive associations between children's physical activity intensity and coaching behaviors were observed during youth sport practices. Specifically, children were most likely to engage in moderate or vigorous physical activity when coaches were watching them perform without verbal feedback or watching with verbal feedback during practices. Consistent with findings from the second study, the sex-composition of the team did not influence the relationships identified. Additionally, prior coaching experience was found to be positively related to children's physical activity levels. However, the findings regarding the associations between coach training and team physical activity level were counterintuitive and coach training did not appear to positively influence children's engagement in physical activity at the team level.

Together, the results of this dissertation provide a deeper understanding of the youth sport factors that influence children's physical activity levels. The outcomes of this dissertation support existence of a positive relationship between sport participation and physical activity in children and youth and highlight specific factors of youth sport that are related children's physical activity levels. These findings point toward ways in which sport can be promoted and to strategies to optimize time spent in physical activity during practices.

Limitations

There are several limitations of this dissertation that should be acknowledged. First, these studies were conducted in one geographic area in the Southern United States, which may limit the generalizability of the results. Next, self-reported measures were used to gather information on youth sport participation in study one, and on coaching characteristics in study two and study three, all with the potential of recall bias. In studies two and three, the observation of only one sport is a limitation, as other sports may have very different outcomes. Additionally, teams were observed for only one practice over the course of the season. This may be problematic as coaches and children participating may exhibit different behaviors at different points of the season. The time of season in which the team was observed was accounted for in the analyses to try to remedy this potential limitation.

Practical Implications

The findings of this dissertation have practical implications for efforts towards improving physical activity levels in children and youth through youth sport. On a larger scale, public health efforts to promote physical activity and reduce sedentary behavior should include an emphasis on sport participation. More specifically, increased frequency of participation and offering opportunities for children to participate in organized non-school and non-organized sport programs should be supported. Youth sport organizations can use the findings from this dissertation to educate coaches on how to structure practices to optimize children's engagement in physical activity. For example, incorporating more fitness and game activities into youth sport practices could benefit

children by increasing their time spent in higher intensity physical activity. Similarly, coaches should be encouraged to exhibit specific behaviors during practices such as, actively watching as children engage in practice activities, that are associated with children's engagement in higher intensity physical activity. Lastly, youth sport programs should prioritize recruiting and retaining experienced coaches and providing coaches with training and opportunities to gain more experience in the youth sport setting.

Based on the results from all three studies, specific characteristics of youth sport programs and coaching characteristics can enhance children's physical activity. It is clear that children are more active when they are involved in sport, especially when children participate in sport frequently, participate in certain types of sport, and are coached by experienced coaches. As children participate in sport, certain features of youth sport programs can enhance children's physical activity levels. Based on the findings from this dissertation, practices should be structured to emphasize fitness and game activities, and coaches should be encouraged to watch children as they perform these practice activities. Collectively, the implications of these findings are important and highlight potential strategies to promote and optimize physical activity levels of youth sport participants.

Considerations for Future Studies

The findings of this dissertation provide evidence supporting a positive influence of youth sport participation on children's physical activity behaviors. This dissertation addressed gaps in the existing literature on this topic, but more research is warranted in larger and more diverse samples to better understand the relationship between factors of the youth sport setting and physical activity in youth. Specifically, future research should

aim to 1) examine the influence of children's participation across different types of sport in larger and more diverse samples; 2) employ experimental study designs to examine the effects of increasing sport participation opportunities across different types of sport, in relation to physical activity levels among children; 3) to employ experimental study designs in testing the effects of practice and social contexts on children's physical activity levels during their participation in youth sport practices; and 4) to observe longitudinal trends to better understand the relationship between children's physical activity and youth sport participation, as physical activity is known to decline (18) and children tend to drop out of sport programs as they transition from childhood to adolescence (19). Additionally, given the mixed findings regarding the influence of coach training, more research is needed to examine current training opportunities and see if these training programs can be modified to include education on promoting physical activity during youth sport.

Conclusions

In summary, the findings of this dissertation addressed several gaps in the literature and expanded the understanding of the relationship between youth sport participation and children's physical activity. Specific characteristics of youth sport that are related to children's physical activity were identified, including the frequency of participation, type of sport, and coaching characteristics, as well as practice contexts and coaching behaviors that occur during practices. These findings can be used to develop evidence-based strategies in which sport can be promoted as well as approaches to optimize time children spend in health-enhancing levels of physical activity. This dissertation offers a strong foundation for future research to build upon and more

research is needed to replicate these outcomes in larger samples and across a variety of sports, to further expand the body of knowledge on the relationship between youth sport and children's physical activity. Together, the results of this dissertation highlight the important role youth sport can play in influencing children's physical activity.

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CHAPTER 6

PROPOSAL

Introduction

Physical activity is defined as any bodily movement that requires energy expenditure (1) and it is well established that physical activity provides an array of health benefits for all ages. Specifically for children and adolescents, physical activity has been associated with improved bone health, weight status, cardiorespiratory and muscular fitness, cardiometabolic health, cognition and reduced risk of depression (2). In 2018, the United States Department of Health and Human Services (USDHHS) released the newest edition of the *Physical Activity Guidelines for Americans*, recommending that children and adolescents (ages 6 through 17 years) participate in 60 minutes or more of moderate-to-vigorous physical activity daily, accompanied by muscle and bone strengthening exercises (2). Despite the overwhelming evidence of health benefits and significant public health efforts to increase physical activity levels, data suggests that majority of children and adolescents are inactive (2,3). Compounding this problem, research shows that rates of compliance with physical activity recommendations decrease markedly during the transition from childhood to adolescence (4–6), indicating an important age range to intervene upon.

The USDHHS and the World Health Organization have pointed to sport participation as an important strategy for promoting physical activity in youth (7–9). Alongside an array of psychological and social developmental health benefits (10), sport has been found to contribute a significant proportion of total physical activity in youth (11,12). Although sport is promoted as a way to increase physical activity, very few studies have objectively measured physical activity levels during youth sport in the United States. Limited research has sought to identify relationships between different

characteristics of youth sport participation and physical activity levels during youth sport. Additionally, coaches can play an influential role in children's health outcomes as they associate with sport participation (13), and the relationship between coaching behaviors and objectively measured physical activity during youth sport remains relatively unexplored. In order to create effective strategies and policies to increase physical activity levels during youth sport, it is imperative to understand the factors that influence physical activity in the sport setting.

Statement of Problem

Despite the large number of children and adolescents involved in sport worldwide, it is unclear how much physical activity is achieved during youth sport. Even less is known about how characteristics of youth sport relate to youth's physical activity levels. This dissertation aims to advance knowledge and understanding of the relationship between physical activity and youth sport participation. Specifically, the proposed studies will aim to describe how sport participation and various characteristics of sport are associated with objectively measured physical activity in youth. The specific aims and objectives to address this overarching goal are outlined below.

Aim 1. To describe the cross-sectional association between objectively measured physical activity and sport participation among a sample of middle school youth.

> **Objective A**: To determine whether physical activity differs between youth who reported sport participation and non-participants.
>
> **Objective B**: To determine whether physical activity is associated with reported frequency of sport participation.

Objective C: To determine whether physical activity differs between youth who reported school sport participation and vs. non-school school sport participation.

Aim 2. To identify contextual factors that influence children's physical activity levels during their participation in youth sport programs.

Objective A: To describe selected contextual factors of youth sport programs.

Objective B: To describe the associations between selected contextual factors and children's physical activity levels during their participation in youth sport programs.

Objective C: To determine if the associations between selected contextual factors and children's physical activity levels differ by girls-only, boys-only, and co-ed teams.

Aim 3. To examine how coaching behaviors and coach experience relate to children's physical activity levels during their participation in youth sport programs.

Objective A: To describe selected coaching behaviors and children's physical activity levels during youth sport programs.

Objective B: To describe the associations between coaching behaviors, coach experience, and children's physical activity levels during their participation in youth sport programs.

Objective C: To determine if the associations between coaching behaviors, coach experience, and children's physical activity levels during their participation in youth sport programs differ between girls-only, boys-only and co-ed teams.

Significance of Proposed Study

Addressing the identified dissertation objectives will provide important information to better understand the complex relationships between sport participation and physical activity in youth. Worldwide, millions of children and adolescents participate in youth sport, thus promoting sport as a way to increase physical activity has the potential to reach a large population of youth. Results from the proposed dissertation could be communicated to the local youth sport programs and coaches to aid in structuring practices and programs for optimal physical activity levels of youth participants. Ultimately, results can be used to influence sport programs and policies hoping to increase participation and ensure high quality experiences for youth.

Literature Review

Overview

Physical activity has been found to be consistently associated with weight status and other health outcomes in youth, and it is recommended that children and adolescents accumulate at least 60 minutes of daily moderate-to-vigorous physical activity (3). Unfortunately, evidence suggests that the majority of adolescents are failing to meeting current physical activity guidelines (7). Participation in sport has been recommended as an approach for promoting physical activity in youth (7,14). Although it is assumed that children and adolescents who participate in youth sports are active, few studies have measured this objectively. Further, little is known about contextual factors of youth sport, including coaching behaviors, and their associations with activity levels of youth sport participants. The overarching purpose of this literature review is to describe the

relationship between sport participation and physical activity in youth. This review addresses different aspects of youth sport participation including how youth sport is defined and categorized, trends in participation, and factors that influence sport participation. Next, the current literature regrading physical activity and youth sport, including how activity has been measured in the youth sport setting, is examined. The review ends with a summary of the existing knowledge regarding the relationship between physical activity and youth sport participation, and limitations within the current body of literature.

