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## **EXAMINING DIFFERENCES IN PHYSICAL ACTIVITY BY SOCIO- DEMOGRAPHICS, EMPLOYMENT, AND SOCIAL SUPPORT AMONG U.S. ADOLESCENTS**

ASHLEIGH MARIE JOHNSON

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by


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## DEDICATION

To my parents

EXAMINING DIFFERENCES IN PHYSICAL ACTIVITY BY SOCIO-DEMOGRAPHICS,  
EMPLOYMENT, AND SOCIAL SUPPORT AMONG U.S. ADOLESCENTS

by

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EXAMINING DIFFERENCES IN PHYSICAL ACTIVITY BY SOCIO-DEMOGRAPHICS,  
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The overall decline in physical activity levels during adolescence supports the examination of intrapersonal-, interpersonal-, and behavior-level factors that may influence physical activity behavior among this population. The three papers within this dissertation aimed to examine associations of socio-demographics and socio-environmental factors with physical activity among U.S. adolescents. Papers 1 and 3 used data from the Family Life, Activity, Sun, Health, and Eating (FLASHE) Study. Paper 1 examined differences in adolescent physical activity by gender and race/ethnicity, and examined modification by grade and socioeconomic status (SES). Paper 3 examined the association of parent- and adolescent-reported parental social support with adolescent physical activity, and if these relations were modified by parent employment. Paper 2 used data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) to examine the association of adolescent and parent weekly hours worked with adolescent physical activity.

The FLASHE study is a cross-sectional study that examined correlates of cancer-related behaviors among U.S. adolescents and their caregivers. Adolescents were eligible if they 1) were 12-17 years and 2) lived in the household for at least 50% of the time. Parents

were eligible if they 1) were 18 years or older, 2) lived with at least one child aged 12-17 years for at least 50% of the time, and 3) agreed to be contacted for participation. The Add Health study examined factors that may influence adolescents' health. Schools served as the primary sampling unit and were eligible if they 1) included an 11th grade and 2) enrolled over 30 students. For this dissertation, only participants with complete data for the primary independent and dependent variables of interest were included. Paper 1 used multiple regression to compare in-school, out-of-school, and weekend MVPA by gender and race/ethnicity, and examine modified by grade level and SES. Paper 2 used multiple regression to examine the relation of adolescent and parent and employment with adolescent physical activity (MET/times/week). Multinomial logistic regression was used to examine the relation of adolescent and parent employment categories with adolescent physical activity tertiles (low, medium, high), using the lowest tertile of physical activity as reference. Paper 3 used multiple regression to examine the relation of parental social support scores with out-of-school and weekend MVPA, and to examine whether these relations were modified by parental employment before and after adjusting for adolescent grade, race/ethnicity, and SES.

Paper 1 results suggested that relations of socio-demographics with physical activity are complex and contradict many assumptions made in literature. Paper 2 results show that adolescent physical activity was inversely associated with adolescent hours worked, with a direct association of parent employment with adolescent physical activity. Paper 3 found that both parent- and adolescent-reported parent social support were associated with adolescent physical activity. These results highlight the complexity of adolescent physical activity behavior, and the need to consider multiple levels of influence, potential disparities among socio-demographic subgroups, and differences by periods of physical activity.



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## INTRODUCTION

Although physical activity is widely known to be associated with numerous physical and mental health benefits among youth, only about 25% of adolescents meet U.S. aerobic physical activity recommendations.<sup>1</sup> Furthermore, the percentage of youth achieving the recommended levels of physical activity declines with age, with a notable drop during adolescence.<sup>1</sup> Previous studies that have examined differences in adolescent physical activity levels by numerous individual- (e.g. race/ethnicity, age, gender) and family-level factors (e.g. socioeconomic status) report notable disparities, with more disadvantaged population subgroups showing lower levels of activity.<sup>2-6</sup> In addition, multiple factors at the interpersonal, social-cultural, and environmental levels have been shown to influence adolescents' physical activity levels (e.g., employment and parental social support).<sup>4,7-9</sup> A better understanding of interpersonal variations in the levels of physical activity and barriers to increased physical activity may be obtained by examining its patterning across the time of day and week; however, most studies to date have primarily examined adolescents' total or leisure time physical activity.

The overall objective of this dissertation research is to determine the prevalence of in-school, out-of-school, and weekend physical activity by socio-demographic factors (gender, race/ethnicity, age, socioeconomic status) and to examine associations of socioenvironmental factors (employment, social support/parenting practices) with overall, and out-of-school and weekend physical activity among U.S. adolescents. To achieve this objective, three studies were proposed. The first study compared the prevalence of engagement in in-school, out-of-school, and weekend adolescent-reported physical activity by gender and race/ethnicity, as

well as explore the potential moderating role of grade and socioeconomic status (paper 1). The second study examined the association of both adolescent and parent weekly hours worked (i.e. employment) with prevalence of engagement in adolescent-reported physical activity (paper 2). The final study examined the association between both parent- and adolescent-reported social support with adolescent-reported out-of-school and weekend physical activity, as well as explore the potential moderating role of parental employment (weekly hours worked) (paper 3).



## BACKGROUND

Accumulating sufficient aerobic physical activity to meet the United States (U.S.) *2018 Physical Activity Guidelines for Americans*, defined for adolescents as engaging in at least 60 minutes of daily moderate-to-vigorous intensity physical activity (MVPA) (henceforth: guidelines), is associated with numerous physical and mental health benefits.<sup>10</sup> Meeting guidelines is associated with improved aerobic and muscular fitness, and a reduced risk of overweight and obesity.<sup>10</sup> These benefits help reduce the risk of more distal outcomes that may develop across the life-course including hypertension, type II diabetes, breast cancer, and cardiovascular disease.<sup>10,11</sup> Furthermore, physical activity levels during this period of the life course are an important area of research given evidence that physical activity during childhood and adolescence tends to track into adulthood.<sup>12</sup>

Despite the numerous known benefits of engaging in physical activity, a majority of adolescents do not accumulate sufficient physical activity to meet guidelines, with notable differences by age and gender. Based on self-report data from the 2017 Youth Risk Behavior Surveillance System (YRBSS), only 26.1% of high school students meet guidelines.<sup>13</sup> Furthermore, physical activity levels decline with age, with only 23% of 12<sup>th</sup> graders meeting guidelines, compared to over 30% of 9<sup>th</sup> graders.<sup>13</sup> Accelerometer-based estimates from the 2005-06 National Health and Nutrition Examination Survey (NHANES) show a similar pattern, with the prevalence of youth meeting aerobic guidelines declining drastically from 6-11 year-olds (42.5%) to 12-15 year-olds (7.5%) as children enter into adolescence, with additional declines in 16-19 year-olds (5.1%).<sup>1</sup> There are also notable differences by gender, with the prevalence of meeting physical activity guidelines higher in males versus females

(35.3% versus 17.5%, respectively).<sup>13</sup> A similar difference in prevalence estimates by gender is observed when device-based measures were used to estimate physical activity levels.<sup>1</sup>

Although there have been consistent reports of physical activity declining with age, patterns of physical activity levels by socioeconomic status (SES) and race/ethnicity are mixed. A recent systematic review by Stalsberg and Pedersen found that a majority of studies supported the hypothesis that adolescents with higher SES are more physically active than those of lower SES.<sup>5</sup> However, a marked proportion of studies included in this review (42%) reported null or inverse relation.<sup>5</sup> In addition, although being of White racial origin is positively associated with physical activity among adolescents in several systematic reviews,<sup>14</sup> a review of reviews by Bauman et al. reported inconsistent or inconclusive findings for differences in physical activity by race/ethnicity status.<sup>15</sup>

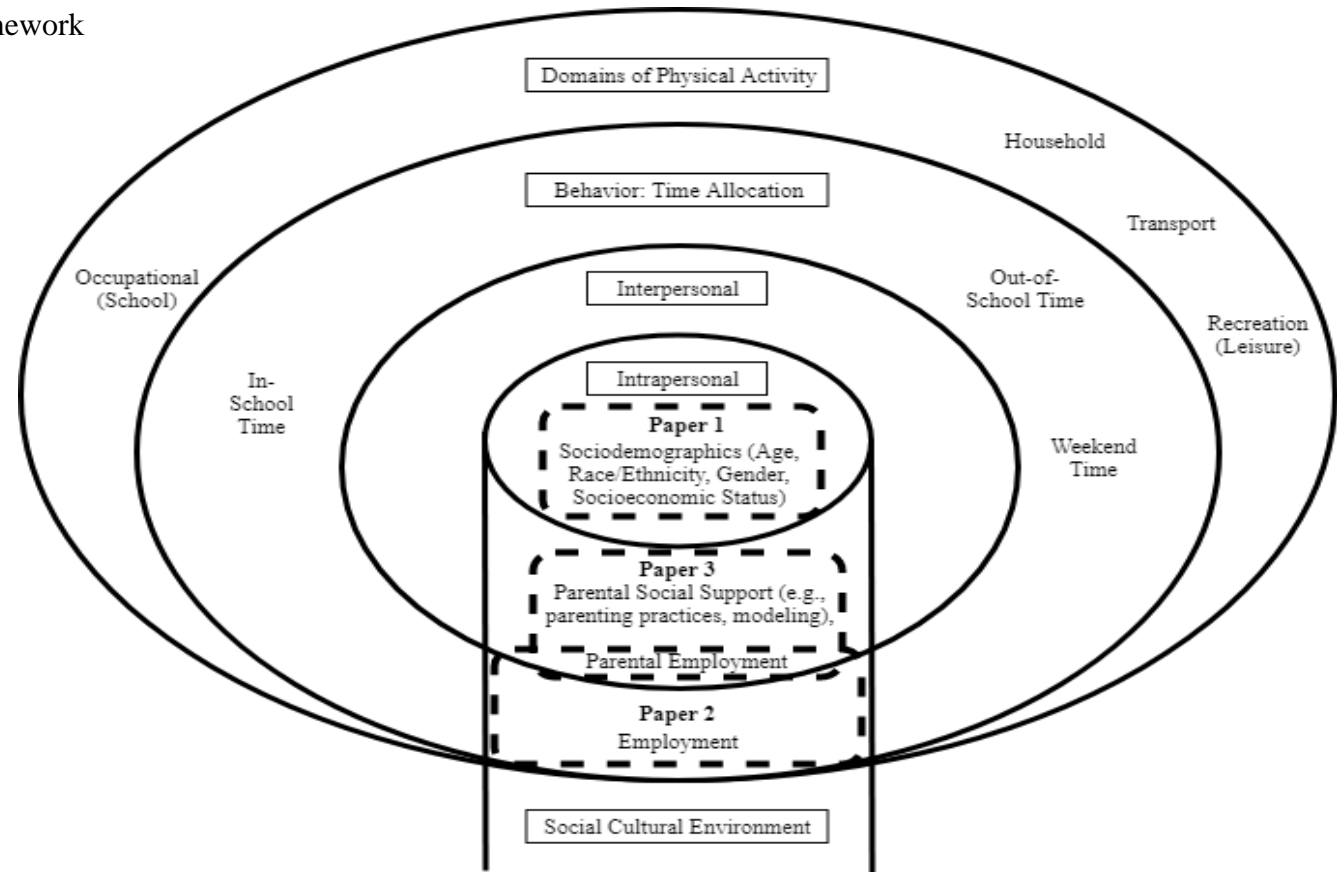
Inconsistent findings are also seen when comparing physical activity levels by racial/ethnic groups across SES strata, although few studies have examined these associations among adolescents. One study by Whitt-Glover et al. reported physical activity differences from the 2003-2004 NHANES by racial/ethnic (African American, White, Mexican American) and SES (low, medium, high) subgroups.<sup>16</sup> Among African American youth aged 12-15 years, the prevalence of meeting guidelines was highest among those of middle SES (12.4%), compared to those of low (9.7%) and high (11.2%) SES.<sup>16</sup> A similar pattern was seen among Mexican Americans, with the highest prevalence of meeting guidelines among those of middle SES (11.3%).<sup>16</sup> However, among Whites, more youth of high SES met guidelines (7.7%) compared to those of low (6.2%) and middle (4.9%) SES.<sup>16</sup> Alternatively, among older adolescents aged 16-19 years, the highest prevalence of youth meeting

guidelines was among those of low SES for all racial/ethnic subgroups.<sup>16</sup> This study is one of the few that has reported physical activity levels by racial/ethnic subgroups across SES strata, particularly among a large sample similar to that of the U.S. adolescent population. However, these data conflict with findings demonstrating lower physical activity levels among racial/ethnic minorities and those of low SES.<sup>5,14</sup> Considering environmental factors, including inter- and intra-personal and behavior levels of influence, and upstream factors such as time allocation may help explain the variations in activity levels among these adolescent subgroups, as well as the overall decline in physical activity during adolescence.

