


Children's physical activity levels in a sports-oriented summer day camp

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ABSTRACT

Physical activity engagement during childhood helps create lifelong patterns of health and fitness. Summer camps are an important domain of influence for health promotion, with over 14 million American children attending annually. No known studies have evaluated the impact of sports-focused camps on activity levels. We test the hypothesis that children attending a sports camp (STEC) spend more time in moderate-to-vigorous physical activity (MVPA) compared to children attending general day camps. A repeated measures design used waist-worn accelerometers to measure MVPA and vigorous physical activity (VPA) among children at a sports camp in Dorchester, Massachusetts ($n = 40$). We compared these data with data from a similar study at five Boston-area non-sports-focused summer day camps (BSC) ($n = 142$), resulting in 764 total person-days analyzed. Multivariable linear regression models estimated differences in percent of accelerometer-monitored time spent in physical activity, adjusting for potential confounders and clustering of observations. STEC children spent a higher percentage of time in MVPA and VPA compared to BSC children (MVPA: 11.4%, $p = .005$; VPA: 2.4%, $p = .023$). These findings support the hypothesis that sports-focused camps can provide children with significantly more activity than general day camps. STEC children also spend a higher percent of time in MVPA than do children in a school-day national sample (NHANES). This is the first study to document that a sports-oriented camp generates more physical activity compared to a

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Submitted for publication September 2017

Accepted for publication January 2018

Published March 2018

JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

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doi:10.14198/jhse.2018.132.13

general summer camp. Our findings are relevant for public health efforts to promote physical activity and prevent chronic disease. **Key words:** EXERCISE, CHILD, SUMMER CAMP, TENNIS, ACCELEROMETER.

Cite this article as:

Barnett, E., Ridker, P., Okechukwu, C., Barrett, J., & Gortmaker, S. (2018). Children's physical activity levels in a sports-oriented summer day camp. *Journal of Human Sport and Exercise*, 13(2), 430-442. doi:<https://doi.org/10.14198/jhse.2018.132.13>

INTRODUCTION

Physical activity plays a significant role in the overall health of children. Research suggests that an increase in children's physical activity is related to a wide range of positive outcomes during childhood, including improved cognitive skills and academic performance (Donnelly & Lambourne, 2011; Efrat, 2011; Rasberry et al., 2011), emotional well-being (Brown, Pearson, Braithwaite, Brown, & Biddle, 2013), and psychological functioning (Kalak et al., 2012). Engagement in moderate-to-vigorous physical activity (MVPA) not only positively impacts health in childhood, but also may contribute to sustainment of physical activity in adulthood and improved health and fitness across the life course (Serdula et al., 1993). Those who are physically inactive during adulthood increase their risk of many diseases, including coronary heart disease, obesity, type 2 diabetes, and some cancers (Lee et al., 2012). Thus, increasing physical activity in childhood can have a long-term impact and should be at the forefront of public health efforts.

The US Department of Health and Human Services issues guidelines for physical activity, recommending that children engage in at least 60 minutes of MVPA each day (Office of Disease Prevention and Health Promotion, 2008). However, the majority of children in the US do not meet this recommendation, and lower levels of physical activity have been observed among minority youth (Gortmaker, Lee, Mozaffarian, et al., 2012; Troiano et al., 2008). Studies have demonstrated that increasing physical activity opportunities for youth during the school day significantly increases activity levels (A. L. Cradock et al., 2014; Kriemler et al., 2010; Long et al., 2013), but little is known about how to impact children's physical activity behaviors during out-of-school time.

Over 14 million American children and youth attend summer day camps each year (Afterschool Alliance, 2010), making summer camps a promising sphere of influence for physical activity promotion. A research project completed in 2013 by the Harvard Prevention Research Center assessed physical activity of children attending five Boston-area summer camps (BSC) (Barrett et al., 2014). While other research has assessed children's activity levels at summer camps using direct observation (Beets, Weaver, Beighle, Webster, & Pate, 2013; Weaver, Beets, Turner-McGrievy, Webster, & Moore, 2014; Zarrett, Sorensen, & Skiles, 2013), the Harvard Prevention Research Center study was the first study of its kind to assess children's daily summer camp activity levels using accelerometers.