Youth Sport Participation in the United States

Definition and Trends

In American culture, the term 'youth sport' has been defined as programs which *"provide a systematic sequence of practices and contests for children and youth"* (15). Youth sport programs differ considerably by features of length of season, competition level, costs, skill of participants and qualifications of coaches. Because of this, various sport programs are often divided into categories of common features. These include but not limited to; interscholastic, intramural, club/travel, and recreational sport programs (15).

Intramural and interscholastic sports are school-sponsored programs, conducted within the school setting. Interscholastic sports have been defined as programs which involve competition in a range of sports between opposing schools and are typically skill-based and competitive (16). Intramural sport programs are characteristically voluntary in nature, provide equal opportunity to participate (regardless of skill level), and are self-contained within the school setting (16,17). In comparison, other sport programs are

offered through community and non-school organizations such as local sponsoring agencies, parks and recreation departments, and sport-specific organizations at the national, state, or local level. These programs vary greatly by the sponsoring body, participant skill and competition level (i.e. club/travel programs vs. recreational programs), and resources and costs required (15,16). Due to the wide-ranging differences in features and characteristics of youth sport programs, participation rates tend to vary over time and by demographic groups.

A survey conducted by the Sports and Fitness Industry Association reported approximately 70% of children, ages 6-12 years old, participated in a sport at least one day of the year in 2018 (18). Although this equates of millions of participants each year in the United States, data suggests that youth participating in sport on a regular basis has declined 7% in the past decade (18). Furthermore, recent data from a National Youth Sport Survey, of over 1,000 parents, reported the average length that a child participates in sport was approximately 3 years, and most children quit regularly playing a sport by the age of 11 years old (19). This observed trend reported for youth sport participation seems to mirror the decline in physical activity levels reported for children transitioning into adolescents (4,6,20). These reports signify an important age-range of youth to examine further and potentially intervene upon to help keep engaged in sport.

Factors Influencing Youth Sport Participation

In order to explore the relationship between sport participation and physical activity among youth, it is first important to understand the youth sport landscape and factors that influence participation. It is well established that individual-level factors, such as demographic characteristics; social factors, such as coaching behaviors; and

organizational factors, such as structure of practices and games, all play a role in youth sport participation.

Individual-level factors. Reported differences in participation rates by sex, race/ethnicity and socioeconomic status exist among children and youth in the United States. Similar to differences in physical activity levels by sex, it has been reported that females have lower levels of youth sport participation rates compared to their male counterparts (18,21). Additionally, female youth sport participants have been reported to start an average of half a year later (22) and tend to not involved in multiple sports compared to male participants. (23,24).

Disparities by race and ethnicity among youth sport participants have also been reported. Data from 2017 indicated that the highest percentage of youth sport participants were predominantly non-Hispanic white and the lowest percentage were non-Hispanic black, for both male and female participants (21). Similarly, additional reports indicated the highest percentage of female youth sport participants were predominantly white from suburban neighborhoods (25,26).

Socioeconomic status is another factor in which differences in sport participation have been reported. Surveillance data has indicated that children from lower socioeconomic status homes are facing participation barriers (18,21). Results from the 2019 State of Play reported that in 2018, less than a quarter of children and adolescents (ages 6-12 years old) living in households with an income under $25,00 played sports on a regular basis, compared to almost half of children from homes earing above $100,000 (18). This is not surprising given that families, on average, have been reported to spend

almost $700 per child for one sport each year (18). Additionally, less than half of youth from households with parent education less than a high school degree reported participating in a sport team or lesson, compared to youth from households with parent education being a college degree or higher (21).

In summary, youth sport participation has been found to be lower among females, racial and ethnic minorities and youth from lower income households. These reports are consistent with research regarding physical activity among youth. It would be important to examine the relationship between these individual-level factors as they relate to physical activity levels among youth sport participants. This could help guide resources and promotion efforts of sport to certain demographic groups to increase engagement among youth.

Coaching Behavior. The quality of the ones' youth sporting experience is largely influenced by their coach (27). Beyond their supervisory duties, youth sport coaches can play a fundamental role in developing participants' skills, performance, and ultimately influencing health outcomes of youth through sport (13). Thus, the development of coaching proficiencies through appropriate training and certifications are critical to be effective in the youth sport setting. Coaching effectiveness is a recognized term in the sporting field that comprises of components including coaches knowledge, participants' assets and outcomes, and coaching contexts (28) and has been defined as *"The consistent application of integrated professional, interpersonal and intrapersonal knowledge to improve athletes' competence, confidence, connection and character in specific coaching contexts."*(29). It has been reported that coach effectiveness training has demonstrated positive outcomes to participant's perceived confidence and attrition rates (13,30).

Accordingly, coaches across the youth sport settings are encouraged to develop a foundation for coaching effectiveness to influence their youth participants.

Unfortunately, less than 20% of youth sport coaches have been trained in the past three years (18). This includes training in CRP, basic first aid, concussion management, injury and safety prevention, physical condition, sport skills and tactics, and effective motivational techniques. Furthermore, in 2018, it was estimated that four out of ten coaches had never been trained in the above mentioned areas (18). Coaches with inadequate training and experience in the aforementioned areas pose a risk to the participants and ultimately can affect the level of perceived physical benefits of their youth sport experience (31).

To further understand the impact of coaches in the youth sport setting, it would be important to examine coaching experience, training and behavior, as they relate to participants' activity levels, as this topic has been relatively unexplored.

Practice and Game Structure. It is recommended that youth sport programs are designed and governed according to age-appropriate standards and missions to benefit the children participating. The term *sport readiness* implies that the development (physical, cognitive, and psychological) of a child should matches the demands of the sport (32,33). Thus, it is recommended by health professionals that practices and games are developmentally appropriate to ensure the most positive experience for youth sport participants (33). Simple adjustments can be used to do so, such as shorter games, smaller equipment, and frequent changing of positions to help match the participants' development levels (32,33). Furthermore, the National Alliance for Youth Sports has

developed national standards, including guidelines for the focus of skill enhancement, practice and game structure, scoring, coaching and competition level (34). For children, ages 9 and 10 years old, it is recommended that practice and games are limited to a maximum of one hour per day, three times a week; for adolescents, ages 11 and older, it is recommended that the practice and games are limited to a maximum of 1.5 hours per day, three times a week (34). Further, for both of these age groups, it is encouraged that scoring is not emphasized (34). Additionally, many developmental models have been created that provide recommendations for healthy development of, and positive experiences for, youth sport participants including: the American Development Model (35), The Long-Term Athlete Development model (36) and the Sports-Based Youth Development Movement (37).

Coaches and organizations are encouraged to use these models and guidelines to develop their programs and structure practices. Doing so may provide beneficial opportunities for the youth participants, including opportunities for participants to be physically active. Very little research exists examining the differences between practice and game structure and how these sport programming factors may influence physical activity during youth sport (38). It would be valuable to conduct research to examine differences in physical activity during practice and games in youth, as sport structure can play a role in influencing youth' sport experience and ultimately healthy development.

Summary. It is clear that many factors may influence youth sport participation including participant demographic characteristics, coaching behaviors, and organizational structure of practices and games. Youth sport participation has been reported to be lower among females, racial and ethnic minorities and youth from lower income households. As

disparities in participation by sex, race/ethnicity, socioeconomic status have been noted, it would be important for research studies to identify these factors and include them in the analyses. Coaches are known to play an influential role in their youth participants' sport experience. However, examination of the associations between coaching experience, training and behavior, and participants' activity levels have been relatively unexplored. Lastly, the organizational structure of youth sport programs can impact youth's participation, including opportunities for participants to be physically active. A recent review by Pfeiffer and colleagues (2019) noted how little research has examined the differences between sporting structures (i.e. practices and games) and how these factors may influence physical activity during youth sport (38). In summary, little known about how the aforementioned factors associate with physical activity levels of youth. This is an important topic to explore, as the information can be used to improve sport programs and policies that provide youth the opportunity to be more physically active.

Measuring Physical Activity of Youth Sport Participants

It is essential to use valid, reliable and practical methods to measure physical activity. Numerous methodological approaches have been used to quantify physical activity in children and adolescents, each displaying its own strengths and limitations (39). Typically, these methodologies are categorized into two groups: subjective and objective measurements. Widely used subjective measures of physical activity in children and youth include self-report, proxy report, diaries and interviews (40). Self-report measures, such as surveys, have advantages of being non-invasive and are typically easier to administer to large groups; and when children are too young to be able to recall their activities, a parent proxy report typically is used for a more accurate account of details.

Subjective measures of physical activity provide important information, however, because they rely on one's recollection, they generally display lower validity compared to objective measures of physical activity.

Objective Measures

To address limitations of recall biases, objective measures are often sought out when designing studies to assess physical activity in children and adolescents. Direct observation and monitoring devices (e.g. heart rate monitors, pedometers, accelerometers and doubly labeled water) are well-known examples of objective measures (39,40).