## Conceptual Model

An ecological model of adolescents' in-school, out-of-school, and weekend time physical activity with considerations for the social cultural environment is presented in Figure 1, adapted from the Ecological Model of Four Domains of Active Living.<sup>17</sup>

Figure 1. Conceptual Framework



### *Conceptual Model*

In identifying factors that may influence physical activity among adolescents at different time points, ecological models provide a robust conceptual framework. Physical activity behavior is complex due to the multiple interpersonal, social cultural, and environmental influences that must be considered.<sup>4,6</sup> Ecological models take these factors into account and posit that behavior is influenced at multiple levels, including the intrapersonal, interpersonal, organizational, physical environment, and policy levels.<sup>18</sup> Figure 1 depicts a conceptual model adapted from the Ecological Model of Four Domains of Activity Living (Appendix A), developed by Sallis et al. to illustrate the multiple levels of influence on four active living (physical activity) domains: *recreation (leisure)*, *household, occupation*, and *transport*.<sup>17</sup> The Sallis et al. model includes intrapersonal, perceived environment, behavior, behavior settings, and policy environment levels of influence.<sup>17</sup> However, this model applies to the general population, rather than to adolescents specifically. The adapted conceptual model above (Figure 1) focuses on the **intrapersonal** (e.g. demographic, biological, and family situation factors), **interpersonal** (e.g. parental social support, parenting practices, parental employment), and **behavior** (e.g. employment, time use) levels of influence among adolescents, specifically in the context of the **social cultural environment**. The adapted model also considers **time allocation** at the behavior level of influence, with delineation between in-school, out-of-school, and weekend time.

Time allocation is an important consideration for understanding adolescent physical activity levels throughout the day and week. Youth experience numerous mental, physical, environmental, and social changes during adolescence, which likely influence the time use

changes that are seen among adolescents compared to children.<sup>19</sup> Adolescence is also a time of increasing autonomy, with adolescents spending less time being supervised than younger children.<sup>19</sup> Furthermore, adolescents start working for pay, and spend more time studying, in school, and in organized activities (e.g. clubs) than do children.<sup>19</sup> Changes in how time is spent in-school, out-of-school, and on the weekend can affect physical activity engagement, highlighting the need to examine different influential factors and potential variation in activity by time periods throughout the day and week.

As demonstrated in the model above, time allocation – specifically the time of day and/or day of the week in which physical activity may occur – is taken into consideration. Paper 1 focuses on the intrapersonal level of influence, specifically demographics (e.g., grade, race/ethnicity, gender, and socioeconomic status (SES)) that are reported correlates of physical activity.<sup>6</sup> Paper 2 examined both parental and adolescent employment at the behavior level of influence. Finally, paper 3 focuses on social support/parenting practices – an important factor at the interpersonal level of influence – with considerations for the role of parent employment.<sup>7,20</sup> The conceptual model also demonstrates that each of these papers occur within an adolescent’s social cultural environment, which includes social relationships and social rules regarding family structure, relationships, norms, values, and beliefs.<sup>21</sup>

It is important to explore how multiple levels of influence help or hinder physical activity engagement among adolescents. Considering factors at different levels - including social class variables such as gender, race/ethnicity, grade, and SES – while considering time periods during the day and week helps to explore reasons for the decline in physical activity levels during adolescence and the noted disparities among this population.

## **Literature Review**

This literature review presents findings from studies examining patterns of adolescent physical activity levels during the day and/or week. In addition, the results of studies examining the relationship between 1) parental and adolescent employment and 2) parental social support with adolescent physical activity are presented. The strengths and limitations of existing research, as well as notable gaps in the literature that this research aimed to address, will also be discussed.

### ***Physical Activity by Day (Week vs. Weekend) and Time (In vs. Out of School)***

Adolescent physical activity levels are known to vary by socio-demographics such as race/ethnicity, gender, age, and SES.<sup>1,3,5,6,14,16</sup> However, a majority of studies examining such differences consider total volume of MVPA, rather than examining activity levels by times of the day and/or day of the week. These are important considerations, as adolescents experience different environmental influences on their physical activity behavior throughout the week.<sup>17</sup> Most adolescents spend a majority of their weekday time in-school, where physical activity is influenced by structured school days and state physical education mandates.<sup>30</sup> Conversely, out-of-school and weekend is discretionary and less regulated, with the potential for more variability among adolescent physical activity levels due to differences in environmental influences.<sup>4,15,17,22-24</sup> These potential variations in the school, neighborhood, and home environments may disproportionately affect activity levels across adolescent subgroups during in-school, out-of-school, and weekend time. This supports the need for examination of physical activity by time of day and week while considering important

demographics such as race/ethnicity, gender, age, and SES. However, few studies have been conducted in this area, highlighting a notable gap in the literature.

Evidence for the relationship between time of day and/or day of the week with adolescent physical activity is presented in Table 1. Previous research can be divided into studies examining 1) adolescent physical activity patterns during weekday time only and 2) studies examining patterns during both weekday and weekend time. The methods for defining distinct time periods during the day varied by study, as did the physical activity outcome measures. Both device-based (e.g. accelerometer, pedometer, heart-rate monitor) and self-report measures (e.g. MARCA, questionnaires, daily diary) were used.

#### *Weekday Only Patterns of Adolescent Physical Activity*

Three cross-sectional studies examined weekday time only, with two of these studies using adolescent-reported physical activity. Olds et al. used Multimedia Activity Recall for Children and Adolescents (MARCA), a computerized activity diary, to examine reported physical activity on weekdays among adolescents aged 10-18.<sup>25</sup> Adolescents reported higher physical activity before and after school (out-of-school) and during recess and lunch (in-school), compared to other times in a 24-hour cycle.<sup>25</sup> There were also differences by age, with older adolescents (aged 14-18) reporting less physical activity in-school, at lunch, and during recess compared to younger adolescents (aged 10-13).<sup>25</sup> MARCA was also used by Stanley et al. to compare lunchtime (in-school) and afterschool (out-of-school) activities among adolescents aged 10-14.<sup>26</sup> This study found that 65% of reported lunchtime activities were classified as moderate- to vigorous-intensity physical activities, compared to 43% of



afterschool activities, suggesting that adolescents are more active during lunchtime (during in-school time) than afterschool (during out-of-school time).<sup>26</sup>

A third study by Mota et al. used accelerometers to examine MVPA during four periods of the weekday among adolescents aged 8-15: morning (9:00–11:59 a.m.), noon (12:00–2:59 p.m.), late afternoon (3:00–5.59 p.m.), and evening (6:00–9.59 p.m.).<sup>27</sup> No patterns of daily physical activity were found, although there were differences by gender. Girls engaged in more MVPA during morning and noon times (in-school), while boys engaged in more MVPA during late afternoon and evening (out-of-school).<sup>27</sup> These conflicting results among studies examining patterns of adolescents' weekday activity may be due, in part, to the use of different measures of physical activity (self-reported versus accelerometer-derived). Further, these findings are limited, in that only weekday physical activity was considered, versus examination of an adolescent's entire week (i.e. including weekends).

#### *Weekday and Weekend Patterns of Adolescent Physical Activity*

Examining physical activity during weekdays and weekends provides more information about patterns of adolescent activity across the day and week than examining times during weekdays only. Eight cross-sectional studies examined adolescent physical activity during weekdays and weekends, primarily through the use of device-based measures of physical activity. Four of these studies examined minutes per day of MVPA using accelerometer-derived physical activity, with similar results. Nilsson et al. found that 15-year-olds spent significantly more time in MVPA on weekdays than on weekend days ( $p < 0.01$ ).<sup>28</sup> Belton et al. reported similar findings among 11-14 year olds – although there

were statistically significant differences among females only – with more time spent in MVPA on weekdays (49.14 min/day) than on weekends (41.57 min/day) ( $p < 0.005$ ).<sup>29</sup> In addition, Treuth et al. examined physical activity levels among 6<sup>th</sup> grade girls only, but also found higher MVPA levels on weekdays (26 min/day  $\pm$  13) than on weekends (18 min/day  $\pm$  14) ( $p < 0.001$ ).<sup>30</sup> A study by Aibar et al. did not directly compare weekdays and weekends, but examined time segments on weekdays (non-school time, school-time, and school-time travel) and weekends (morning, afternoon, and night).<sup>31</sup> Aibar et al. found that two of the three highest levels of MVPA were during weekday segments, specifically non-school-time (29.2  $\pm$  17.5 min/day) and school-time (25.8  $\pm$  14.2 min/day), in addition to weekend morning-time (28.2  $\pm$  25.8 min/day).<sup>31</sup>

Studies using other device-based measures of physical activity (i.e. pedometer and heart rate monitor) have found some similar findings. For example, a study by Hohepa et al. used pedometers to examine daily step counts among 12-18 year olds and found that adolescents had significantly more steps on weekdays (12,259 steps  $\pm$  287) than on weekends (8241 steps  $\pm$  329) ( $p < 0.0001$ ).<sup>32</sup> In addition, a study by Gavarry et al. examined minutes per day of MVPA using a heart rate monitor and found that moderate-intensity physical activity levels were higher during weekdays than weekends among girls aged 11-13 (78  $\pm$  38 versus 56  $\pm$  38 min, respectively) and boys ages 14-16 (43  $\pm$  27 versus 25  $\pm$  16 min, respectively) ( $p < 0.05$ ).<sup>33</sup> However, a later study by Gavarry et al. utilizing heart rate monitors among youth aged 6-20 found no significant main effect of day of the week on physical activity levels within any of the age groups examined (primary, junior high, senior high).<sup>34</sup>

Only one study used adolescent-reported physical activity, which was used to examine estimated daily MET values. This study, by Peiró-Velert et al., found that adolescents aged 12-16 reported significantly higher daily energy expenditure on weekends (41.60 kcal/kg per day,  $s = 9.02$ ) than on weekdays (38.69 kcal/kg per day,  $s = 5.63$ ) ( $p < 0.001$ ).<sup>35</sup> Similar to above, these conflicting findings may be due to the use of different physical activity measures (self-report versus device-based). Table 1 provides a summary of characteristics of studies examining adolescent physical activity by time of day and/or day of the week.