Nevertheless, no known studies to date have evaluated the impact of a sports-focused summer day camp on physical activity, nor have they compared the activity levels of children at sports-focused compared to non-sports-focused day camps. A systematic review found that youth who participate in sports are more physically active compared to those who do not participate in sports (Nelson et al., 2011). Furthermore, there is some evidence to suggest that participation in sports contributes to children's overall health and that youth who regularly participate in sports are less likely to have adverse health outcomes (Drake, Keith M. et al., 2012; Romani, 2011; Weintraub et al., 2008). While the evidence base is growing for the effect that sports programs can have on children's health, it is unknown whether children who attend sports-oriented summer camps experience significantly more physical activity than those who attend general summer day camps.

Sportsmen's Tennis and Enrichment Center (STEC) provides youth in the Dorchester neighborhood and surrounding Boston communities with safe, accessible, and affordable physical activity opportunities. Compared to other Boston neighborhoods, Dorchester has a high prevalence of obese/overweight individuals and residents who report inadequate physical activity (Boston Public Health Commission, 2013). Youth from Dorchester also have lower sports participation levels than youth from other Boston neighborhoods: Dorchester youth comprise 21% of Boston's 5-18 year olds, but represent only 18% of all youth sports and

physical activity participants in Boston (A. Cradock et al., 2002; Hannon et al., 2006). Founded in 1961, STEC was the first non-profit tennis club built to provide tennis training, academic programs, and social enrichment for low-income children. STEC is now one of more than 500 National Junior Tennis and Learning chapters of the United States Tennis Association (United States Tennis Association Foundation, n.d.). Like its similar centers across the country, STEC focuses on improving educational, physical, and cultural opportunities in predominantly minority and low-income communities. STEC's geographic location, membership in a national network of similar centers, focus on tennis—commonly called 'the sport of a lifetime' because it can be played at any age—and diverse enrichment and athletic offerings present a unique opportunity for physical activity research.

The present study evaluates the effect of STEC's youth summer tennis camp on physical activity, measured by accelerometers. This study quantifies the amount of physical activity that camp participants attain while at STEC and analyzes whether physical activity varies by age, sex, race/ethnicity, level, or past STEC participation. Estimates derived from accelerometer data collected over the course of two weeks are compared with estimates derived from a similar study completed by the Harvard Prevention Research Center that quantified children's physical activity at five Boston summer (non-sports-oriented) camps.

METHODS

Sample and Setting

STEC. A cross-sectional repeated measures design used waist-worn accelerometers to measure physical activity levels among children ages 9-17 at STEC summer tennis camp in Dorchester, Massachusetts, from July 7 – July 18, 2014. We recruited children attending the STEC summer tennis camp during the two weeks of data collection to wear accelerometers during camp hours for one week (5 days), except for swimming periods. Eligible children were between the ages of 9-17 and were planning to attend the camp for at least four out of five days of the week during the data collection period.

Boston Summer Camps

A cross-sectional repeated measures design used waist-worn accelerometers to measure physical activity levels among children ages 5-12 attending one of five summer camps in Boston, Massachusetts, from July – August, 2013 (Barrett et al., 2014). The research team recruited children attending one of the five Boston summer camps during the data collection period to wear accelerometers during the camp day for one week (5 days), except while swimming (Barrett et al., 2014). Eligible children were between the ages of 5-12 and were planning to attend the camp for at least four out of five days of the week during the data collection period.

Parents completed written informed consent forms. Trained research assistants obtained parent consent and child assent. The Harvard T.H. Chan School of Public Health Committee on Human Subjects approved this study.

Measures

Physical activity

Past research has established strong evidence for validity of accelerometers as measures of physical activity among children by comparing them to gold standard measures of activity-related energy expenditure (e.g., doubly labeled water) and fitness (e.g., VO_{2max}) (Freedson, Pober, & Janz, 2005; Trost, Loprinzi, Moore, & Pfeiffer, 2011). We used ActiGraph accelerometers (models GT3X and GT3X+; Pensacola, FL) to assess

physical activity for all participants. We modeled protocols and accelerometer data reduction after those used in the National Health and Examination Survey (NHANES) (Long et al., 2013; Troiano et al., 2008).

Trained RAs distributed accelerometers to all STEC participants at the start of the camp day on each day of data collection. Participants fastened accelerometers at the hip with an adjustable belt. We instructed participants to keep the accelerometer on for the entire camp day, except during swimming periods. RAs collected accelerometers at the end of the camp day or when participants left. We used daily wear sheets to record the times participants put on and took off the accelerometers.