Accelerometry. Accelerometers are electromechanical devices that capture activity "counts" which ultimately reflect movement intensity. It is well documented that accelerometers produce reliable indicators of physical activity in children and adolescents and have been validated versus direct and indirect measures of energy expenditure (41,42). Additionally, calibration procedures can identify physical activity intensity zones (e.g. moderate-to-vigorous physical activity), a great strength of this measurement. Due to the advantages mentioned, accelerometry has become a commonly used tool in researching children and physical activity. Surprisingly, very few studies have utilized accelerometry and other objective measures of physical activity specifically in the youth sport setting (Sprengeler et al., 2019).

As with any measurement tool, accelerometry has limitations including cost and the inability to measure certain activities such as cycling and swimming. An additional imitation is that accelerometers are not able to assess the context of the physical activity occurring. When examining physical activity of youth during sport, the ability to identify

and capture information on contextual factors of physical activity is essential to better understand all aspects of the youth sport setting and participants' experiences.

Direct Observation. Direct observation is considered an effective and appropriate method for assessing children's physical activity behaviors (39). Unlike some methods previously described, direct observation does not rely on the recall of information, nor does it require external and typically expensive measurement devices. Direct observation has many strengths including the ability for simultaneous assessment of social and physical environmental contexts in which physical activity occurs. The identification of relevant contextual characteristics could aid in a deeper understanding of both individual and environmental level differences in physical activity among children and adolescents. In the past few decades, multiple observational systems have been created to do so, with potential to be used in settings such as youth sport.

One of the first observational systems, developed by McKenzie and colleagues, was the System for Observing Fitness Instruction Time (SOFIT) (43). SOFIT offers information on physical activity levels and different characteristics of children's activity levels within the physical education setting. Following this development, McKenzie and colleagues expanded the utilization of observation towards settings other than the school, resulting in the creation of the System for Observing Play and Leisure Activity in Youth (SOPLAY) (44) and the System for Observing Play and Recreation in Communities (SOPARC) (45). Similarly, the Observation System for Recording Activity in Children (OSRAC) variations (46–48) were also developed, which ultimately led to the development of the Observation System for Recording Activity in Children: Youth Sports (OSRAC:YS) (47). All direct observation instruments mentioned are based on

momentary time sampling techniques and systematic observations and have demonstrated as reliable and valid systems for measuring children's physical activity levels and contextual factors of activity. However, OSRAC:YS is the only system that has been validated for measuring physical activity and contextual factors of physical activity during youth sports practices specifically (47).

Summary. Various methodological approaches have been used to quantify physical activity among youth, but very few studies have employed objective measures of physical activity in the youth sport setting. Accelerometry and direct observation are two valid and reliable ways to measure physical activity in this setting. Several direct observation systems have been used to examine physical activity behaviors of youth, but only one system, OSRAC:YS, has been developed specifically for the youth sport setting (47). By applying this direct observational system in the youth sport setting, we can gather data about participants' physical activity levels as well as contextual factors including practice context, social context, and even coaching behaviors. Very few studies have examined these factors, that are specific to the youth sport setting, using an objective measure of physical activity. This information would be valuable in understanding the effect on youths' physical activity levels during youth sport.

Physical Activity and Sport Participation – Cross-sectional Associations

There is a notable reliance on cross-sectional studies when examining the existing literature on the associations between sport participation and physical activity in adolescents. Multiple studies have utilized the cross-sectional design in order to use large-scale surveys (NHANES, YRBS, etc.), allowing examination of larger and more

diverse samples. These studies provide important evidence of the relationship between sports participation and physical activity levels in youth.

Contribution to Daily Physical Activity and Moderate-to-Vigorous Physical Activity

The existing literature indicates that sport provides an opportunity of daily physical activity for children and adolescents. When examining total daily physical activity and sport participation, two studies found that youth sport contributed a substantial amount of daily physical activity (20% - 60%) in the children examined (11,12). Katzmarzyk and Malina (1998) determined that male and female adolescents expended approximately 20% of their daily energy expenditure during sport (Katzmarzyk & Malina, 1998). However, the study was limited, using a self-report assessment tool of activity. Wickel and Eisenmann (2007) aimed to remedy the past methodological issue by use of an objective measure of physical activity, by accelerometer. Results indicated that youth sport contributed nearly 60% of the daily moderate-to-vigorous physical activity among 12-14-yr-olds, markedly higher than the 23% observed in the study conducted by Wickel and Eisenmann (2007). Discrepancies between subjective and objective measures of physical activity among the youth population (<19 years old) are not uncommon (49), with objective measures typically resulting in underestimates of physical activity compared to subjective measures. Despite the variation in amounts reported, both studies reported similar conclusions, that youth sport can provide a significant amount of daily physical activity for youth and adolescents.

It is generally assumed that participation in sport aids youth in meeting the recommended guidelines (i.e., 60 minutes of daily moderate-to-vigorous physical

activity). However, the literature-based evidence is scarce. A recent review by Pfeiffer and colleagues, noted that the amount of total daily moderate-to-vigorous physical activity achieved during youth sport has been reported to range from 20-45 minutes per day (11,12,38,50–52). Additionally, multiple studies have reported that youth who participate sport are significantly more likely to meet the physical activity guidelines. Using self-reported surveys, Vella and colleagues reported that higher rates of sports participation were associated with an increased likelihood of meeting the national physical activity guidelines (OR=2.07), among a nationally representative sample of Australian children (n=12,188), ages 12-17 years-old (53). A more recent study by Sprengler and colleagues, used accelerometry to measure physical activity levels in a sample of 6-17 year-old German children. Results indicated that more frequent participation (i.e. at least 2 days per week) in youth sport, significantly increased the chance to meeting the physical activity guidelines (OR=3.83) during a typical school week (54). Also using accelerometry, Marques and colleagues examined physical activity levels of 10-18 year-old Portuguese children (N=973) and found that those who were engaged in organized sports were more likely to achieve physical activity guidelines (OR=1.64) compared to their non-participant peers (55).

Overall, the findings from the existing literature support the conclusion that participation in youth sport can provide a substantial amount of daily physical activity and contribute to meeting recommended amounts of moderate-to-vigorous physical activity for children and adolescents. Frequency of participation in youth sport has also been found to impact physical activity levels, with more frequent participation reported to increase the chance of youth meeting the recommended physical activity guideline (54).

It is important to note that these studies vary methodologies used to measure physical activity, as well as sample characteristics. These differences in methodologies could be contributing to the variations in physical activity levels reported in the literature (38) and further research is necessary to compare results and better understand the role youth sport can play in providing physical activity for youth.

Comparison to Non-Sport Participants

Additional findings have supported a positive relationship between sport participation and achieving greater levels of physical activity among youth when compared to their non-participant peers. Research has indicated that youth sport participants were more likely to be physically active (56–58), have higher quintiles of physical activity (59) and have higher levels of moderate-to-vigorous physical activity (60) than their non-participant peers. These findings were consistent across both sexes, when studied in samples including of adolescent females (57,58), and both male and female youth in high-school (60). These studies utilized self-reported surveys and explored samples ranging in size, from approximately 400 to 50,000 participants.

Engagement in youth sport has been found to be related to high levels of objectively measured moderate physical activity and vigorous physical activity. The aforementioned study, by Marques and colleagues, found that those children who were engaged in organized sports were more likely to spend more time in moderate physical activity (OR=1.01), vigorous physical activity (OR=1.09) and moderate-to-vigorous physical activity (OR=1.01) than non-participants (55). These results align with other studies in supporting the conclusion that children who participated in organized sport

spend significantly more time in various physical activity levels (moderate physical activity, vigorous physical activity and moderate-to-vigorous physical activity) compared to non-sport participants (12,55,61).

In large, the cross-sectional literature has supported the conclusion that youth sport participants are more physically active and display higher intensity levels of physical activity compared to youth who do not participate in sport, by way of both subjective and objective measures of physical activity. Although the existing literature has consistently reported these conclusions, it would be important to conduct further examination of the differences in objectively measured physical activity between sport participants and non-participants in a sample of United States youth, as this data is limited.

Differences by Sex and Socioeconomic Status

It is assumed that, like trends observed with physical activity levels, indicating males attaining greater levels of physical activity compared to females, sport participation would vary by sex among youth. Multiple studies examined the amount of moderate-to-vigorous physical activity attained during youth sport, measured by accelerometry, but found no significant differences by sex (51,52,62). Although drop-out rates of youth sport has been found to be greater in females than males (26,63), research has generally found that males and females achieve similar levels of physical activity during youth sport (38).

Few studies have examined the role of socioeconomic status in the relationship between sport participation and physical activity levels in youth. This is important, as low socioeconomic status youth may be disadvantaged in their ability to participate in

organized sports due to financial and other barriers (63), resulting in lost opportunity to engage in physical activity. A study by Walter and colleagues, examined cross-sectional associations between socioeconomic status, gender, sport participation and moderate-to-vigorous physical activity in a sample of 1,709 adolescents (60). The authors found that organized sport participation during high school was positively associated with socioeconomic status for both sexes, after adjusting for race. They also found that organized sport participation and weekly hours of moderate-to-vigorous physical activity to be positively associated with socioeconomic status for both sexes. It is important to note that physical activity levels and sport participation was assessed by self-reported survey.