Table 1. Characteristics of studies examining adolescent physical activity by time of day and/or day of the week

Reference	Study Design	Study Population	Periods of Measure	Physical Activity Measure	Results
<b>Weekday Only</b>					
Olds, et al. (2009)	Cross sectional	Adolescents aged 10-18 in Australia (n=6,024)	Time of day on weekdays	Adolescent-reported physical activity	<ul style="list-style-type: none"> <li>- Older adolescents (14-18) had less MVPA during in-school hours than younger adolescents</li> <li>- Older adolescents less active than younger adolescents (10-13) at lunch and recess</li> </ul>
Stanley, et al. (2011)	Cross sectional	Adolescents aged 10-14 in Australia (n=794)	Lunchtime and after school time on weekdays	Adolescent-reported physical activity	<ul style="list-style-type: none"> <li>- Adolescents reported more activity during lunchtime than after-school time</li> </ul>
Mota, et al. (2003)	Cross sectional	Adolescents aged 8-15 in Portugal (n=84)	Time of day on weekdays	Accelerometer derived physical activity volume	<ul style="list-style-type: none"> <li>- No pattern of daily physical activity</li> <li>- Girls engaged in more MVPA during morning and early afternoon (in-school) than boys</li> <li>- Boys engaged in more MVPA during late afternoon and evening (out-of-school) than girls</li> </ul>

Weekday and Weekend					
Nilsson, et al. (2007)	Cross sectional	Adolescents aged 9-15 in Europe (n=1954)	Weekdays and Weekend	Accelerometer derived physical activity volume	<ul style="list-style-type: none"> <li>- Overall physical activity higher during weekdays than weekends (<math>p&lt;0.01</math>)</li> <li>- More variability among students for in-school time and leisure time activity levels (<math>p&lt;0.01</math>)</li> </ul>
Belton, et al. (2016)	Cross sectional	Adolescents ages 11-14 in Ireland (n=413)	Time blocks during weekdays (around school, during school, and after school) and weekend (morning, midday, afternoon)	Accelerometer derived physical activity	<ul style="list-style-type: none"> <li>- Significant differences between weekday and weekend MVPA for females (49.14 vs 41.57 min respectively (<math>p &lt; 0.005</math>), but not males (55.48 vs 54.28 min respectively)</li> </ul>
Treuth, et al. (2007)	Cross sectional	Sixth and 8 <sup>th</sup> grade girls in six major U.S. cities (n=1603)	Time of day on weekdays and weekend	Accelerometer derived physical activity	<ul style="list-style-type: none"> <li>- More MVPA on weekdays (26 minutes/day) than weekends (18 minutes/day) (<math>p&lt;0.001</math>)</li> <li>- Bursts of activity on mornings and early afternoons occurred on weekdays only</li> </ul>
Aibar, et al. (2014)	Cross sectional	Adolescents ( $M_{age}= 14.33$ years) in France and Spain (n=829)	Time blocks on weekdays (school-travel, school, non-school time) and weekend (morning, afternoon, night time)	Accelerometer derived physical activity	<ul style="list-style-type: none"> <li>- Most active segments were non-school (<math>29.2\pm17.5</math> min) and school time (<math>25.8\pm14.2</math> min) during weekdays, and morning-time (<math>28.2\pm25.8</math> min) on the weekend</li> </ul>

Hohepa, et al. (2008)	Cross sectional	Students aged 12-18 years in New Zealand (n=236)	Weekdays and weekend	Pedometer-derived physical activity	- Higher step count on weekdays ( $12,259 \pm 287$ ) than on weekends ( $8241 \pm 329$ ) ( $p < 0.0001$ )
Gavarry, et al. (1998)	Cross sectional	Students aged 11-16 in Nice, France (n=87)	Five time periods on school versus free day (i.e. weekends)	Heart rate monitor derived physical activity	- More activity during physical activity lessons, recreation, and lunch break than evening time - More activity on school days than free days and weekends
Gavarry, et al. (2003)	Cross sectional	Youth aged 6-20 in France (n=232)	Five time periods on school versus free day (i.e. weekends)	Heart rate monitor derived physical activity	- No significant main effect of day of the week on physical activity levels within any age group (primary, junior high, senior high).
Peiro'-Velert, et al. (2008)	Cross sectional	Students in grades 7-10 in Spain (n=323)	Weekdays and weekend	Adolescent-reported physical activity	- Higher daily energy expenditure during the weekend ( $41.60 \text{ kcal/kg/day}$ , $s = 9.02$ ) than during the week ( $38.69 \text{ kcal/kg/day}$ , $s = 5.63 \text{ kcal}$ ).

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Overall, current evidence suggests that adolescents are more active during weekdays (including in-school and out-of-school time) than on the weekends. However, there are several notable gaps in the literature. Most studies examining adolescent physical activity patterns by day and/or week have been conducted outside of the U.S.<sup>25-29,31-35</sup> Furthermore, no known studies have examined these physical activity patterns among a large, nationally representative sample of U.S. adolescents.

### ***Parental and Adolescent Employment and Adolescent Physical Activity***

Disparities and variations in adolescent physical activity levels may be due, in part, to different time constraints such as employment, affecting adolescents at the behavior (i.e., time allocation) level of influence.<sup>17</sup> Working for pay (i.e., employment) typically occurs outside of school and on the weekends,<sup>36</sup> which can limit the time available for leisure time physical activity. Time constraints, such as employment, have previously been reported as a perceived barrier to physical activity among adolescents.<sup>37,38</sup> However, few studies have examined the relationship between employment with physical activity among adolescents.

Parental employment is another important environmental factor to be considered when examining adolescent physical activity behavior. Parental employment can limit a parent's availability,<sup>39,40</sup> which can be particularly influential when adolescents are not in school.<sup>41</sup> However, a majority of the work involving the association between parental employment and adolescent physical activity has been conducted among children (versus adolescents), using employment as a proxy for SES.<sup>42,43</sup>

Evidence for the association of adolescent employment and parent employment with adolescent physical activity is presented in Table 2. Previous research can be classified as

studies examining the association between 1) adolescent employment with adolescent physical activity and 2) parental employment with adolescent physical activity. The methods for measuring employment varied by study (e.g., hours worked per week, full-time employment - yes/no), as did methods to quantify the physical activity outcome. Both device-based (e.g. accelerometer) and self-report measures (e.g. questionnaires, 3-Day Physical Activity Recall) were used.

#### *Adolescent Employment and Adolescent Physical Activity*

Four cross-sectional studies examined the association of adolescent employment with adolescent physical activity. Pruitt and Springer examined data from the Monitoring the Future Study, a nationally representative survey of young people, to examine the association between adolescent-reported physical activity and employment among U.S. 10<sup>th</sup> and 12<sup>th</sup> graders, and reported a ‘U-shaped’ relationship.<sup>44</sup> Tenth graders working 10 hours per week reported higher overall physical activity levels compared to non-working 10<sup>th</sup> graders.<sup>44</sup> However, both 10<sup>th</sup> and 12<sup>th</sup> grade students working over 10 hours per week reported less overall physical activity compared to non-workers, which remained significant after controlling for race, gender, parental education, age, urbanity, gender by race interaction, grades, and time use (time with friends, time spent alone, movies, community, television, parties).<sup>44</sup> A similar pattern was reported by Carrière, who used a measure of adolescent-reported total accumulated energy expenditure (kcal/kg/day) to examine leisure time physical activity among 15-17 year old students in Canada. The odds of being physically active were nearly twice as high for students working >5 to ≤10 and >10 to ≤15 hours per week compared to non-working students (adj. OR=1.8 [95% CI:1.4-2.3] and adj. OR=1.9 [95%



CI:1.4-2.6], respectively), after taking age, gender, household income, and urban/rural residence into account.<sup>45</sup> Furthermore, the odds were more than double for adolescents working between 15 and 20 hours per week, compared to non-working adolescents (adj. OR=2.6 [95% CI:1.8-3.7]).<sup>45</sup> However – similar to findings by Pruitt and Springer – the odds were lower beyond 20 hours of work per week, although still higher than non-workers.<sup>45</sup>

A study by Safron, et al. examined the relationship between employment - defined as hours worked per week in a paid or unpaid job - and adolescent-reported physical activity among 8<sup>th</sup>, 10<sup>th</sup>, and 12<sup>th</sup> graders in the U.S.<sup>46</sup> Although hours worked per week was directly associated with reported exercise among 8<sup>th</sup> graders, there was an inverse association among 10<sup>th</sup> and 12<sup>th</sup> graders.<sup>46</sup> Another study found conflicting findings among 12<sup>th</sup> grade females in South Carolina, U.S.<sup>47</sup> The study, by Dowda et al., used both accelerometers and adolescent-reported physical activity (3-Day Physical Activity Recall) to examine physical activity levels.<sup>47</sup> This study found that girls who worked reported significantly higher METs per day (mean=66.4, SE 0.5) than girls who did not work (mean=59.5, SE 0.5) ( $p<0.001$ ).<sup>47</sup> Overall, the limited evidence has reported mixed findings for the relationship between adolescent employment with adolescent physical activity. However, there is some evidence that suggests adolescents who work engage in more physical activity, although this relationship may vary depending on the adolescent's grade and if adolescents are working more than 20 hours a week.<sup>44,46,48</sup>

#### *Parental Employment and Adolescent Physical Activity*

Three prospective cohort studies examined the relation between parental employment with adolescent physical activity. Johnson and Allen used mother-reported adolescent

physical activity among a sample of mother-child dyads, including adolescents aged 10-18, and found that mother-reported maternal hours worked per week was inversely associated with adolescent physical activity.<sup>43</sup> Similar findings were found in a study by Martin, et al., although adolescent-, rather than parental-, reported measures were used for both employment and physical activity.<sup>49</sup> This study examined adolescent-reported maternal hours worked per week and adolescent-reported physical activity among a nationally representative sample of 7<sup>th</sup>-12<sup>th</sup> graders in the U.S.<sup>49</sup> Similar to the findings noted above, maternal hours worked per week was inversely associated with adolescent physical activity, specifically sports and exercise engagement.<sup>49</sup>

These results conflict with another study by Datar, et al., which used mother-reported weekly hours worked among a nationally representative sample of 5<sup>th</sup> and 8<sup>th</sup> graders in the U.S.<sup>50</sup> Although mother-reported physical activity was used for 5<sup>th</sup> graders, adolescent-reported physical activity was used among 8<sup>th</sup> graders (days per week that the child did at least 20 minutes of vigorous exercise).<sup>50</sup> An additional 20 hours of work per week among mothers increased the likelihood of at least 5 days per week of vigorous activity by one percentage point among 8<sup>th</sup> graders.<sup>50</sup> Table 2 provides a summary of characteristics of studies examining the relation between adolescent or parental employment with adolescent physical activity.