We restricted valid minutes of physical activity to those during the defined camp day. We estimated percent accelerometer time spent in MVPA or VPA per day by dividing minutes of MVPA or VPA per day by minutes of accelerometer wear time per day. We used percent time spent in physical activity as the outcome to account for different wear times between STEC and Boston summer camp participants.

Other data

Parents and coaches reported participants' age, sex, and race/ethnicity on consent forms in response to open-ended questions. STEC coaches and administrators reported level of camper (beginner, intermediate, advanced), first time at STEC camp (Y/N), and participant in other STEC programs (Y/N). We derived weather data (inches of precipitation, deviation from average annual mean daily temperature, dew point) from National Oceanic and Atmospheric Administration (NOAA) local daily reports for Boston, MA (National Oceanic and Atmospheric Association, n.d.).

Statistical Analysis

As in the Boston summer camps study, we collected STEC Actigraph accelerometer data in 1-minute epochs and then converted them to vigorous (VPA) and MVPA minutes. For accelerometer analyses, we followed algorithms used in previous studies to identify age-specific Metabolic Equivalent of Task (MET) cut-points for MVPA and VPA (Gortmaker, Lee, Mozaffarian, et al., 2012; Troiano et al., 2008;). We applied the Freedson group age-specific criteria, with thresholds of 4 METs for moderate activity and 6 METs for vigorous activity (Trost et al., 2011). We defined nonwear periods as 60 or more consecutive minutes of zero accelerometer counts, per national guidance. SAS code specifying the national NHANES protocol is available at http://appliedresearch.cancer.gov/nhanes_pam/ (National Cancer Institute, n.d.).

After converting accelerometer data, we computed basic descriptive statistics to quantify the amount of MVPA and VPA children at STEC get on a daily basis. Second, we assessed the crude difference in percent MVPA and percent VPA by comparing STEC data to data from the Boston summer camps. Third, adjusting for weather and participant demographics (age, sex, and race/ethnicity), we conducted a multilevel multivariable linear regression, with day nested within child nested within camp, to test the hypothesis that children attending STEC engage in MVPA or VPA during a higher percentage of camp time compared to children attending the Boston summer camps. Finally, we specified a multilevel model, with day nested within child, to assess which of the following variables may predict percent MVPA within STEC: age, sex, race/ethnicity, tennis level, and past STEC participation.

RESULTS

Participants

Out of 52 eligible STEC participants, 41 (79%) provided parental consent and assent, and 40 (77% of eligible) provided at least two hours per day of accelerometer wear for at least two days. Each consenting participant

wore an Actigraph accelerometer on an elastic belt around the waist. STEC data analyzed comes from 40 camp participants, who wore the meters over the course of approximately 4.5 days each for an average of 299 minutes per day, yielding an estimated 53,244 person-minutes of data.

Out of 179 eligible Boston summer camp participants, 164 (92%) provided parental consent and assent, and 142 (79% of eligible) provided at least five hours per day of accelerometer wear for at least two days. Each child who consented wore an Actigraph accelerometer on an elastic belt around the waist. Boston summer camp data analyzed comes from 142 camp participants, who wore the meters over the course of approximately 4.1 days each for 549 minutes per day, yielding an estimated 319,570 person-minutes of data.

STEC participants' average age was 11.5 years, while Boston summer camp participants' average age was 7.6 years. Both STEC and Boston summer camps provided a multi-racial/ethnic sample, with the largest proportion being black (43% for STEC, 36% for BSC). Both the STEC and Boston summer camp samples had slightly more boys than girls (55% for STEC, 54% for BSC). Demographics and accelerometer data from both samples are summarized in Table 1.

Table 1. Characteristics of Sportsmen's Tennis and Enrichment Center (STEC) participants and Boston summer camp (BSC) participants: Demographics and accelerometer data.