Overall, there has been little research focused on examining differences between sex and socioeconomic status in relation to sport participation and physical activity levels. Even fewer studies have done so using objective measures of physical activity.

Summary. In summary, participation in youth sport has been reported as a significant contributor to total daily physical activity and provide an opportunity for moderate-to-vigorous physical activity among youth. Additionally, evidence indicates that youth who participant in sport are generally more physically active than their peers who do not partake in sport. The cross-sectional literature provides important information regarding the relationship between youth sport and physical activity, however, very few studies examine youth sport participants in a sample of United States adolescents, using objective measures of physical activity. Furthermore, relationships between other factors that may affect physical activity during youth sport should be explored, including sex and

socioeconomic status among youth sport participants, as there has not been a substantial amount of evidence to draw conclusions.

Physical Activity and Sport Participation – Longitudinal Findings

Longitudinally designed studies examining the association between sport participation and physical activity as youth transition from childhood to adolescents are limited. This volume of literature consists of prospective and cohort studies, grouping by demographic characteristics. Majority of the studies consistently reported that sport participation at a younger age predicts participation at older ages and is highly associated with physical activity levels in those older ages. However, sport participation does not seem to protect against overall declines in physical activity over time.

Very few studies have used objective measures of physical activity to examine the longitudinal associations between sport participation and physical activity from childhood to adolescence (64–66). When examining a sample of UK children (n=609), Basterfield and colleagues found that sports club participation at age 9 was highly predictive of sport club participation at age 12 and sport club participation at age 9 was significantly associated with overall physical activity at age 12, using accelerometry to measure physical activity (64). A study by Telford and colleagues, examined a sample of Australian youth (ages 8-16 years old), and used both accelerometers and pedometers as measures of physical activity. They found similar results, in which sport participants were significantly more physically active at all time points than their non-participant peers (66). However, even though sport participants were found to be more active than their non-participant peers, results indicated that the physical activity levels and sport participation diminished during adolescences (66).

Similarly, studies using subjective measures of physical activity also indicate that sport participation does not protect against the declines in physical activity over time in children and adolescents. Using a 7-day physical activity recall measure, a study examining Canadian children (n=1028) over a five year period, found that participation in organized physical activity, including sports, during early adolescence was associated with more physical activity throughout secondary school (67). However, the results suggested that participation in such activities did not protect against declines in physical activity over time, as physical activity declined by 8% per year in both participant and non-participant groups of organized physical activity (67). Although the measures included sports, it is important to note that this study was examining organized physical activity, not sport specifically. Consistent with previous findings, Dovey and colleagues, found significant changes between the ages of 15 and 18 years old, with a reduction in the amount of time spent in physical activity and the number of activities participated in (68). Furthermore, a study by Walters and colleges examined whether organized sport participation during adolescence is associated with moderate-to-vigorous physical activity during young adulthood, 5 years later (60). Results indicated that moderate-to-vigorous physical activity decreased between high school and young adulthood for both genders and interestingly, adolescents who participated in sport during high school showed a steeper decline in weekly moderate-to-vigorous physical activity hours than their non-participating peers in young adulthood (60).

All of the aforementioned studies consistently indicate a decline in physical activity and participation in sports during the transition from childhood to adolescents.

Trajectories of Sport Participation

Few studies have examined physical activity behaviors using trajectory groups of youth sport participants over time. Two studies (65,69) aimed to identify patterns of organized sport participation and physical activity in children and adolescents by examining subgroups through latent class analyses. Kwon and colleagues, uniquely identified three trajectories groups of sport participation (no participation, dropout from participation, and consistent participation) and four trajectory groups of daily moderate-to-vigorous physical activity (consistently inactive, consistently active, decreasing moderate physical activity, and substantially decreasing high physical activity), as measured by accelerometers, and television viewing time in a sample of United States children and adolescents (N=537; ages 5-19 years). They found that all children in the "consistently inactive" group also followed a trajectory of no participation in sports. Howie and colleagues, examined organized sport trajectories (consistent participators, dropouts, and joiners) and health associations (physical activity, body composition and self-rated health) in an Australian cohort (N=824; ages 5-17 years), using a subjective measure of physical activity (International Physical Activity Short Form (IPAQ)) (70). Results indicated that consistent participation in sport was associated with health benefits, including physical activity levels for males, when compared to sport non-participants and sport "joiner" trajectories. Interestingly, they found limited associations between organized sport trajectories and physical activity in young adulthood for females (70).

Female Sport Participation Over Time

Several studies have focused on female sport participation and physical activity rates over time (57,71,72). Eime and colleagues, used self-report measures of sport participation and physical activity in a sample of Australian adolescents (N=700) (71). Regarding physical activity, results indicated no significant changes in average duration of moderate-to-vigorous physical activity or total MET-mins, using 42-h recall diary, however, participation in competitive sport and club sport significantly decreased and non-competitive forms of physical activity increased over time (71). In a study of approximately 400 females, the 3DPAR was used to measure physical activity and sport participation in activities from 8th to 12th grade (72). Unlike the results from Eime and colleagues (2016), vigorous physical activity was found to decline by over 10% over the four years (72). Furthermore, there was a strong association between sport participation and the probability of participating in different forms of vigorous physical activity in 8th and 12th grade (Pate, Dowda, O'Neill, & Ward, 2007). Similar results were found in a study of over 400 adolescent females, using self-reported measures of physical activity (3DPAR), showing that those who participate in sports in 8th, 9th and 12th grades were more likely to be vigorously active in 12th grade (57). When reporting the differences in these findings, it is important to note that the samples involved drastically differ by geographic location and the studies differ by the type of subjective measurement of physical activity used.

Differences by Race/Ethnicity and Socioeconomic Status Over Time

Aside from independent examinations of physical activity and sport participation, this relationship is less understood among demographic sub-groups in the transition from childhood to adolescents. In a previously mentioned study, Pfeiffer and colleagues, found that females who participate in sports in 8^{th}, 9^{th} and 12^{th} grades were more likely to be vigorously active in 12^{th} grade. Interestingly, the results did not indicate any significant differences while controlling for race (57). Their results suggest that race/ethnicity does not play a role in the association between sport participation and physical activity in adolescent females. One study found socioeconomic status to be a modifying factor in the relationship between sport participation and physical activity in female adolescents (66). Examining Australian youth by an objective measure of physical activity, Telford and colleagues, found that females who had lower socioeconomic status were less physically active, more sedentary, not as physically fit, and were less likely to participate in sport compared to females with higher socioeconomic status ($p<.05$) (66). In large, these studies have controlled for socioeconomic status and race/ethnicity within their analyses and many have stratified by sex when reporting results on the relationship between sport participation and physical activity. However, there is a lack examination of the modifying effects of socioeconomic status and race/ethnicity longitudinally beyond this. A plausible reason for lack of examination of these variables as modifying factors on this topic could be due to lack of representative study samples (65).

Summary. Consistent with the cross-sectional literature, longitudinal studies consistently reported that youth who participate in sport are more likely to be physically active compared to their non-participant peers. Results also indicate declines in physical

activity for many sport participants over time (57,60,68,73). It is notable that the strength of the association between sport participation during youth leading to future physical activity varies in the literature (38) and does not appear to occur in all subgroups (4). Nonetheless, the majority of the evidence suggests that there are positive associations of youth sport participation and future physical activity. Both the longitudinal and cross-sectional literature reinforce the importance of sport, as an opportunity for youth to engage in physical activity.

Physical Activity and Sport Participation – Contextual Factors

Although the quantification of physical activity of youth engaged in sport is of interest, very few studies have addressed the contextual factors of physical activity of the youth sport environment (47,50,74,75). This contextual information may help better understand the potential to promote physical activity in the youth sport environment. The observational systems that have been administered in the youth sport setting include the SOFIT system (50), the OSRAC:YS (47), and a modified version (74), and/or combination of the both (75).

A study by Guagliano and colleagues used a combination of direct observation and accelerometry to examine physical activity levels of Australian females (N=94) during three organized sports (netball, basketball, and soccer) (50). This was one of the few studies to compare activity levels of youth between game and practices. Their results indicated that females achieved a significantly greater percentage of moderate-to-vigorous physical activity during practices compared to games (33.8% vs 30.6%). They also noted that roughly two-thirds of the youth sport participants' time was spent in sedentary or light physical activity (50). This finding is consistent with multiple studies

found in the literature, indicating a large portion of youths' time in sport is spent in sedentary and light physical activity (12,47,51,76). Additionally, Guagliano and colleagues explored lesson context and coach behavior through the direct observation using SOFIT. Results indicated that coaches spent the largest portions of practice time in knowledge delivery (18.5%) and time management (15.0%) but did not find any overarching significant differences between practice and games regarding lesson context. They also found that there were significantly more occasions where coaches demonstrated physical activity during practices compared to games, consistently across all sports (50).

Following this, a study by Kantars and colleagues, aimed to examine whether national policies for hockey sport practices increased physical activity time without comprising skill development time, by comparting two samples of youth sport leagues (Michael A. Kanters et al., 2015). Researchers used a modified SOFIT method, encompassing hockey-specific contextual factors, to measure individual physical activity levels and practice context in which they occurred, among recreational league hockey practices. They found that individuals spent 33% of practice time engaged in moderate physical activity, 23% in vigorous physical activity and the highest percentage, 44%, spent in sedentary behavior (74). The indicated amount of practice time spent engaged in moderate-to-vigorous physical activity found is similar to other findings (47,50,75).