Table 2. Characteristics of studies examining the relation between adolescent or parental employment with adolescent physical activity

Reference	Study Design	Study Population	Employment Measure	Physical Activity Measure	Results
<b>Adolescent Employment with Adolescent Physical Activity</b>					
Carrière (2005)	Cross sectional	Students aged 15-17 in Canada (n=1,598)	Adolescent-reported hours worked per week	Adolescent-reported physical activity	- Odds of being physically active highest among students working 15 to 20 hours a week (adj. OR=2.6 [95% CI:1.8-3.7]) compared to non-working students
Pruitt & Springer (2010)	Cross sectional	Nationally representative sample of black and white 10 <sup>th</sup> and 12 <sup>th</sup> graders in the U.S. (n=17,573)	Adolescent-reported hours worked per week	Adolescent-reported physical activity	- Tenth and 12 <sup>th</sup> graders working >10 hours per week reported less overall physical activity - Tenth and 12 <sup>th</sup> graders working >20 hours per week reported less sports participation and exercise, respectively
Safron, et al. (2001)	Cross sectional	Nationally representative sample of 8 <sup>th</sup> , 10 <sup>th</sup> and 12 <sup>th</sup> graders in the U.S. (n=183,703)	Adolescent-reported hours worked per week	Adolescent-reported physical activity	- Hours worked per week directly associated with reported exercise among 8 <sup>th</sup> graders and inversely associated with reported exercise among 10 <sup>th</sup> and 12 <sup>th</sup> graders

Dowda, et al. (2007)	Cross sectional	Twelfth grade females in South Carolina, U.S. (n=1,381)	Adolescent-reported employment	Adolescent-reported physical activity and accelerometer derived physical activity volume	- Girls who worked reported significantly higher METs (mean=66.4, SE 0.5) than girls who did not work (mean=59.5, SE 0.5)
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### Parental Employment with Adolescent Physical Activity

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Johnson & Allen (2012)	Prospective cohort	Sample of mother-child dyads with adolescents aged 10-18 in U.S. (n=359)	Mother-reported hours worked per week	Mother-reported adolescent physical activity	- Maternal hours worked per week inversely associated with adolescent physical activity
Martin, et al. (2018)	Prospective cohort	Nationally representative sample of 7th–12th graders in the U.S. (n=10,518)	Adolescent-reported maternal hours worked per week	Adolescent-reported physical activity	- Maternal hours worked per week inversely associated with adolescent sports and exercise engagement
Datar, et al. (2014)	Prospective cohort	Nationally representative sample of 5 <sup>th</sup> and 8 <sup>th</sup> graders in U.S. (n=18,520)	Mother-reported hours worked per week	Parent-reported physical activity (5 <sup>th</sup> graders) and adolescent-reported physical activity (8 <sup>th</sup> graders)	- An additional 20 hours of work per week for mothers increased likelihood of $\geq 5$ days/wk of vigorous physical activity by 1 percentage point among 8 <sup>th</sup> graders

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Overall, current evidence suggests variations in the relation between adolescent employment with adolescent physical activity, as well as conflicting results for the relation between parental employment with adolescent physical activity. These findings may be due – in part – to the limited evidence base, which supports the need for additional research in this area. Furthermore, no known studies have examined the relation of adolescent and parent employment combined (i.e. summed hours worked for pay per week) with adolescent physical activity.

### ***Parent Social Support for Adolescent Physical Activity***

Social support, defined as the perceived reinforcement and encouragement received from the social environment, can vary outside of school and in the home environment.<sup>51</sup> Parental social support for physical activity is an important component of adolescents' social cultural environment at the interpersonal level, and includes 1) emotional (e.g., displays of empathy, care, and love), 2) instrumental (e.g., tangible aid and services), 3) informational (e.g., suggestions and advice), and 4) appraisal (e.g. information used for self-evaluation) support.<sup>52</sup> Social support is also an important component of physical activity parenting practices, which can include encouragement of physical activity, modeling of physical activity, and logistic support.<sup>53</sup> Numerous studies have examined the relationship between parental or family social support with adolescent physical activity levels, reporting direct associations.<sup>9,54,55</sup>

Evidence for the relationship between parental social support for physical activity and adolescent physical activity is presented in Table 3. Previous research can be divided into 1) adolescent-reported and 2) parent-reported measures of parental social support for physical

activity. The methods for measuring social support varied by study, as did the physical activity outcome measures. Both device-based (e.g. accelerometer, pedometer) and self-report measures were used.

#### *Adolescent-reported Parental Social Support for Adolescent Physical Activity*

Six studies examined the relation between parental social support and adolescent physical activity using adolescent-reported parental social support, including three cross-sectional studies. Cheng et al. examined parent social support for physical activity with a five item measure (*stimulating, accompanying, watching, inviting, feedback, transport*) and adolescent-reported physical activity among 14-19-year olds in Brazil.<sup>56</sup> This study found that parental social support was directly associated with reported physical activity among male ( $\beta=0.14$ ,  $p<0.01$ ) and female ( $\beta=0.17$ ,  $p<0.01$ ) adolescents.<sup>56</sup> Similar results were found by Hohepa et al. among 12 to 18-year-olds in New Zealand.<sup>20</sup> This study used a one item measure for parent social support (*encouragement*) and adolescent-reported physical activity using the New Zealand Child Nutrition Survey.<sup>20</sup> Results showed that low parental support was associated with reduced odds of being regularly active after school among both high school juniors (OR: 0.47, 95% CI: 0.38–0.58) and seniors (OR: 0.41, 95% CI: 0.29–0.60).<sup>20</sup> A third cross-sectional study by Prochaska et al. examined parent social support with five items (*encouragement, praise, transport, participation, watching*) among 6<sup>th</sup>-8<sup>th</sup> graders in San Diego, CA.<sup>55</sup> This study used both adolescent-reported (PACE+) and accelerometer-derived (uniaxial) measures of physical activity.<sup>55</sup> Although parent support was significantly associated with adolescent-reported physical activity ( $r=0.31$ ,  $p<0.01$ ) – similar to the results

noted above - correlations were not significant for accelerometer-derived physical activity levels.<sup>55</sup>

Three prospective cohort studies also used adolescent-reported measures of parent social support for physical activity. Bauer et al. examined social support for physical activity using two items per parent (*encouragement, care about staying fit and exercising*) and adolescent-reported physical activity (total weekly hours of MVPA) among middle and high school students in the U.S.<sup>57</sup> There were notable findings by gender, as paternal encouragement and care for fitness was directly associated with male adolescents' MVPA, while maternal encouragement was directly associated with younger female adolescents' MVPA.<sup>57</sup> Another study by Dowda et al. also reported significant findings using adolescent-reported physical activity (3DPAR), although the sample was limited to female 8<sup>th</sup> graders in South Carolina, U.S.<sup>58</sup> This study examined familial social support using a five-item measure (*encouragement, accompanying, transport, watching, knowledge*), and found consistent trends over time.<sup>58</sup> Specifically, Dowda et al. reported that perceived family support was significantly associated with total METs among female students at 8<sup>th</sup>, 9<sup>th</sup>, and 12<sup>th</sup> grade ( $p < 0.001$ ).<sup>58</sup>

Evidence for a statistically significant relation of social support with physical activity engagement was also documented by a prospective cohort study by Duncan et al., which examined parental social support using five items (*encouragement, participation, watching, transport, communication*) among a cohort of 10-, 12-, and 14-year-olds in the Pacific Northwest, U.S.<sup>59</sup> Physical activity was measured using both adolescent-reported and device-based (pedometer) measures, and youth who perceived that their parents watched their

physical activity more had higher levels of physical activity compared to their peers who did not have this perception ( $p<0.05$ ).<sup>59</sup> These findings suggest that parental social support for physical activity is significantly associated with adolescent-reported physical activity. However, these studies were limited to only adolescent-reported social support.

#### *Parent-reported Parental Social Support for Adolescent Physical Activity*

Few studies have examined the relation of parent social support with adolescent physical activity using parent-reported measures of social support. A large cross-sectional study by Liu et al. examined parent-reported social support using a six-item measure (*encouragement, accompanying, financial support, involvement, knowledge, modeling*) among youth aged 9-17 in China.<sup>60</sup> Adolescent-reported physical activity (IPAQ-SF) was used to estimate average daily minutes of MVPA.<sup>60</sup> Findings showed that parental encouragement, accompanying, financial support, involvement, and role modeling were directly associated with a high level of adolescent MVPA ( $b=1.98, 0.90, 1.07, 0.85, \text{ and } 0.71$ , respectively) ( $p<0.001$ ).<sup>60</sup> Table 3 provides a summary of characteristics of studies examining the relation between parental social support for physical activity with adolescent physical activity.



Table 3. Characteristics of studies examining the relation between parental social support for physical activity with adolescent physical activity

Reference	Study Design	Study Population	Social Support Measure	Physical Activity Measure	Results
<b>Adolescent-reported Parental Social Support</b>					
Cheng, et al. (2013)	Cross sectional	High school students 14-19 years old in Brazil (n=2,361)	Adolescent-reported (5 items)	Adolescent-reported physical activity	- Parental social support directly associated with the level of physical activity among male ( $\beta=0.14$ , $p<0.01$ ) and female ( $\beta=0.17$ , $p<0.01$ ) adolescents
Hohepa, et al. (2007)	Cross sectional	High school students 12-18 years old in New Zealand (n=3,471)	Adolescent-reported (1-item each for mother and father)	Adolescent-reported physical activity	- Low parental support associated with reduced odds of being active after school (Juniors, OR: 0.47, 95% CI: 0.38-0.58; Seniors, OR: 0.41, 95% CI: 0.29-0.60)
Prochaska, et al. (2002)	Cross sectional	6 <sup>th</sup> -8 <sup>th</sup> grade students in San Diego, CA, U.S. (n=138)	Adolescent-reported (5-items)	Adolescent-reported and uniaxial accelerometer-derived physical activity	- Parent support significantly associated with self-reported physical activity ( $r=0.31$ , $p<0.01$ ). - Correlations not significantly associated with accelerometer-based measure of physical activity

Bauer, et al. (2008)	Prospective cohort	Middle and high school students in U.S. (n=4746)	Adolescent-reported (2 items per parent)	Adolescent-reported physical activity	- Paternal encouragement and care for fitness directly associated with male adolescents' MVPA - Maternal encouragement directly associated with younger female adolescents' MVPA
Dowda, et al. (2007)	Prospective cohort	Female 8 <sup>th</sup> graders in South Carolina, U.S. (n=421)	Adolescent-reported (5-items for family support)	Adolescent-reported physical activity	Perceived family support significantly associated with total METs at 8 <sup>th</sup> , 9 <sup>th</sup> , and 12 <sup>th</sup> grade (p<0.001)
Duncan, et al. (2005)	Prospective cohort	10-,12-, and 14-year-old children in Pacific Northwest, U.S. (n=372)	Adolescent-reported (5-items)	Adolescent-reported and pedometer-derived physical activity	Youth who perceived that their parents, siblings, and friends watched their physical activity more had higher levels of physical activity (p<0.05)
<b>Parent-reported Parental Social Support</b>					
Liu, et al. (2017)	Cross sectional	School-age children 9-17 years in China (n=81,857)	Parent-reported social support for physical activity (6 items)	Adolescent-reported physical activity	- Parental encouragement (b=1.98), accompanying (b=0.90), financial support (b=1.07), involvement (b=0.85), and role modeling (b=0.71) for physical activity were directly associated with a high level of adolescent MVPA (p<0.001)

Overall, current evidence suggests that parental social support for physical activity is significantly associated with adolescent-reported physical activity. However, there are notable gaps in the literature. The measures for social support vary by study, with some limited to one- or two-item measures.<sup>20,57</sup> In addition, few studies have explored the role of other social factors that may moderate the relation between social support and physical activity. Furthermore, few studies have utilized both parent- and adolescent-reported measures of social support, particularly among a large sample similar to that of the U.S. adolescent population.