Characteristic	STEC	BSC
<u>Participation</u>		
Individuals	40	142
Person-days	179	585
<u>Camps</u>		
Daily duration range (hours)	3-9	7.5-10
Sites	1	5
<u>Age</u> (years), mean \pm SD	11.5 \pm 2.2	7.6 \pm 1.4
5-6 years	0	21 (15%)
7-8 years	0	101 (71%)
9-10 years	17 (43%)	12 (8%)
11-12 years	9 (23%)	8 (6%)
13-14 years	9 (23%)	0
15-17 years	5 (13%)	0
<u>Sex</u>		
Male	22 (55%)	76 (54%)
Female	18 (45%)	66 (46%)
<u>Race/Ethnicity</u>		
African American/Black	17 (43%)	51 (36%)
White non-Hispanic	7 (18%)	12 (8%)
Asian	5 (13%)	0
Hispanic/Latino	4 (10%)	37 (26%)
Multiracial/Other/Unknown	7 (18%)	42 (30%)
<u>Accelerometer Data</u>		
Average wear time (days per week)	4.5	4.1
Average wear time (minutes per day)	298.8	548.9

Wear time (person-minutes)	53,244	319,570
Percent of time spent in MVPA	24.3%	15.6%
Percent of time spent in VPA	5.5%	3.5%

Note. Table includes consented participants with 2+ days of 2+ hours of wear for STEC and 2+ days of 5+ hours of wear for BSC. Percentages have been rounded up and may not sum to 100.

Differences in Accelerometer Measures between STEC and Boston Summer Camps

The crude analysis indicates that STEC children are more active during monitored time at camp compared to Boston summer camp children; the percent of wear time per day that is MVPA is 24% for STEC children, compared to 16% for Boston summer camp children (see Table 1). After controlling for covariates, children at STEC were more active, measured in percent of accelerometer wear time spent in MVPA and VPA, compared to children at Boston summer camps (MVPA: 11% difference, $p = .005$, 95% CI = 3.41, 19.42; VPA: 2% difference, $p = .023$, 95% CI = .33, 4.44) (see Table 2).

Table 2. Estimated differences in percent of camp day accelerometer wear time spent in moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA) between Sportsmen's Tennis and Enrichment Center (STEC) and Boston summer camp (BSC) participants.

Measure	STEC	BSC	Crude Difference	Adjusted Difference ^b	95% CI	<i>p</i>
N ^a	179	585				
Percent of time spent in MVPA	24.3%	15.6%	8.7%	11.4%	3.41,	0.005
Percent of time spent in VPA	5.5%	3.5%	2.0%	2.4%	19.42	0.023
					0.03, 4.44	

^a Refers to the number of person-days (from 40 STEC subjects and 142 BSC subjects).

^b Adjusted difference represents the difference in scores in STEC compared to BSC, after adjusting for age, sex, race/ethnicity, weather, nesting of days within children, and nesting of children within camps.

Predictors of Physical Activity within STEC

Physical activity significantly varied by age, after adjusting for other covariates, as indicated by regression coefficients in the models for Table 3. Every year increase in age was associated with a decrement of 3.1% MVPA time ($p = .009$, 95% CI = -5.29, -.83). MVPA also varied by past STEC participation; campers who participated in school year programs at STEC averaged 11.3% more MVPA time compared to those who did not participate in school year programs ($p = .006$, 95% CI = 3.43, 19.14). Being an intermediate or advanced player was associated with a 14.2% increase in MVPA time compared to beginners ($p = .06$, 95% CI = 4.36, 23.97). In addition, being Asian was associated with 11.8% more MVPA time ($p = .042$, 95% CI = .47, 23.14) compared to black participants. There were no significant predictors of percent wear time spent in VPA.

Table 3. Regression estimates from linear models predicting percent of camp day accelerometer wear time spent in moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA) for Sportsmen's Tennis and Enrichment Center (STEC) participants.