More recently, a study, by Schlechter and colleagues, examined 5-11 year-olds' physical activity during flag football, using a combination of direct observation and accelerometry (Schlechter, Guagliano, Rosenkranz, Milliken, & Dzewaltowski, 2018). Each practice was video recorded, while children (N=211) concurrently wore

accelerometers to measure physical activity. Recorded practices were then divided into continuous context time segments, defined by change in context characteristics, which researchers adapted from SOFIT, OSRAC:YS and a literature review. Compared to other studies which examined pre-determined time intervals in individuals within youth sport practices, researchers aimed to segment practice time by contextual characteristics, type and frequency of segments, and influences of segments on moderate-to-vigorous physical activity of a team. Their results indicated that approximately 34% of practices were spent in moderate-to-vigorous physical activity, across all teams and segments (75). Furthermore, higher percentages of time of moderate-to-vigorous physical activity were accumulated during free-play (~52%), gameplay (~54%), and warm-up (~54%) compared to fitness (~37%) segments. Authors concluded that the percentage of time spent in sedentary behavior and in moderate-to-vigorous physical activity differed by characteristic of task and setting demand of the segment (75).

Lastly, using their developed OSRAC:YS, Cohen and colleagues, explored the influence of contextual factors of physical activity associated with youth soccer participants (N=29, ages 5-10 years old), as well as measuring physical activity by accelerometry (47). Regarding contextual factors, moderate-to-vigorous physical activity was found to be generally higher during the categories of drills and fitness instruction, as well as, during small group and individual practice activities. Additionally, results indicated lower levels of moderate-to-vigorous physical activity during times where coaches demonstrated skills, provided instructions, or were disengaged (47). Data from the accelerometry measures indicated that the youth participants spent roughly one third of practice time engaged in moderate-to-vigorous physical activity (47). Furthermore, the

data showed that youth spent approximately 24% of practice time in sedentary activity, and approximately 37% in moderate-to-vigorous physical activity. These percentages were notably larger compared to other reported data (75), however, these differences could be due to the type of sport observed.

Summary. Direct observation offers the ability to explore physical activity behaviors, including intensity and type of movement, while also assessing contextual factors in the youth sport setting. It is believed that gathering this information is best achieved through direct observation because self-reported data may be unreliable of biased (77), and furthermore, observation allows the context of the physical activity occurring to be captured, unlike accelerometry. However, in the current literature, direct observational studies have varied drastically by design, observational tool used, type of sport, context (game or practice or both), and age of participants observed. Both the variations in study characteristics and the limited amount of direct observational research that exists, makes it difficult to compare results from study to study. Presently, a complete picture of the contextual factors of physical activity in youth sport setting is lacking and additional research is needed.

Summary and Conclusions

Youth sport represents a relevant domain for physical activity promotion among children and adolescents and the current evidence-based literature suggests that participation in sport can contribute to youth's physical activity. However, a relatively small amount of information is known about the amount and intensity of physical activity youth achieve during sport. Studies have varied in methodologies, sample sizes and characteristics, making it difficult to draw conclusions. Furthermore, very few studies

have employed objective measurements to investigate the relationship between physical activity and sport participation, especially among youth in the United States. Therefore, there is a need to conduct additional research among children and adolescents in order to more accurately understand the relationship between physical activity and sport participation.

Among the available research, only one study has used a reliable instrument to obtain information on children's physical activity levels during youth sports practices and the contextual factors associated with physical activity specifically in this environment (47). Using such a measurement instrument is necessary to identify important contextual factors of physical activity in youth sport, including physical, social and coaching behaviors contexts, all of which have been relatively unexplored. This information could provide essential pieces to the larger picture in understanding physical activity in the youth sport and, ideally, to optimize engagement in physical activity and reduction in sedentary behavior across the youth sport landscape.

Study One Methodology

Introduction

It is well established that physical activity provides numerous health benefits for youth including improvements in cardiorespiratory and muscular fitness, cardiometabolic health, bone health, weight status, cognitive function and reduced risk of depression (2,78). The Physical Activity Guidelines for Americans recommend that children and adolescents accumulate 60 minutes of moderate-to-vigorous physical activity each day (2), however, a majority of youth fail to meet this guideline (3). The United States Department of Health and Human Services recently released the *National Youth Sports*

Strategy, promoting sport as a platform to influence youth and provide health benefits associated with increased physical activity (8).

Results from existing cross-sectional research have reported that youth sport participants tend to be more physically active and spend more time in moderate-to-vigorous physical activity their non-sport participant peers (38,56,58,59,61). However, factors including individual-level characteristics (e.g. age, sex, race/ethnicity, etc.), frequency of participation, and setting of sport program participated in (e.g. school, non-school programs) may affect the amount and intensity of physical activity attained during sport participation. Examining these factors could provide important information to guide the development of effective strategies to enhance physical activity during youth sport.

The existing research literature is limited by a lack of studies which include both an objective measure of physical activity and examination of factors including individual-level participant characteristics, frequency of participation, and setting of sport program participated in. Additionally, much of the existing literature regarding physical activity and youth sport has focused on a specific type of sport or setting. Although this information is important, a more extensive examination of one's sport experience would be valuable, as one's ability to participate in sport and be physically active may be influenced by a variety of factors. The present study will address this gap by examining the contribution of individual-level characteristics, frequency of participation, and setting of sport program with objectively measured physical activity in a sample of United States youth.

Purpose

The purpose of this study is to examine the cross-sectional relationship between objectively measured physical activity and characteristics of sport participation in a sample of middle school youth. The aim of this study will be addressed using three objectives.

Objective A: To determine whether physical activity differs between adolescents who reported sport participation and non-participants.

Objective B: To determine whether physical activity is associated with reported frequency (# of days) of sport participation.

Objective C: To determine whether physical activity differs between adolescents who reported school sport participation vs. non-school school sport participation.

Methods

Study Design

A cross-sectional study design will be used to examine the relationship between objectively measured physical activity and characteristics of sport participation in a sample of middle school youth.

Data Source and Participants

Data will be drawn from the Evaluation of Activity Surveys in Youth (EASY) study (79). A mixed methods qualitative/quantitative sequential research design was used in the EASY study to develop a valid and reliable physical activity self-report instrument

for youth, grades 6th – 8th. Data from the EASY study includes information on 264 male (n=134) and female (n=130) participants, with a mean age of 12.0 ± 0.9 years. Further detail regarding EASY protocol are reported elsewhere (79).

Measures

Participant Characteristics

Participant characteristics including age, sex, socioeconomic status (determined by free and reduced lunch of child), and race/ethnicity, as well as, anthropometric measures of participant's height, weight, and body mass index (BMI) % will be used for the present study's analyses. Operational definitions of the participant characteristics are presented in Table 6.1.

Sport Participation

Sport participation information will be assessed using data from the EASY instrument (79), completed by children in 6th, 7th and 8th grades. Children were asked about activities completed in the past week (0-7). The following questions specifically asked about sport and will be used in the present study's analysis: 1) "In the past week (7 days) did you play on an organized school sports team?", 2) "In the past week (7 days) did you play on an organized, non-school sports team?", and 3) "In the past week (7 days) did you play non-organized sports?". Operational definitions of the sport participation variables are presented in Table 6.1.

Physical Activity

Children's physical activity was measured by accelerometry (ActiGraph GT1M and GT3X models; Pensacola, FL), a valid tool used to objectively measure children's physical activity levels (80). Children were instructed to wear the accelerometer on the right hip for seven consecutive days during waking hours (except for water-based activities). Data were collected and stored in 30-second epochs and any period of ≥ 60 minutes of consecutive zero counts was defined as non-wear time. Children had to have worn the accelerometer for at least eight hours on at least three days to be included in the analyses. Average minutes per hour spent in sedentary, light, moderate-to-vigorous, vigorous, and total physical activity will be calculated for each participant. Operational definitions of the physical activity variables are presented in Table 6.1.

Data Analyses

Descriptive statistics (percentages or means and standard deviations) will be calculated to describe the participant characteristics. Analyses will adjust for participants' age, sex, socioeconomic status, race/ethnicity, and BMI%. Statistical significance will be set at $p < 0.05$. Analyses will be performed using SAS 9.4 Statistical software (SAS Institute, Cary, NC).

Analysis 1: Objective A

In order to determine whether physical activity differs between adolescents who reported sport participation and non-participants the following analysis will be conducted. Participants will be classified as a sport "participant" (≥ 1 day(s) per week participated) or "non-participant" (< 1 day of week participated) from self-reported sport-

related questions from the EASY instrument. ANOVA will be used to determine if there are differences in physical activity (sedentary, light, moderate-to-vigorous, vigorous, and total) between sport participants and non-participants.

Analysis 2: Objective B

To determine whether physical activity is associated with reported frequency (# of days) of sport participation the follow analysis will be conducted. The frequency (reported days per week (0-7) of each participants' data will be analyzed for the sport-related questions from the EASY instrument. Multiple linear regression analysis will be used to determine whether physical activity (sedentary, light, moderate-to-vigorous, vigorous, and total) is associated with reported frequency (# of days) of sport participation.

Analysis 3: Objective C.