### **PUBLIC HEALTH SIGNIFICANCE**

Meeting physical activity guidelines is associated with numerous short- and long-term health benefits for adolescents, and is directly associated with physical activity levels in adulthood.<sup>10,61,62</sup> However, physical activity levels decrease during adolescence, and there are notable disparities among socio-demographic subgroups such as race/ethnicity and SES.<sup>3,13,16</sup> There is a need to increase understanding of factors that facilitate or inhibit physical activity overall in adolescents as well as these differences in physical activity engagement between subgroups of adolescents, which may be further informed by examining adolescent activity levels by time of day and week, particularly during out-of-school time which likely has more environmental variations for adolescents than a structured school day.<sup>63</sup> However, there is limited research examining the relation between different levels of influence (i.e. intrapersonal, interpersonal, behavior) with adolescent physical activity during specific periods of time, particularly among a large, nationally-representative sample of U.S.

adolescents.<sup>17,37,38,64</sup> Findings from the dissertation research can be used to identify opportunities for intervention at different levels of influence during this critical life stage. This information can then be incorporated into the development of public health programs aimed at increasing and/or maintaining activity levels, which help to increase the percentage of adolescents who meet physical activity guidelines and experience the associated health benefits.

## **DISSERTATION PURPOSE AND OBJECTIVES**

### ***Purpose***

A majority of U.S. adolescents fail to meet guidelines, with known socio-demographic disparities. There are also many environmental factors associated with adolescent physical activity, although there are notable gaps in the literature. Most studies examining adolescent physical activity focus on total or leisure time activity rather than considering physical activity patterns by day and/or week. Furthermore, few studies include both parent and adolescent physical activity factors (e.g., employment, social support), or explore social factors that may moderate the relation between influences such as parental social support and adolescent activity levels (e.g., parental employment). In addition, few studies examining these associations have been conducted within the U.S. among a large sample of adolescents.

The purpose of this dissertation research is to examine associations of adolescent in-school, out-of-school, and weekend physical activity with socio-demographic and socio-environmental factors - including employment and social support/parenting practices - while exploring variations in these associations by individual- (gender, race/ethnicity, grade) and

family-level (socioeconomic status) factors among U.S. adolescents. The dissertation research analyzed data from Family Life, Activity, Sun, Health, and Eating (FLASHE) Study<sup>65</sup> and the Add Health Study.<sup>66</sup> The FLASHE Study is a national cross-sectional survey developed by the National Cancer Institute (NCI) to examine correlates of physical activity, diet, and other cancer preventative behaviors among U.S. parent-adolescent dyads.<sup>65,67</sup> The Add Health Study is school-based longitudinal study of a nationally-representative sample of U.S. adolescents in grades 7-12 aimed to examine the causes of adolescent health and health behavior, including physical activity.<sup>66</sup>

## **Specific Aims**

### ***Paper 1***

*The Overall Purpose of this Study is to compare adolescent reported in-school, out-of-school, and weekend moderate to vigorous intensity physical activity (MVPA) by gender and race/ethnicity using the Family Life, Activity, Sun, Health, and Eating (FLASHE) Study; a nationally representative sample of U.S. adolescents aged 12-17 years. Potential modification of these relations by 1) grade (6<sup>th</sup>-8<sup>th</sup> grade versus 9<sup>th</sup>-12<sup>th</sup> grade) and 2) socioeconomic status (eligibility for receiving free or reduced lunch, yes versus no) will also be explored.*

*Aim #1.1:* To describe and examine differences in reported mean daily minutes of in-school, out-of-school, and weekend MVPA overall, and by 1) gender and 2) race/ethnicity.

Hypothesis #1.1.1: Mean daily minutes of in-school, out-of-school, and weekend MVPA will differ overall.

Hypothesis #1.1.2: Mean daily minutes of in-school, out-of-school, and weekend MVPA will be differ by gender (male and female).

Hypotheses #1.1.3: Mean daily minutes of in-school, out-of-school, and weekend MVPA will differ by race/ethnicity (White, Hispanic, Black, and other race/ethnicity).

*Aim #1.2:* To evaluate if associations of gender and race/ethnicity with reported mean daily minutes of in-school, out-of-school, and weekend MVPA are modified by 1) grade (6<sup>th</sup>-8<sup>th</sup> grade versus 9<sup>th</sup>-12<sup>th</sup> grade) and 2) socioeconomic status (eligibility for receiving free or reduced lunch, yes versus no).

Hypothesis #1.2.1: The magnitude of the relation between gender and in-school, out-of-school, and weekend MVPA will differ by grade level (6<sup>th</sup>-8<sup>th</sup> versus 9<sup>th</sup>-12<sup>th</sup>).

Hypothesis #1.2.2: The magnitude of the relation between race/ethnicity and in-school, out-of-school, and weekend MVPA will by grade level (6<sup>th</sup>-8<sup>th</sup> versus 9<sup>th</sup>-12<sup>th</sup>).

Hypothesis #1.2.3: The magnitude of the relation between gender and in-school, out-of-school, and weekend MVPA will differ by socioeconomic status (eligibility for receiving free or reduced lunch, yes versus no).

Hypothesis #1.2.4: The magnitude of the relation between race/ethnicity and in-school, out-of-school, and weekend MVPA will differ by socioeconomic status (eligibility for receiving free or reduced lunch, yes versus no).

## ***Paper 2***

*The Overall Purpose of this Study* is to examine the unadjusted and adjusted association of adolescent and parent weekly hours worked with adolescent-reported physical activity, operationalized as MET/times/week, by individual-level factors including age, gender, and race/ethnicity, and family-level factors including socioeconomic status - defined as total household income, and parent availability - using the Add Health Study; a U.S. representative sample of adolescents in grades 7-12.

*Aim #2.1:* To examine the association of adolescent weekly hours worked with adolescent-reported physical activity, before and after adjusting for age, gender, race/ethnicity, parent availability, and socioeconomic status.

Hypothesis #2.1.1 There will be a direct association between adolescent weekly hours worked with adolescent-reported physical activity among adolescents working up to 20 hours per week, and an inverse association among adolescents working over 20 hours per week.

*Aim #2.2:* To examine the association of parent weekly hours worked with adolescent-reported physical activity, before and after adjusting for age, gender, race/ethnicity, parent availability, and socioeconomic status.

Hypothesis #2.2.1: There will be an inverse association between parent weekly hours worked with adolescent-reported physical activity.

*Aim #2.3:* To examine the association of adolescent and parent weekly hours worked (summed by dyad) with adolescent-reported physical activity, before and after adjusting for age, gender, race/ethnicity, parent availability, and socioeconomic status.

Hypothesis #2.3.1: There will be an inverse association between the sum of adolescent and parent weekly hours worked and adolescent-reported physical activity.

### ***Paper 3***

*The Overall Purpose of this Study* is to examine the unadjusted and adjusted association of parent- and adolescent-reported parental social support with adolescent-reported mean minutes of daily out-of-school and weekend moderate-to-vigorous intensity physical activity (MVPA) by individual-level factors including grade and race/ethnicity, and family-level factors including socioeconomic status – defined as receiving free or reduced lunch – using the Family Life, Activity, Sun, Health, and Eating (FLASHE) Study; a sample of U.S. adolescent-parent dyads. Potential modification of these relations by parental employment (weekly hours worked) will also be explored.

*Aim #3.1:* To evaluate if associations of mean parental social support scores (parent-reported) with adolescent-reported mean daily minutes of out-of-school and weekend MVPA are modified by parental employment ( $\leq 30$  versus  $>30$  hours worked weekly), before and after adjusting for grade, race/ethnicity, and socioeconomic status.

Hypothesis #3.1.1: Mean parental social support scores (parent-reported) will be directly associated with adolescent-reported out-of-school and weekend MVPA.

Hypothesis #3.1.2: The magnitude of the relation between parent social support (parent-reported) and out-of-school and weekend MVPA will be higher among the high parent employment group ( $>30$  hours worked weekly) versus the low parent employment group ( $\leq 30$  hours worked weekly).



*Aim #3.2:* To evaluate if associations of mean parental social support scores (adolescent-reported) with adolescent-reported mean daily minutes of out-of-school and weekend MVPA are modified by parental employment ( $\leq 30$  versus  $>30$  hours worked weekly), before and after adjusting for grade, race/ethnicity, and socioeconomic status.

Hypothesis #3.2.1: Mean parental social support scores (adolescent-reported) will be directly associated with adolescent-reported out-of-school and weekend MVPA.

Hypothesis #3.2.2: The magnitude of the relation between parent social support (adolescent-reported) and out-of-school and weekend MVPA will be higher among the high parent employment group ( $>30$  hours worked weekly) versus the low parent employment group ( $\leq 30$  hours worked weekly).

*Aim #3.3:* To evaluate if associations of mean parental social support scores (combined parent- and adolescent-reported) with adolescent-reported mean daily minutes of out-of-school and weekend MVPA are modified by parental employment ( $\leq 30$  versus  $>30$  hours worked weekly), before and after adjusting for grade, race/ethnicity, and socioeconomic status.

Hypothesis #3.3.1: Mean parental social support scores (combined parent- and adolescent-reported) will be directly associated with adolescent-reported out-of-school and weekend MVPA.

Hypothesis #3.3.2: The magnitude of the relation between parent social support (combined parent- and adolescent-reported) and out-of-school and weekend MVPA will be higher among the high parent employment group ( $>30$  hours worked weekly) versus the low parent employment group ( $\leq 30$  hours worked weekly).

# **PAPER 1 - COMPARING PHYSICAL ACTIVITY PATTERNING ACROSS THE DAY AND WEEK AMONG U.S. ADOLESCENTS**

## **Background**

Accumulating sufficient physical activity to meet guidelines has numerous health benefits for adolescents, including improved aerobic and muscular fitness and a reduced risk of overweight and obesity, and reduced lifetime risk of type II diabetes, breast cancer, and cardiovascular disease.<sup>10,11</sup> However, only 26.1% of U.S. high school students report meeting aerobic physical activity guidelines, defined as at least 60 daily minutes of moderate-to-vigorous intensity physical activity (MVPA).<sup>10,13</sup> There are additional disparities by gender and grade, with lower prevalence of physical activity engagement reported among female (versus male) high school students (17.5%) and 12<sup>th</sup> grade adolescents (versus 9<sup>th</sup> graders) (22.9%).<sup>13</sup> Additional differences by gender are also seen in physical activity levels by time of the day and/or week. For example, significant differences have been found between weekday and weekend MVPA for females (but not males),<sup>29</sup> and females have been shown to engage in more MVPA in-school (versus out-of-school), while the reverse was seen in males.<sup>68</sup> Adolescent physical activity levels have also been reported to vary by race/ethnicity and socioeconomic status (SES), although these findings have been less consistent.<sup>5,15</sup>

Researchers have examined numerous environmental factors associated with adolescent physical activity, with considerations for both the physical (e.g. school, home, neighborhood) and social (e.g. parents, peers) environment.<sup>4,15,69</sup> These factors, shown to influence physical activity, are also known to vary across different socio-demographic groups, including those defined by SES and race/ethnicity.<sup>16,70,71</sup> However, many studies exploring environmental factors of adolescent physical activity are limited to examining total

MVPA only, or physical activity within only the leisure time domain.<sup>72,73</sup> These approaches fail to take into account patterns of physical activity throughout the day and/or week, during which adolescents experience different physical and social environments; moreover, the temporal patterning of these different physical and social environments likely differs among different socio-demographic groups.<sup>74</sup>

Examining adolescent physical activity patterning across the day and week by known socio-demographic correlates of physical activity has the potential to provide insight into the conflicting findings for adolescent activity levels across different socio-demographic groups such as race/ethnicity and SES. Therefore, the purpose of this study was to 1) describe and examine differences in adolescent reported in-school, out-of-school, and weekend MVPA by gender and race/ethnicity, and 2) evaluate if relations of gender and race/ethnicity with adolescent reported in-school, out-of-school, and weekend MVPA are modified by 1) grade (6<sup>th</sup>-8<sup>th</sup> versus 9<sup>th</sup>-12<sup>th</sup> grade) and 2) SES (eligibility for receiving free or reduced lunch, yes versus no), based on a nationally representative sample of U.S. adolescents.