<i>Independent Variable</i>	MVPA (minutes)			VPA (minutes)		
	β	95% CI	p	β	95% CI	p
Intercept	27.98	4.13, 51.84	0.023	8.68	-0.80, 18.16	0.071
Age (yr)	-3.06	-5.29, -0.83	0.009	-	-1.84, 0.79	0.425
Female (=1) vs. Male (=0)	-6.39	-13.69, 0.90	0.084	-	-4.96, 3.65	0.758
<u>Race/Ethnicity</u>						
Asian (=1) vs. Black (=0)	11.80	0.47, 23.14	0.042	6.23	-0.38, 12.84	0.064
Latino/Hispanic (=1) vs. Black (=0)	-2.25	-14.26, 9.76	0.704	-	-7.75, 6.29	0.834
Non-Hispanic White (=1) vs. Black (=0)	-0.22	-8.95, 8.51	0.959	3.99	-1.14, 9.11	0.123
Missing/Multiracial/Other/Unknown (=1) vs. Black (=0)	7.76	-1.04, 16.57	0.082	2.77	-2.43, 7.96	0.285
<u>Tennis level</u>						
Intermediate/Advanced (=1) vs. Beginner (=0)	14.17	4.36, 23.97	0.006	3.10	-2.67, 8.86	0.282
<u>Past STEC participation</u>						
First time participant (=1) vs. Returning player (=0)	-4.26	-12.38, 3.86	0.293	-	-5.58, 4.00	0.737
School year participant (=1) vs. Not a school year participant (=0)	11.28	3.43, 19.14	0.006	3.46	-1.17, 8.09	0.137
<u>Weather</u>						
Percent deviation from annual temperature	0.08	-0.17, 0.33	0.523	0.08	-0.01, 0.17	0.080
Total precipitation	-1.73	-9.43, 5.97	0.657	1.07	-1.73, 3.87	0.453
Dew point	-0.16	-0.64, 0.33	0.519	-	-0.34, 0.01	0.067

Note. 40 participants and 179 person-days. Models are adjusted for nesting of days within participants.

DISCUSSION

Community interventions to improve physical activity can be disseminated in many settings. Past research has identified out-of-school time as an important setting for physical activity interventions targeting children (Afterschool Alliance, 2010; Barrett et al., 2014; Beets et al., 2013; Weaver et al., 2014; Zarrett et al., 2013). This study systematically measured the physical activity of children who attend summer programs so that researchers and practitioners who plan interventions can better understand the physical activity contributions of existing community resources such as STEC, as well as begin to disentangle any activity differences

between sports- and non-sports-focused programs. The primary aim was to test the hypothesis that participants in a sports-focused camp show higher levels of percent wear time spent in MVPA compared to participants in non-sports-focused camps. A secondary aim was to analyze whether MVPA within STEC varied by certain predictors. A major strength of this study is that it employed a community-engaged research approach; for example, it addressed community needs (e.g., asked research questions that were developed with the help of community representatives) and disseminated results to the community, with an end goal of community capacity-building.

Results indicated that STEC participants averaged 71.9 minutes of MVPA/day, well above the Department of Health and Human Services' 60 minutes/day national recommendation. In an effort to place the results in a broader context, we also compared STEC accelerometer data with US national averages for children, obtained from the 2003 – 2006 National Health and Nutrition Examination Survey (NHANES), analyzed in 2012 to estimate physical activity levels during the school day among 2548 youth ages 6-19 (Long et al., 2013; Troiano et al., 2008). We found that STEC campers were more active during monitored time at camp compared to the national sample, in which the percent of wear time spent in MVPA per day was less than 11% for all groups reported: 10.3% for boys ages 6-11, 4.8% for boys ages 12-19, 8.0% for girls ages 6-11, and 2.7% for girls ages 12-19 (Long et al., 2013). In the national sample, activity during the school day (hours similar to summer camp hours) accounted for the largest proportion of daily MVPA on weekdays (approximately 45%), but still is considerably less than the activity accrued during the STEC day (Long et al., 2013). The proportion of wear time per day that was MVPA for the school-day national sample was 7.0% for boys and 4.7% for girls (Long et al., 2013) (Appendix A), compared to 29.0% for boys at STEC and 19.1% for girls at STEC. Children participating in STEC spent a much higher percent of accelerometer wear time in MVPA than did children in the school-day national sample.

This paper does not address the fact that camp-day physical activity may *not* result in an increase of total physical activity if children ultimately decrease physical activity outside of camp (e.g., compensate for their busy day by sitting on the couch all evening). While outside the scope of our paper, this issue was addressed in a separate study regarding school-day physical activity, which found that higher school-day MVPA was in fact associated with higher daily MVPA among US youth. That is, there was no evidence that children experienced same-day 'compensation' (Long et al., 2013). Even if STEC children completed no physical activity for the remainder of the day, they still would have exceeded national recommendations.