To determine whether physical activity differs between adolescents who reported school sport participation vs. non-school school sport participation the following analysis will be conducted. Participants will be categorized as a participant in a "school" sport, "non-school" sport, or "both" from self-reported sport-related questions from the EASY instrument. ANOVA will be used to examine associations of children's physical activity levels (sedentary, light, moderate-to-vigorous, vigorous, and total) and types of sport setting (school and/or non-school).

Table 6.1. Operational definitions of variables for Study 1

Variable	Source	Operational Definition
Physical activity (PA) – *Dependent Variable*		
Sedentary behavior	Accelerometer	Average counts (min/hr)[1]
Light	Accelerometer	Average counts (min/hr)[1]
Moderate-to-vigorous	Accelerometer	Average counts (min/hr)[1]
Vigorous	Accelerometer	Average counts (min/hr)[1]
Total	Accelerometer	Average counts (min/hr)[1]
Sport participation – *Independent Variables*		
Sport participation 'Participant' 'Non-participant'	EASY instrument	Days per week of sport participation; 'Participant' (i.e. ≥ 1 day(s) per week participated) or 'Non-participant' (< 1 day of week participated)
Frequency Days/week	EASY instrument	Days per week (0-7) of sport participation
Type of sport setting 'School' 'Non-school' 'Both'	EASY instrument	Setting of sport participated in: 'school' sport (i.e. non-organized school team or organized school team); 'non-school' sport (i.e. non-organized team) or, 'both' (i.e. non-organized school team, organized school team, non-organized team)
Participant characteristics – *Covariates*		
Age	EASY study	Age in years
Sex	EASY study	Male or female
Race/ethnicity	EASY study	Black, White, Hispanic Other
Socio-economic status	EASY study	Free and reduced lunch status of child: 'Yes' (i.e. eligible for free or reduced price lunch) or 'No' (i.e. not eligible for free or reduced price lunch)
Anthropometric measures – *Covariates*		
Height	EASY study	Measured in cm
Weight	EASY study	Measured in kg
Body mass index %	EASY study	$kg_{\bullet}m^{-2}$ calculated from height and weight measurements and percentile

		based on the CDC growth charts for youth ages 2 through 19 years.
[1]Freedson cut-points		

Study Two Methodology

Introduction

For decades, youth sport has been thought to provide numerous social and psychological developmental benefits for those participating (10). In addition, youth sport has been widely promoted as a way for participants to attain the health benefits associated with physical activity, including improvements in cardiorespiratory and muscular fitness, cardiometabolic health, bone health, weight status, cognitive function and reduced risk of depression among others (2,78). In 2019, the United States Department of Health and Human Services highlighted these benefits of sport participation and regular physical activity within the *National Youth Sports Strategy* (8).

Although it is often assumed that youth who engage in sport are active, very few studies have objectively examined participants' physical activity during sport (47,50,51,74,75). Furthermore, the contextual factors associated with physical activity in the youth sport setting (i.e. practice and social context) have been relatively unexplored. These contextual factors may play a role in influencing the amount and intensity of physical activity that youth participating in sport achieve, as activity is likely to vary depending on the context of the practice or game structure.

Direct observation offers the ability to explore physical activity behaviors while also assessing contextual factors in the youth sport setting. However, in the current literature, direct observational studies have varied drastically by design, observational tool used, type of sport, context (game or practice or both), and age of participants observed. Furthermore, to our knowledge, no study has used direct observation to

examine the contextual factors across sex-specific (i.e., girls-only, boys-only) and combined (i.e. co-ed) sport teams. Understanding the context of physical activity that occurs during these different types of sport teams could lead to strategies that program directors and coaches may implement to increase children's time spent in physical activity during sport for youth sport participants to affect all types of teams.

Recently, the Observational System for Recording Activity in Children – Youth Sport (OSRAC:YS), was created to provide an objective measurement of physical activity as well as the contextual factors of physical activity in the youth sport setting (47). The data gathered from the OSRAC:YS can provide systematic information about children's physical activity and the contextual and behavioral circumstances of their activity in the youth sport setting.

Purpose

The purpose of this study is to identify contextual factors that influence children's physical activity levels during their participation in youth sport programs using a direct observational method. The study will address three objectives.

Objective A: To describe selected contextual factors of youth sport programs.

Objective B: To describe the associations between selected contextual factors and children's physical activity levels during their participation in youth sport programs.

Objective C: To determine if the associations between selected contextual factors and children's physical activity levels differ by girls-only, boys-only, and co-ed teams.

Methods

Study Design

A cross-sectional study design will be used to examine selected contextual factors and physical activity of youth sport participants using the OSRAC:YS.

Participants and Setting

Sport teams will be recruited from organized youth soccer programs run by the local YMCA in Greenville and Columbia, South Carolina during the fall 2020 season. Eligible programs will include girls-only, boys-only and co-ed formed teams, serving youth ages 7-10 years old. From the eligible programs, an equal amount of girls-only, boys-only and co-ed teams will be randomly selected to partake in the study, with a goal of recruiting 12 teams total (4 girl-only, 4 boys-only, 4 co-ed). Specifically, random selection will occur by first identifying of all eligible teams participating in this age group (7-10 year-olds) with assistance from the program directors. Then, all eligible teams will be stratified by type of team (i.e., girls-only, boys-only and co-ed). Lastly, 12 total teams (4 teams of each type) will be randomly selected by a randomized selection via Microsoft Excel program.

Researchers will first seek approval from the youth program directors of the YMCA programs. Once approval is obtained, team coaches will be approached and invited to participate in the study. Prior to data collection, this study will go through the procedure to be approved by the University of South Carolina IRB.

Measures

Children's physical activity and contextual factors of the youth sport environment will be measured via momentary time sampling procedures using the OSRAC:YS. The OSRAC:YS has been found to be a reliable tool for measuring children's physical activity and contextual factors among youth participants during practice (47). Cohen and colleagues (2014) found estimates from the OSRAC:YS to be strongly correlated with accelerometer-based estimates of moderate-to-vigorous physical activity ($r = 0.73$, $p<.001$). Additionally, the OSRAC:YS was found to be reliable measure of contextual factors of physical activity, demonstrating moderate to strong agreement between observers (Kappa coefficients of 0.67 to 0.93) (47). The OSRAC:YS consists of 5 observational categories: 1) physical activity level, 2) practice context, 3) social context, 4) coach behavior, and 5) coach proximity. For the purpose of this study, the analysis will be focused on practice and social context categories.

Physical Activity

Children's physical activity levels will be coded as part of the OSCRAC:YS procedure, using The Children's Activity Rating Scale (CARS) (81). The CARS instrument comprises 5 levels of activity defined as stationary/motionless, stationary/movement of trunk or limbs, slow/easy movement, moderate movement, and fast movement. These ratings have been shown to be representative of sedentary, low-intensity, moderate-intensity, and vigorous-intensity physical activity (81) and will be categorized accordingly after observation is completed. Operational definitions of the physical activity levels are presented in Table 6.2.

Contextual Factors

Practice Context. Practice context codes will be used to describe the type of practice activity. These include: 1) warm up, 2) drills, 3) tactic/instruction, 4) fitness, 5) game, 6) cooldown, and 7) transition. Operational definitions for each practice context code are found in Table 6.2.

Social Context. The social context category of OSRAC:YS describes the social structure, including the interaction of the focal child with other children that is influenced by the practice context. Social context includes four codes: 1) solitary, 2) 1 vs 1, 3) greater than 2 but less than full team, and 4) full team. Operational definitions for each social context code are found in Table 6.2.

Procedures

One or more researchers will attend at least 2 practices per team (24 practices total) over the course of the fall youth soccer season to directly measure physical activity and contextual factors of physical activity during practices using the OSRAC-YS.

Procedures previously employed by Cohen and colleagues will be used to administer the OSRAC:YS (47). Researchers will have a schedule of all participating teams' practices for the course of the fall 2020 soccer season. Researchers will arrive to the practice facility for observation. Prior to each observed practice, youth participants will be randomly assigned to 10-min observation blocks. To do so, the researcher will identify youth participants by description (e.g., hair color, color of shirt worn, sex, etc.) in the order that they arrive to the practice facility. The researcher will then assign the first youth participant on the list to be observed first, the second to be observed next, and will

move down the list until the practice terminates. This procedure will be used for selection for each observation session. Additionally, a single coach will be identified for observation for the contextual categories involving coaching (i.e., coaching behavior and proximity). At the beginning of each practice, researchers will identify the first single focal child to be observed continuously during a single 10-min observation period. Prerecorded audio cues to "observe" and "record" will prompt researchers through the observation cycles and the OSRAC:YS codes will be recorded on a tablet using MOOSES™ observational software. Each period will include 20 observation cycles consisting of a 10-s observation period followed by 20-s recording period. During each 10-s observation interval, the researchers will follow along identifying physical activity levels of the focal child and contextual factors from each category described above. At the completion of the 10-min observation block, an automated alarm will signal the end of the session. The process will be repeated with a new focal child until the end of practice (i.e., 60-min practice would equate to six 10-min observation intervals). Physical activity level will be coded as the highest level observed for 3 or more seconds of the 10-s observation interval. Practice context, social context, coach behavior, and coach proximity follow the same 3-s protocol. For each category, a single code will be recorded based on its occurrence with a standard of 3-s established as the baseline. For each observation interval, the researcher will identify and record findings for all 5 OSRAC:YS categories. A detailed observation protocol script can be found in Appendix A.