## **Methods**

### *Overview*

This study used data from the Family Life, Activity, Sun, Health, and Eating (FLASHE) Study, a cross-sectional, internet-based survey developed by National Cancer Institute (NCI) to examine psychosocial, generational (parent-adolescent), and environmental correlates of cancer-related behaviors, including physical activity, among U.S. adolescents aged 12-17 years.<sup>67</sup> The FLASHE sample was drawn from the Ipsos' Consumer Opinion Panel, which invites people to join through a variety of methods including print advertising, panelist referral, and Internet banner ads.<sup>75</sup> Ipsos selected panelists for FLASHE screening

using balanced sampling on the characteristics of race/ethnicity, household size, household income, Census division, and gender.<sup>75</sup> The target population for balancing was the U.S. population of adults in households with at least one adolescent between the ages of 12-17 years. More information on the FLASHE study design and sampling strategy is provided elsewhere.<sup>75</sup>

### *Study participants*

The study sample of FLASHE consisted of U.S. adolescents and their caregivers, recruited as dyads. Adolescents were eligible to participate if they 1) were aged 12-17 years and 2) lived in the household for at least 50% of the time. If more than one child in the household was eligible, one child was randomly selected. Parents were eligible to participate if they 1) were 18 years or older, 2) lived with at least one child aged 12-17 years for at least 50% of the time, and 3) agreed to be contacted for participation. For this study, only adolescent-parent dyads with complete data for the primary independent and dependent variables of interest were included.

### *Data Collection and Measures*

Data for the FLASHE study were collected between April-October 2014. Data collection methods included self-administered surveys that assessed 1) diet-related behaviors and 2) physical activity-related behaviors for both the adolescent and the parent (four web-based surveys total), and an additional accelerometer-derived physical activity assessment for a subsample of adolescents (data had yet to be released as of October 2019).<sup>76</sup> For the current study, data are based on self-reported physical activity.

### *Study Variables*

FLASHE variables included socio-demographic and physical activity, and are presented in Table 1.1.

#### Socio-demographics

Demographic questions were collected from the participant via a self-administered questionnaire attached to the end of the first survey, which was randomly selected as either the diet- or physical activity-related survey. The primary independent variables for this study were gender, categorized as either male or female, and race/ethnicity, categorized as Hispanic, non-Hispanic White, Non-Hispanic Black or African American, and Non-Hispanic Other; Black Hispanics were classified as Hispanic. Grade and SES were included as potential effect measure modifiers. Grade was categorized from grades 6<sup>th</sup>-12<sup>th</sup>. For this study, grade was categorized as 6<sup>th</sup>-8<sup>th</sup> grade (middle school) and 9<sup>th</sup>-12<sup>th</sup> grade (high school). Free or reduced lunch was used as a proxy for SES, with eligibility defined as those with an annual household income  $\leq 185\%$  of the Federal Poverty Level, equating to a yearly household income of \$44,123 in 2014 for a family of four.<sup>77</sup> For this variable, parents were asked “*Does {TEEN} currently receive free or reduced price lunch at school?*”. Age, in years, was included for descriptive purposes only.

#### Physical Activity

The primary dependent variables were self-reported daily minutes of MVPA in-school, out-of-school, and on the weekend, collected via the adolescent physical activity-related survey. Proportion of time spent in MVPA in-school, out-of-school, and on the weekend (with denominators of total time spent in-school, out-of-school, and on the weekend, respectively) were collected via the adolescent physical activity-related survey and included as secondary dependent variables in the descriptive analyses. Questions were

derived from the Youth Activity Profile (YAP),<sup>78</sup> a self-administered 7-day recall questionnaire for use among students aged 9-18 years.<sup>79</sup> The YAP is a 15-item questionnaire aimed to capture 1) activity at school, 2) activity out-of-school, and 3) sedentary habits. For the FLASHE study, the YAP was adapted to provide separate estimates of activity occurring at school (five items), out-of-school (three items), and on the weekend (two items).<sup>79</sup> In order to calibrate and validate the YAP, participants wore a GT3X+ ActiGraph on the dominant wrist for 7 days and then completed the YAP.<sup>79</sup> Calibration was provided by regressing percentage time in MVPA on each YAP subsection score (in-school, out-of-school, weekend), age, and the interaction between these two factors on measured outcomes recorded by the GT3X+.<sup>79</sup> Validity (median absolute percentage error, equivalence testing) was assessed by applying the final algorithms to independent samples of adolescents. The YAP had good criterion validity and predicted values within 10%-20% of those produced by the GT3X+.<sup>79</sup>

#### *IRB Statement and Protection of Human Subjects*

Ethical review and approval for the original FLASHE study was provided by U.S. Government's Office of Management and Budget, NCI's Special Studies Institutional Review Board, and Westat's Institutional Review Board. Data are deidentified and publicly available. Institutional Review Board exemption status for this study was sought from the University of Texas Health Science Center Committee for the Protection of Human Subjects (HSC-SPH-19-0675).

#### *Statistical Analysis*

Data management and statistical analyses were performed using STATA 15.1 (StataCorp, College Station, TX). Descriptive statistics were calculated for socio-

demographic and physical activity variables. Categorical variables were presented as prevalence estimates, and continuous variables were presented as means with standard deviations. Differences between genders on socio-demographic variables were assessed using chi-square test for categorical variables.

Analysis of variance (ANOVA) was used to compare grade- and gender-adjusted in-school, out-of-school, and weekend MVPA by gender and race/ethnicity groups. Multiple regression was conducted in order to describe and examine mean daily minutes of in-school, out-of-school, and weekend MVPA by gender and race/ethnicity, and examine whether these relations are modified by grade (6<sup>th</sup>-8<sup>th</sup> versus 9<sup>th</sup>-12<sup>th</sup> grade) and SES (eligibility for receiving free or reduced lunch, yes versus no). To evaluate potential modification of these relations, interaction terms for gender\*grade and race/ethnicity\*grade were first created and included in the gender and race/ethnicity models, respectively. Next, the gender\*grade\*SES and race/ethnicity\*grade\*SES interaction terms were created and tested in the models for gender and race/ethnicity, respectively. Weights were used in all regression analyses to allow results to be comparable to the U.S. population.

## **Results**

The final analytic sample was 1,413 adolescents with a mean age of 14.5 years (SD=1.6). The sample was 51.3% female and 64.5% were non-Hispanic White (Table 1.2). Thirty percent were eligible for free or reduced-price lunch. Adolescents were similarly distributed across males and females in age, race/ethnicity, grade level, and eligibility to receive free or reduced-price lunch ( $p>0.05$ ).

Reported mean daily minutes of MVPA were 56.8 (SD=12.6) in-school, 57.9 (SD=10.5) out-of-school, and 104.6 (SD=19.2) on the weekend (Table 1.3). Mean proportion

of time spent in MVPA on a daily basis was reported to be 11.8% (SD=2.6) in-school, 12.1% (SD=2.2) out-of-school, and 10.9% (SD=2.0) on the weekend. No significant differences by gender were found for grade-adjusted physical activity levels (Table 1.4). Significant differences by race/ethnicity were found for grade- and gender-adjusted in-school and weekend MVPA only, with Whites reporting significantly less in-school MVPA compared to all other racial/ethnic groups ( $p<.05$ ). Those classified as Other race/ethnicity group reported significantly less weekend time in MVPA than Hispanics, while Whites reported significantly more weekend time in MVPA than Blacks and Other racial/ethnic group ( $p<.05$ ). Proportion of time spent in MVPA for each period of physical activity is presented overall, by gender, and by race/ethnicity in Figures 1.1-1.3.

#### *Multiple Regression*

##### *Gender*

No statistically significant physical activity differences by gender were found at the middle school or high school level when the gender\*grade interaction term was included in the model (Table 1.5). However, when comparing physical activity levels by eligibility status with the gender\*grade\*SES interaction term, males not eligible for free or reduced-price lunch (compared to those eligible) reported significantly less in-school MVPA for both middle school (6<sup>th</sup>-8<sup>th</sup> grade) ( $p=.03$ ) and high school (9<sup>th</sup>-12<sup>th</sup>) ( $p<.01$ ). No statistically significant differences by eligibility status were found among females or for males' out-of-school or weekend MVPA.

##### *Race/ethnicity*

Statistically significant physical activity differences by race/ethnicity were found for reported in-school, out-of-school, and weekend MVPA when the race/ethnicity\*grade



interaction term was included in the model (Table 1.6). At the middle school level, in-school MVPA was significantly lower among Whites compared to Blacks ( $p<.001$ ) and Other race/ethnicity ( $p<.01$ ). Conversely, at the high school level, in-school MVPA was significantly higher among Hispanics compared to Whites ( $p<.001$ ).

Out-of-school MVPA was significantly lower among Hispanics compared to Whites ( $p<.01$ ) at the middle school level. However, at the high school level, Whites reported significantly lower out-of-school MVPA than Hispanics ( $p<.01$ ), and significantly more out-of-school MVPA than Other race/ethnicity group ( $p<.01$ ). Significant differences for weekend MVPA were found at the high school level only, with significantly more MVPA reported among Whites compared to Blacks ( $p<.01$ ) and Other race/ethnicity group ( $p<.001$ ). Significant physical activity differences by eligibility status were seen for in-school MVPA among Hispanics only when the race/ethnicity\*grade\*SES interaction term was included in the model, with those eligible reporting significantly more MVPA than those not eligible at both the middle school ( $p=.02$ ) and high school level ( $p=.02$ ).

## **Discussion**

This study described and examined differences in adolescent reported in-school, out-of-school, and weekend MVPA by gender and race/ethnicity, and evaluated if these relations were modified by grade (middle school versus high school) and SES (eligibility for receiving free or reduced lunch, yes versus no) among a nationally representative sample of U.S. adolescents. No statistically significant physical activity differences by gender were found at either the middle or high school level. However, physical activity differences by eligibility for receiving free or reduced lunch status within gender were found, although among males only for in-school MVPA. Statistically significant physical activity differences by

race/ethnicity were also found, although these relations differed by grade level and physical activity period (i.e., by day or time of week). At the middle school level, Hispanics had significantly less out-of-school MVPA than Whites, but had significantly more in-school and out-of-school MVPA than Whites at the high school level. Further, although Blacks and Other racial/ethnic group both had significantly more in-school MVPA than Whites at the middle school level, the inverse was seen for weekend MVPA at the high school level. Significant physical activity differences by eligibility status within race/ethnicity groups were also found among Hispanics for in-school MVPA only, with eligible Hispanics found to have higher MVPA compared to ineligible Hispanics at both the middle and high school levels.