Consistent with past research, the results in this sample show that children's physical activity declines as they enter adolescence (Gortmaker, Lee, Craddock, et al., 2012; Troiano et al., 2008). Although physical activity in the STEC sample did not vary significantly by sex, the coefficient suggests that girls at STEC may be less active than boys. The lack of significance may be due to the small sample size or to the fact that STEC is more effectively equalizing the amount of activity between boys and girls. Campers who participated in STEC's school year programs had a higher percent of MVPA, suggesting that familiarity with a program or place may impact physical activity. In addition, intermediate and advanced players experienced more activity, which may be explained by their ability to elongate points on the court by keeping the ball in play, thus spending less time receiving inactive instruction. The results suggesting that Asian participants experience a higher percent of MVPA at STEC may be attributed to the small sample size, as there were only five Asian participants in the STEC sample.

This study's primary limitation is that the two populations are not directly comparable. Ideally, we would have collected data from the Boston summer camps and STEC camp during the same summer for children of the same age range. Although this was not logistically feasible, we used the same methodology, measures, and

data collection protocols. Further, research suggests a linear decline in MVPA as age increases, so the statistical model should account for the differences in age distribution (Gortmaker, Lee, Cradock, et al., 2012; Troiano et al., 2008). We made other efforts to ensure that the studies were as comparable as possible. The same instructor trained research assistants, using nearly identical training materials, and the same model and type of accelerometer was used for both studies. The STEC data analysis also duplicates the protocol used to analyze Boston summer camp and NHANES accelerometer data. Implicit in the comparison of data from different years is the assumption of temporal stability; the suitability of this assumption is supported by past research, which suggests that there has been no significant change in children's physical activity since 2003 (Gortmaker, Lee, Cradock, et al., 2012; Troiano et al., 2008). Since total accelerometer wear time was longer for children at Boston summer camps, one may suggest that it was easier to keep STEC children active in a shorter amount of time. We adjusted for accelerometer wear time by reporting differences in percent of wear time spent in physical activity. However, future studies could compare summer camps that have more similar day lengths.

This study utilized a convenience sample to collect data from one site in Dorchester, MA. For this reason, and because the sample size was relatively small, the results may not be generalizable to a larger population. Children who attended STEC may be systematically different from those who attended other Boston area summer camps (e.g., those who attend STEC may prefer sports and may be more active). Similarly, children who agreed to participate in the study may be systematically different from those who did not agree (e.g., they may have more health-conscious parents), so generalizability even to the STEC population is not guaranteed. However, the high response rate (77%), diversity of the participants, and observational nature of the study (*i.e.*, the population is not restricted the way it would be with a randomized controlled trial) suggest that the sample is representative of the population of interest—children who attend STEC summer camp—and bode well for external validity. Ultimately, however, future research should test the generalizability of these findings by conducting similar studies among different populations and settings (e.g., urban and suburban areas, other tennis camps, and other sports camps). Until then, the results can be helpful for estimating trends and useful for hypothesis generation, especially for summer camp physical activity studies. Researchers specifically interested in further understanding the health impact of inner-city tennis centers could investigate physical activity levels at other National Junior Tennis and Learning chapters, which reach more than 225,000 under-resourced youth (United States Tennis Association Foundation, n.d.).

Many unmeasured factors could have affected children's level of activity during camp time. For example, we did not measure sleep patterns, maturity level, height/weight, or physical activity levels at other times of the day. In addition, while ActiGraph accelerometers have been validated, they cannot be used in water, so values of physical activity may be underestimated because they did not capture swim periods during camp days. If underestimation has occurred, it likely has occurred not only in STEC but also in Boston summer camps.

CONCLUSION

Evaluating the physical activity contributions of STEC's programs will be helpful to the surrounding Dorchester community and also to the Center as its leaders seek to expand STEC's reach and improve upon existing opportunities. By more thoroughly understanding the impact of a not-for-profit tennis and enrichment model, other communities may be inspired to establish similar centers in their neighborhoods, ultimately helping to potentially decrease the incidence of disease, increase physical activity opportunities, improve the community's overall health, and diminish health disparities.

The results of our study may not be surprising. After all, it makes sense that children at a sports camp would be more active than children at a general day camp. However, this is the first and only study to our knowledge that uses real data to document physical activity differences between sports- and non-sports-oriented summer camps. This study does not intend to detract from other positive experiences and outcomes that may result in attending a non-sports-oriented camp. However, having data that support our hypothesis that sports camps generate significantly more physical activity for children could have important implications at the community, school, and policy level. Support for and promotion of more sports-oriented programs could ultimately play a key role in the management and prevention of obesity, diabetes, and chronic disease.

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