Training and Reliability of the OSRAC:YS. Two researchers will complete training and demonstrate reliability using the OSRAC:YS. Training will include informal observations, memorizing codes, definitions, and protocol, debriefing sessions, and *in*

situ observations, prior to data collection. To demonstrate reliability, the primary researcher will be accompanied by the second trained researcher to 20% of observation sessions for inter-rater reliability assessment. The researchers simultaneously but independently, will observe the same focal child during these sessions using split headphones and auditory prompts.

Physical activity levels coded will be aggregated to provide estimates of sedentary ('stationary/motionless' and 'stationary/movement of trunk or limbs'), light (LPA) ('slow/easy movement'), total physical activity (TPA) ('slow/easy movement', 'moderate movement' and 'fast movement'), and moderate-to-vigorous physical activity (MVPA) ('moderate movement' and 'fast movement'). The overall percentage of intervals spent in sedentary, LPA, MVPA and TPA will be calculated. The percentage of intervals spent in physical activity by observational contextual categories (i.e., social and practice context) will also be calculated.

Percent agreement for each of the 5 OSRAC:YS categories will be calculated for inter-rater reliability sessions using the following equation: [#agreements / (#agreements + #disagreements)] x 100. Cohen's kappa will be calculated for all inter-rater reliability assessments (20% of observation sessions). Percent agreements and kappa values for each session will be averaged to provide overall mean percent agreement and kappa values.

Data Analyses

Physical activity levels, coded using the OSCRAC:YS, will be aggregated into four different levels of intensity: sedentary ('stationary/motionless' and

'stationary/movement of trunk or limbs'), LPA ('slow/easy movement'), MVPA ('moderate movement' and 'fast movement'), and TPA ('slow/easy movement', 'moderate movement' and 'fast movement'). Once aggregated, the number and percentage of intervals spent in sedentary, LPA and MVPA levels will be described. Statistical significance will be set at $p < 0.05$. Analyses will be performed using SAS 9.4 Statistical software (SAS Institute, Cary, NC).

Analysis 1: Objective A

In order to describe the selected contextual factors of youth sport programs, the number and percentage of intervals observed in in each contextual category will be presented.

Analysis 2: Objective B

Multiple logistic regression analyses will be conducted to examine the associations between time spent in physical activity and contextual factors observed during youth sport practices. Two separate logistic regression models (using PROC GLIMMIX) will be conducted for physical activity variables of MVPA and TPA. The physical activity levels will be classified as dichotomous variables (e.g. MVPA and non-MVPA; TPA and non-TPA) for the analyses. Practice and social contextual factors will be imputed into the model as independent variables. Observation intervals will be used as the unit of analysis and children nested within team will be included as random effects.

Analysis 3: Objective C

Lastly, an interaction term will be introduced to the logistic regression models to examine the potential moderating role of type of team (i.e., boys-only, girls-only and co-ed) (Team type x contextual category).

Table 6.2. Operational definitions of variables for Study 2

Variable	Source	Operational Definition
Physical activity - *Dependent Variable*		
Sedentary behavior	OSRAC-YS	Coded using CARS - 'stationary/motionless' and 'stationary/movement of trunk or limbs'
Light	OSRAC-YS	Coded using CARS – 'slow/easy movement'
Moderate-to-vigorous	OSRAC-YS	Coded using CARS – 'moderate movement' and 'fast movement'
Total	OSRAC-YS	Coded using CARS – 'slow/easy movement', 'moderate movement' and 'fast movement'
Contextual Variables – *Independent Variables*		
Practice Context:		
Warm-up	OSRAC-YS	Intervals coded during observation as any activity performed at a low- to moderate-intensity aerobic activity and or stretching that occurs at the start of practice.
Drills	OSRAC-YS	Intervals coded during observation as any activity with a set purpose to focus on a specific component of the activity/sport.
Tactic/Instruction	OSRAC-YS	Intervals coded during observation as any activity with a set purpose on learning the rules of the game or skill development.
Fitness	OSRAC-YS	Intervals coded during observation when the objective of the practice activity is aimed at improving a player's physical fitness; Activities performed at moderate-to high-intensity PA levels.
Game	OSRAC-YS	Intervals coded during observation as a full team activity in which all players of the team are involved as a whole in the play, either working together or opposing other players.
Cool-down	OSRAC-YS	Intervals coded during observation as activities occurring at the end of a

		practice with focus on reducing the intensity of the activity.
Transition	OSRAC-YS	Intervals coded during observation as a change between two practice contexts that do not include activities associated with sport activity.
Social Context:		
Individual	OSRAC-YS	Intervals coded during observation when an action or PA behavior is independent of the action of another player.
1 vs. 1	OSRAC-YS	Intervals coded during observation when the focal child is paired with another player to complete a desired task or activity.
Small Group	OSRAC-YS	Intervals coded during observation as any activity involving more than 2 players (the focal child and at least two other children/teammates) but less than all players on the team.
Full Team	OSRAC-YS	Intervals coded during observation when all players are involved in a single activity in which player participation and actions are dependent on each other.
Participating team characteristics – *Descriptive Variables & Interaction Terms*		
Age group	Registration information from participating organization	Age level(s) of participating team
Type of Team 'Boys-only' 'Girls-only' 'Co-ed'	Registration information from participating organization	Team type identification by sex groupings of participating team
Contextual variable operational definitions are from Cohen et al. 2014		

Study Three Methodology

Introduction

It is well-known that youth sport coaches play an important role in influencing children and youth. Beyond their supervisory duties, youth sport coaches can play a fundamental role in developing participants' skills, performance, and ultimately influencing health outcomes of youth through sport (13). Thus, the development of coaching proficiencies through appropriate training and certifications are critical to be effective in the youth sport setting.

Unfortunately, less than 20% of youth sport coaches have been trained in the past three years (18). This includes training in CRP, basic first aid, concussion management, injury and safety prevention, physical condition, sport skills and tactics, and effective motivational techniques. Furthermore, in 2018, it was estimated that four out of ten coaches had never been trained in the above mentioned areas (18). Coaches with inadequate training and experience pose a risk to the youth participants and ultimately can affect the level of perceived physical benefits of their youth sport experience (31). Overall, little is known about the role coaches play in influences children's physical activity levels during youth sport.

To further understand the impact of coaches in the youth sport setting, it would be important to examine coaching experience and behavior as they relate to participants' activity levels, as this topic has been relatively unexplored.

Purpose

The purpose of this study is to examine how coaching behaviors and coach experience relate to children's physical activity levels during their participation in youth sport programs. The aim of this study will be addressed using three objectives.

Objective A: To describe selected coaching behaviors and children's physical activity levels during youth sport programs.

Objective B: To describe the associations between coaching behaviors, coach experience, and children's physical activity levels during their participation in youth sport programs.

Objective C: To determine if the associations between coaching behaviors, coach experience, and children's physical activity levels during their participation in youth sport programs differ between girls-only, boys-only and co-ed teams.

Study Design

A cross-sectional study design will be used to examine how coaching behaviors and coach experience relate to children's physical activity levels during their participation in youth sport programs.

Measures

Participants and Setting

Participants in the present study will be the same as Study 2. Coaches and participants of organized youth soccer teams including girls-only, boys-only and co-ed

formed teams, serving youth ages 7-10 years will serve as the study sample. Data collection will occur in the fall 2020 season. An equal amount of girls-only, boys-only and co-ed teams will be randomly selected to partake in the study, with a goal of recruiting 12 teams total (4 girl-only, 4 boys-only, 4 co-ed). Researchers will first seek approval from the youth program directors of the YMCA programs. Once approval is obtained, team coaches will be approached and invited to participate in the study. Prior to data collection, this study will go through the procedure to be approved by the University of South Carolina IRB.

Measures

As in Study 2, children's physical activity and contextual factors of the youth sport environment will be measured via momentary time sampling procedures using the OSRAC:YS (47). The OSRAC:YS consists of 5 observational categories: 1) physical activity level, 2) practice context, 3) social context, 4) coach behavior, and 5) coach proximity. For the purpose of this study, the analysis will be focused on coach behavior and coach proximity context categories.

Coach Characteristics

Prior to each team's scheduled observation visit, coaches will receive a brief coaching survey. Survey items will include questions regarding coaching history (i.e., number of seasons coached), training (e.g. coaching clinic/workshop), perceived benefits of sport participation for children, priorities in planning a team practice, and demographic information (i.e. age, sex, race/ethnicity, education level, personal history of sport

participation). Operational definitions for coach and participant characteristics are found in Table 6.3.

Physical Activity

Children's physical activity levels will be coded as part of the OSCRAC:YS procedure, using The Children's Activity Rating Scale (CARS) (81). The CARS instrument comprises 5 levels of activity defined as stationary/motionless, stationary/movement of trunk or limbs, slow/easy movement, moderate movement, and fast movement. These ratings have been shown to be representative of sedentary, low-intensity, moderate-intensity, and vigorous-intensity physical activity (81) and will be categorized accordingly after observation is completed. Operational definitions for physical activity variables are found in Table 6.3.