The lack of statistically significant physical activity differences by gender observed in the current study conflict with existing evidence that adolescent females are less active than males.<sup>13</sup> However, this is a positive result and may suggest that females' physical activity has improved in recent years given increased public awareness and programming. Many of these programs target younger age groups, which is consistent with the notion that early activity predicts later activity across the lifespan. The physical activity differences seen by race/ethnicity, with Whites reporting significantly lower in-school MVPA compared to all other racial/ethnic groups, also contradicts with what is typically hypothesized in the literature<sup>14</sup> but further supports the conflicting findings regarding race/ethnicity and physical activity levels.<sup>15</sup> This could be due, in part, to the use of race/ethnicity as a proxy for SES within studies, which may not be appropriate when examining in-school activity. Studies have suggested that in-school physical activity factors may be largely patterned by SES (versus race/ethnicity),<sup>80</sup> with additional findings of adolescents of racial/ethnic minorities having higher activity levels than White students at the same schools.<sup>81</sup> In contrast to results

for in-school MVPA, Whites reported significantly more weekend MVPA than Blacks and Other racial/ethnic group. This may be due in part to racial/ethnic differences in neighborhood-level factors, as fewer adolescents of racial/ethnic minorities (compared to Whites) live in neighborhoods supportive of physical activity.<sup>82</sup> Overall, these results demonstrate that there are inconsistent findings regarding the relation between race/ethnicity and physical activity, suggesting the need to further examine potential racial/ethnic variations in physical activity correlates while considering how these correlates may vary by in-school, out-of-school, and weekend time.

No significant differences by gender at either the middle or high school level were similar to findings for overall physical activity levels by gender. When examining physical activity levels with considerations for gender, grade, and SES, those eligible for free or reduced-price lunch reported significantly more in-school MVPA compared to those not eligible, contradicting what has typically been hypothesized in the literature regarding SES.<sup>5</sup> However, in-school opportunities for physical activity are particularly important among low-income populations where youth have fewer facilities outside of school,<sup>83</sup> and these findings may be a reflection of varying physical activity opportunities within schools that are majority low SES versus majority high SES, particularly considering that lower SES schools have more access to grant funding for physical education.<sup>84</sup> It should also be noted that differences by SES were seen among males only, suggesting the need to further examine differences in physical activity correlates by gender and SES, particularly with in-school time.

When examining physical activity levels by both race/ethnicity and grade, the way in which physical activity varied across race/ethnicity groups was different for each of the physical activity periods, as well as for middle school versus high school. Further, findings

were not always consistent with what is hypothesized in the literature regarding physical activity levels among Whites compared to other racial/ethnic groups.<sup>14</sup> These findings strongly suggest there is a need to also look at racial/ethnic subgroups separately for middle and high school, because the relation for race/ethnicity with MVPA likely differs not only by different periods of physical activity, as previously noted, but also by grade level. For example, although there were no significant differences by race/ethnicity for weekend MVPA at the middle school level, there were notable differences at the high school level, which may be reflective of racial/ethnic differences in how high school students spend their time outside of school.

Similar to the results seen among males regarding differences by SES, Hispanics eligible for free or reduced-price lunch (compared to non-eligible Hispanics) reported significantly more in-school MVPA at both the middle school and high school level. These findings suggest not only are there inconsistent results for SES, as previously noted, there is a need to consider racial/ethnic subgroups and different periods of physical activity when examining the relation of SES and physical activity among adolescents.

### *Strengths and Limitations*

This study has numerous strengths. FLASHE was conducted among a large, nationally representative sample of U.S. adolescents, which provides external study validity with sufficient statistical power to detect differences by socio-demographic variables within each period of physical activity, and to explore potential moderation by grade level and SES. This study also used a valid and reliable measure of physical activity,<sup>79</sup> which asked participants to report within specific and theoretically relevant periods of activity (in-school, out-of-school, weekend). This study also addresses multiple gaps in the literature. This study

examined physical activity by time of day and/or week, versus overall or leisure time only, and is one of the few to examine this relation among a large, nationally representative sample of U.S. adolescents. Further, this study reported the contrasting findings based on using total minutes of MVPA, versus the proportion estimate, for each of the physical activity periods and demonstrating the importance of considering both in future physical activity research. Examining activity by time of day and/or week is an important consideration due to the different environmental influences of physical activity behavior experienced during these periods, with additional differences in these influences by socio-demographic groups.<sup>16,70,71,74</sup> Although specific environmental influences were not included in this study, these results are the first step to identifying and addressing potential physical activity disparities among different socio-demographic groups. These findings improve understanding of adolescent physical activity (including the notable declines during this life stage), and support the need for additional research to confirm these findings regarding adolescent physical activity levels by setting/time of day. Further, these results can be used to inform future epidemiological research on physical activity engagement among youth and potential physical activity differences by race/ethnicity, SES, grade level, and gender.

The limitations of this study must also be noted. Analyses were conducted using cross-sectional FLASHE data, which limits the ability to make causal inferences. Further, although the FLASHE study sample was selected to be similar to the U.S. population and weights were used in analyses, it should be noted that recruitment was conducted through a consumer opinion panel and had an overall study response prevalence of less than 30%,<sup>75</sup> which could limit external validity of the results. Also, although the measure for physical activity has been shown to be a reliable and valid measure,<sup>79</sup> it is based on participant-report

and therefore prone to recall and reporting bias, and possible social desirability bias. Despite these inherent limitations of self-reported physical activity, data from the FLASHE study allowed for assessment of physical activity periods (in-school, out-of-school, weekend) across a nationally representative sample of adolescents.

## **Conclusion**

There is a need to examine adolescent physical activity variation across the day and week as well as by socio-demographic (e.g. racial/ethnic, gender) groups, due to the different physical activity correlates that are experienced during these times that likely differ by these subgroups. This study suggests that the relations of gender, race/ethnicity, grade level, and SES with adolescent physical activity are complex and contradict many assumptions made in the literature. There is a particular need to look at these adolescent subgroups within different time periods and settings of physical activity, rather than only overall estimates of physical activity, in order to obtain a more accurate understanding of physical activity levels within this population. Future research should examine other potential relations of these socio-demographics with physical activity, such as the relations between grade level and SES, as well as gender and race/ethnicity, within each of the different time periods of physical activity. Additional research should also be conducted examining environmental correlates specific to in-school, out-of-school, and weekend physical activity, and how these vary by different socio-demographic subgroups, to help further explore these findings.

Table 1.1. Paper 1 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Variables

Construct	Variable	Survey	Type
Physical Activity Periods: Minutes per day spent in moderate- to vigorous-intensity physical activity (MVPA)			
In-school	(Derived) Minutes per day spent in MVPA at school	Adolescent	Dependent
Out-of-school	(Derived) Minutes per day spent in MVPA out-of-school	Adolescent	Dependent
Weekend	(Derived) Minutes per day spent in MVPA during the weekend	Adolescent	Dependent
Physical Activity Periods: Proportion of time spent in moderate- to vigorous-intensity physical activity (MVPA)			
In-school	(Derived) Proportion of time spent in MVPA at school, percentage	Adolescent	Dependent
Out-of-school	(Derived) Proportion of time spent in MVPA out-of-school, percentage	Adolescent	Dependent
Weekend	(Derived) Proportion of time spent in MVPA during the weekend, percentage	Adolescent	Dependent
Socio-demographics			
Gender	Are you male or female? • ( <i>Male, Female</i> )	Adolescent	Independent
Race/ethnicity	(Recoded) Are you Hispanic, Latino/a or Spanish origin? Which one or more of the following would you say is your race? • ( <i>Hispanic, Black or African American only, White only, Other</i> )	Adolescent	Independent
Socioeconomic status	Does {TEEN} currently receive free or reduced-price lunch at school? • ( <i>Yes, No</i> )	Parent	Covariate
Grade	(Derived) What grade are you in? • ( <i>6<sup>th</sup>-8<sup>th</sup> grade, 9<sup>th</sup>-12<sup>th</sup> grade</i> )	Adolescent	Covariate
Age	What is your age? • ( <i>12 years old to 17 years old</i> )	Adolescent	Covariate

Table 1.2. Paper 1 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Participant Characteristics

Characteristic	Total Sample (N=1,413)	Male (n=688, 48.7%)	Female (n=725, 51.3%)	P value for differences by gender
Age (M=14.5 years, SD=1.6)	n (%)	n (%)	n (%)	
12-13 years	472 (33.4)	226 (32.9)	246 (33.9)	0.59
14-15 years	487 (34.5)	232 (33.7)	255 (35.2)	
16-17 years	454 (32.1)	230 (33.4)	224 (30.9)	
Race/Ethnicity				
Hispanic	143 (10.1)	70 (10.2)	73 (10.1)	0.68
Black	232 (16.4)	120 (17.4)	112 (15.5)	
White	912 (64.5)	434 (63.1)	478 (65.9)	
Other	126 (8.9)	64 (9.3)	62 (8.6)	
Grade Level				
6 <sup>th</sup> -8 <sup>th</sup>	580 (41.1)	284 (41.3)	296 (40.8)	0.98
9 <sup>th</sup> -12 <sup>th</sup>	831 (58.8)	403 (58.6)	428 (59.0)	
Eligibility for Free or Reduced Lunch				
Yes	419 (29.7)	216 (31.4)	203 (28.0)	0.27

M=Mean, SD=Standard Deviation



Table 1.3. Paper 1 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Participant Overall In-School, Out-of-School, and Weekend Physical Activity Levels (N=1,413)

	<b>In-School</b>	<b>Out-of-School</b>	<b>Weekend</b>
	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>
<b>Mean daily minutes of MVPA (min/day)</b>	56.8 (12.6)	57.9 (10.5)	104.6 (19.2)
<b>Proportion of time spent in MVPA<sup>a</sup> (%)</b>	11.8 (2.6)	12.1 (2.2)	10.9 (2.0)

SD=Standard Deviation

MVPA=Moderate to Vigorous-Intensity Physical Activity

<sup>a</sup>Based on total time spent in-school, out-of-school, or on the weekend

Table 1.4. Paper 1 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Participant In-School, Out-of-School, and Weekend Grade- and Gender-Adjusted Mean Daily Minutes of Moderate to Vigorous-Intensity Physical Activity (MVPA) for Gender and Race/Ethnicity Groups

		<b>In-School</b>	<b>Out-of-School</b>	<b>Weekend</b>
	<b>n</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>
<b>Total<sup>a</sup></b>	1,413	56.8 (12.6)	57.9 (10.5)	104.6 (19.2)
	<b>n</b>	<b>Mean (SE)</b>	<b>Mean (SE)</b>	<b>Mean (SE)</b>
<b>Gender<sup>b</sup></b>				
<b>Male</b>	687	57.1 (0.3)	58.2 (0.3)	105.5 (0.7)
<b>Female</b>	724	56.6 (0.3)	57.7 (0.3)	103.8 (0.6)
<b>p-value<sup>c</sup></b>		0.31	0.27	0.07
<b>Race/Ethnicity<sup>d</sup></b>				
<b>Hispanic</b>	143	58.7 (0.8)	58.5 (0.7)	105.9 (1.0)
<b>Black</b>	232	58.1 (0.6)	57.6 (0.5)	102.3 (1.1)
<b>White</b>	911	56.0 (0.3)	58.0 (0.3)	105.7 (0.6)
<b>Other</b>	125	58.5 (0.8)	57.3 (0.7)	100.1 (1.5)
<b>p-value</b>		<b>&lt;0.00</b>	0.61	<b>&lt;0.00</b>