Contextual Factors

Coaching Behavior. Coach behavior codes aim to describe the actions of the coach and include: 1) watching with feedback, 2) watching without feedback, 3) demonstration, 4) management/general instruction, and 5) disengaged/off task. Operational definitions for each coaching behavior code are found in Table 6.3.

Coaching Proximity. Lastly, coach proximity describes the location of the coach relative to the focal child and is recorded as one of two codes: 1) proximal or 2) distal. The coach will be considered proximal or distal depending on if the coach is inside or outside of the playing boundary. The boundary of play will be defined by the parameters established by the coach for the specific practice activity. Any time the coach is within

the boundary of the playing area, he/she will be considered proximal to the players. Operational definitions for each coaching proximity code are found in Table 6.3.

Procedures

As previously described in Study 2, one or more researchers will attend at least 2 practices per team (24 practices total) over the course of the fall youth soccer season to directly measure physical activity and contextual factors of physical activity during practices using the OSRAC-YS as well as gather information by the coaching survey, completed by each coach.

Procedures previously employed by Cohen and colleagues will be used to administer the OSRAC:YS (47). Researchers will have a schedule of all participating teams' practices for the course of the season. Researchers will arrive to the practice facility for observation. Prior to each observed practice, youth participants will be randomly assigned to 10-min observation blocks, as described in Study 2. Additionally, a single coach will be identified for observation for the contextual categories involving coaching (i.e., coaching behavior and proximity). At the beginning of each practice, researchers will identify the first single focal child to be observed continuously during a single 10-min observation period. Prerecorded audio cues to "observe" and "record" will prompt researchers through the observation cycles and the OSRAC:YS codes will be recorded on a tablet using MOOSES™ observational software. Each period will include 20 observation cycles consisting of a 10-s observation period followed by 20-s recording period. During each 10-s observation interval, the researchers will follow along identifying physical activity levels of the focal child and contextual factors from each

category described above. At the completion of the 10-min observation block, an automated alarm will signal the end of the session. The process will be repeated with a new focal child until the end of practice (i.e., 60-min practice would equate to six 10-min observation intervals). Physical activity level will be coded as the highest level observed for 3 or more seconds of the 10-s observation interval. Practice context, social context, coach behavior, and coach proximity follow the same 3-s protocol. For each category, a single code will be recorded based on its occurrence with a standard of 3-s established as the baseline. For each observation interval, the researcher will identify and record findings for all 5 OSRAC:YS categories. A detailed observation protocol script can be found in Appendix A.

Physical activity levels coded will be aggregated to provide estimates of sedentary ('stationary/motionless' and 'stationary/movement of trunk or limbs'), light (LPA) ('slow/easy movement'), total physical activity (TPA) ('slow/easy movement', 'moderate movement' and 'fast movement'), and moderate-to-vigorous physical activity (MVPA) ('moderate movement' and 'fast movement'). The overall percentage of intervals spent in sedentary, LPA, MVPA and TPA will be calculated as well as the percentage of intervals spent in physical activity by observational contextual categories (i.e., coach behavior and proximity).

Data Analyses

Physical activity levels, coded using the OSCRAC:YS, will be aggregated into four different levels of intensity: sedentary ('stationary/motionless' and 'stationary/movement of trunk or limbs'), LPA ('slow/easy movement'), MVPA

('moderate movement' and 'fast movement'), and TPA ('slow/easy movement', 'moderate movement' and 'fast movement'). Coaching experience will be categorized by number of seasons of coaching experience (0-6+ years) with 0 indicating no prior coaching experience. Coaching training will be categorized as 'yes' (i.e., coach has indicating any type of prior training) 'no' (i.e., coach has indicated no prior training) via the coaching survey. Participating team and coach characteristics will be described. Statistical significance will be set at $p < 0.05$. Analyses will be performed using SAS 9.4 Statistical software (SAS Institute, Cary, NC).

Analysis 1: Objective A

In order to describe the selected coaching behaviors and children's physical activity levels during youth sport programs, the number and percentage of intervals observed in in each contextual category will be described. The corresponding percentage of time spent in each physical activity level will also be described.

Analysis 2: Objective B

Multiple logistic regression analyses will be conducted to examine the associations between time spent in physical activity, coach experience and coaching behaviors observed during youth sport practices. Two separate logistic regression models (using PROC GLIMMIX) will be conducted for physical activity variables of MVPA and TPA. The physical activity levels will be classified as dichotomous variables (e.g., MVPA and non-MVPA; TPA and non-TPA) for the analyses. Coaching behavior and proximity contextual factors and coaching experience will be imputed into the model as

independent variables. Observation intervals will be used as the unit of analysis and children nested within team will be included as random effects.

Analysis 3: Objective C

Lastly, an interaction term will be introduced to the logistic regression models to examine the potential moderating role of type team (i.e., boys-only, girls-only and co-ed) on coaching independent variables (Team type x coach behavior; Team type x coach proximity; Team type x coaching experience).

Table 6.3. Operational definitions of variables for Study 3

Variable	Source	Operational Definition
Physical activity – *Dependent Variable*		
Sedentary behavior	OSRAC-YS	Coded using CARS - 'stationary/motionless' and 'stationary/movement of trunk or limbs'
Light	OSRAC-YS	Coded using CARS – 'slow/easy movement'
Moderate-to-vigorous	OSRAC-YS	Coded using CARS – 'moderate movement' and 'fast movement'
Total	OSRAC-YS	Coded using CARS – 'slow/easy movement', 'moderate movement' and 'fast movement'
Coaching Variables – *Independent Variables*		
Coaching behavior:		
Watching with Verbal Feedback	OSRAC-YS	Intervals coded during observation when a coach is observed as watching a player then providing feedback to the skill or task performed by the player.
Watching without Verbal Feedback	OSRAC-YS	Intervals coded during observation when a coach appears to be watching the focal player or more than one player but not providing feedback to their performance.
Demonstration	OSRAC-YS	Intervals coded during observation as any skill demonstrated by the coach or participation of the coach in the practice activity.
Management/General Instruction	OSRAC-YS	Intervals coded during observation when a coach is engaged in practice set-up activities, provides activity instructions to the team or general team or sport discussions with the players, such as information on an upcoming game.
Disengaged/Off Task	OSRAC-YS	Intervals coded during observation when a coach appears to be removed or uninvolved in any form to the practice activities.

Coach proximity:		
Proximal to the Child	OSRAC-YS	Intervals coded during observation when a coach is within the boundary of the activity.
Distal to the Child	OSRAC-YS	Intervals coded during observation when a coach outside of the playing boundary.
Experience	Coach Survey	Self-reported coaching experience in seasons (0-6+)
Training 'Yes' 'No'	Coach Survey	Self-reported coach training categorized into: 'Yes' (i.e., has had prior coaching training) or, 'No' (i.e., has not had prior coaching training)
Participating team characteristics – ***Descriptive Variables & Interaction Terms***		
Age group	Registration information from participating organization	Age level(s) of participating team
Type of Team 'Boys-only' 'Girls-only' 'Co-ed'	Registration information from participating organization	Team type identification by sex groupings of participating team
Coaching behavior and proximity variable operational definitions are from Cohen et al. 2014		

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APPENDIX A

OBSERVATIONAL PROTOCOL SCRIPT FOR STUDIES TWO AND THREE

1. Arrive at practice facility parking lot (20 minutes prior to practice time to ensure data collection occurs at the very beginning of practice time)
2. Gather equipment (direct observational tools- i.e. headphones for audio prompt, tablet)
3. Arrive at appropriate field of scheduled observed team
4. Position self on the sideline of the playing field, with a clear view of the practice
5. Ready all observational tools (i.e. tablet and headphones with audio prompt) and prepare to start at the beginning of practice
    a. The date will be recorded to account for the type and portion of season that the observation is occurring
6. A single focal child and a single coach will be identified (this coach will be the focal coach for the entire practice to coding the contextual factors of coach proximity and behavior) using the previously described method for selection (See methods section of Study 2).
7. The prerecorded audio cue to "observe" will prompt the start of each 10-s observation cycle
8. During each 10-s observation interval physical activity levels of the focal child and contextual factors (i.e. practice context, social context, coach behavior, and coach proximity) will be identified
    a. Physical activity level will be coded as the highest level observed for 3 or more seconds of the 10-s observation interval
    b. Practice context, social context, coach behavior, and coach proximity will follow the same 3-second protocol but do not include a rank

9. Prerecorded audio cue to “record” will prompt the end of the 10-s observation cycle and during the next 20-s identified physical activity levels of the focal child and contextual factors will be recorded
10. This process of 10-s observation and 20-s of recording will continue for the same focal child for a 10-min observation cycle (20 cycles of continuous 10-s observation and 20-s recording per child)
11. Prerecorded audio cue will prompt the end of the 10-min observation cycle
12. A new, single focal child and the same coach will be identified for the next observation cycle
13. Steps 7-11 will be repeated with a new focal child and the same coach until the end of practice (6 children per 60-min practice)
14. Once the last 10-min observation is completed, equipment will be gathered
15. Exit field and practice facility
16. Return to office and download and import data to device to save appropriately

* The same coach will be observed for the entire practice to code for the contextual factors of coaching proximity and behavior. If there is more than one coach, one will be randomly selected for observation at the beginning of the observation period.

*The number for children observed will depend on the practice length. One child will be observed for 10-min. If the practice duration is 60-min, six children will be observed.