SD=Standard Deviation; SE=Standard Error; Bold indicates significance

<sup>a</sup>Unadjusted

<sup>b</sup>Adjusted for grade level

<sup>c</sup>Calculated using analysis of covariance (ANCOVA)

<sup>d</sup>Adjusted for grade level and gender

Table 1.5 Paper 1 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Mean Daily Minutes of In-School, Out-of-School, and Weekend Moderate- to Vigorous-Intensity Physical Activity (MVPA) Estimated from Multiple Regression Models - Gender

		In-School	Out-of-School	Weekend
		Mean (SE)	Mean (SE)	Mean (SE)
Gender*Grade (n=1,411)		Mean Daily Minutes of MVPA		
Middle School				
Male		67.7 (0.6)	66.4 (0.5)	115.3 (1.1)
Female		67.7 (0.5)	65.7 (0.5)	114.5 (1.1)
p-value <sup>a</sup>		0.96	0.38	0.60
High School				
Male		49.8 (0.4)	52.1 (0.4)	97.3 (0.9)
Female		48.9 (0.4)	51.7 (0.4)	96.0 (0.9)
p-value		0.14	0.56	0.30
Gender*Grade*SES <sup>b</sup> (n=1,383)		Mean Daily Minutes of MVPA		
Middle School				
Male				
Eligible		69.4 (1.0)	66.0 (0.6)	114.1 (0.8)
Not Eligible		66.6 (0.8)	66.6 (0.5)	116.1 (0.6)
p-value		0.03	0.43	0.06

<b>Female</b>			
<b>Eligible</b>	68.1 (1.0)	65.4 (0.6)	114.3 (0.9)
<b>Not Eligible</b>	66.8 (0.8)	65.9 (0.5)	114.3 (0.6)
<b>p-value</b>	0.32	0.55	0.96
<b>High School</b>			
<b>Male</b>			
<b>Eligible</b>	51.6 (0.8)	53.0 (0.8)	97.2 (2.1)
<b>Not Eligible</b>	49.0 (0.5)	51.5 (0.5)	97.0 (1.3)
<b>p-value</b>	<b>&lt;0.01</b>	0.12	0.91
<b>Female</b>			
<b>Eligible</b>	48.7 (0.8)	51.0 (0.9)	94.2 (2.2)
<b>Not Eligible</b>	48.9 (0.5)	52.0 (0.5)	96.7 (1.3)
<b>p-value</b>	0.78	0.32	0.33

SE=Standard Error; Bold indicates significance

<sup>a</sup>Calculated using analysis of covariance (ANCOVA)

<sup>b</sup>Socioeconomic status: Defined as eligibility for free or reduced-price lunch (Yes/No)

Table 1.6 Paper 1 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Mean Daily Minutes of In-School, Out-of-School, and Weekend Moderate- to Vigorous-Intensity Physical Activity (MVPA) Estimated from Multiple Regression Models - Race/Ethnicity

		<b>In-School</b>	<b>Out-of-School</b>	<b>Weekend</b>
		<b>Mean (SE)</b>	<b>Mean (SE)</b>	<b>Mean (SE)</b>
<b>Race/Ethnicity*Grade (n=1,411)</b>		<b>Mean Daily Minutes of MVPA</b>		
<b>Middle School</b>				
<b>White</b>		66.4 (0.5)	66.6 (0.5)	115.6 (1.0)
<b>Hispanic</b>		66.5 (1.0)	63.7 (0.9)	112.6 (1.9)
<b>Black</b>		69.8 (1.0)	65.4 (0.9)	114.4 (2.0)
<b>Other</b>		71.0 (0.9)	67.0 (0.8)	115.0 (1.8)
<b>p-value<sup>a</sup></b>		<b>&lt;0.00</b>	<b>0.01</b>	0.56
<b>High School</b>				
<b>White</b>		48.4 (0.4)	51.8 (0.4)	98.4 (0.8)
<b>Hispanic</b>		52.7 (0.8)	54.0 (0.7)	100.5 (1.5)
<b>Black</b>		49.3 (0.8)	52.0 (0.7)	93.2 (1.6)
<b>Other</b>		48.9 (0.9)	49.4 (0.8)	86.9 (1.7)
<b>p-value</b>		<b>&lt;0.00</b>	<b>&lt;0.01</b>	<b>&lt;0.00</b>
<b>Race/Ethnicity*Grade*SES<sup>b</sup> (n=1,383)</b>		<b>Mean Daily Minutes of MVPA</b>		
<b>Middle School</b>				

<b>White</b>				
<b>Eligible</b>	66.6 (1.1)	66.7 (0.7)	115.3 (1.0)	
<b>Not Eligible</b>	66.2 (0.7)	66.6 (0.4)	115.8 (0.6)	
<b>p-value</b>	0.79	0.91	0.69	
<b>Hispanic</b>				
<b>Eligible</b>	68.9 (1.6)	63.2 (1.0)	112.5 (1.4)	
<b>Not Eligible</b>	63.6 (1.4)	63.7 (0.9)	112.0 (1.2)	
<b>p-value</b>	<b>0.02</b>	0.74	0.80	
<b>Black</b>				
<b>Eligible</b>	69.0 (1.5)	65.2 (0.9)	113.1 (1.2)	
<b>Not Eligible</b>	70.6 (1.8)	65.7 (1.1)	116.1 (1.5)	
<b>p-value</b>	0.49	0.72	0.12	
<b>Other</b>				
<b>Eligible</b>	72.9 (1.6)	66.7 (1.0)	114.7 (1.4)	
<b>Not Eligible</b>	69.1 (1.3)	67.2 (0.8)	115.0 (1.1)	
<b>p-value</b>	0.07	0.67	0.87	
<b>High School</b>				
<b>White</b>				
<b>Eligible</b>	48.5 (0.8)	52.2 (0.9)	98.4 (2.2)	
<b>Not Eligible</b>	48.4 (0.4)	51.7 (0.5)	98.3 (1.1)	

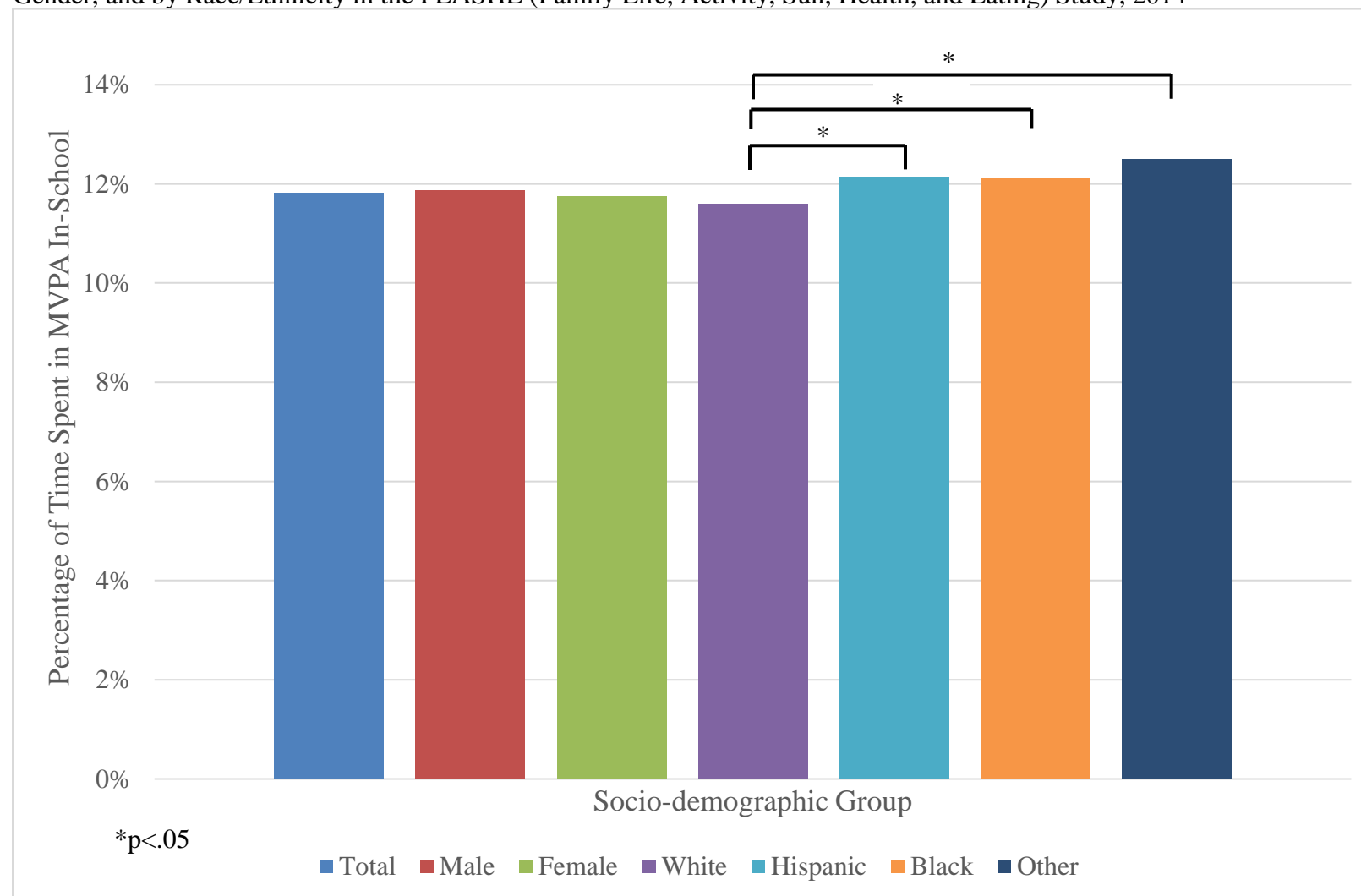
<b>p-value</b>	0.90	0.64	0.98
<b>Hispanic</b>			
<b>Eligible</b>	54.6 (1.1)	54.0 (1.3)	102.3 (3.1)
<b>Not Eligible</b>	51.3 (0.9)	53.8 (1.0)	99.2 (2.3)
<b>p-value</b>	<b>0.02</b>	0.89	0.42
<b>Black</b>			
<b>Eligible</b>	49.4 (1.1)	51.0 (1.3)	90.3 (3.0)
<b>Not Eligible</b>	49.1 (1.1)	52.4 (1.2)	95.3 (2.9)
<b>p-value</b>	0.85	0.43	0.23
<b>Other</b>			
<b>Eligible</b>	49.3 (1.8)	49.3 (2.0)	80.8 (4.9)
<b>Not Eligible</b>	48.8 (0.9)	49.4 (1.0)	88.4 (2.4)
<b>p-value</b>	0.80	0.95	0.16

SE=Standard Error; Bold indicates significance

<sup>a</sup>Calculated using analysis of covariance (ANCOVA)

<sup>b</sup>Socioeconomic status: Defined as eligibility for free or reduced-price lunch (Yes/No)

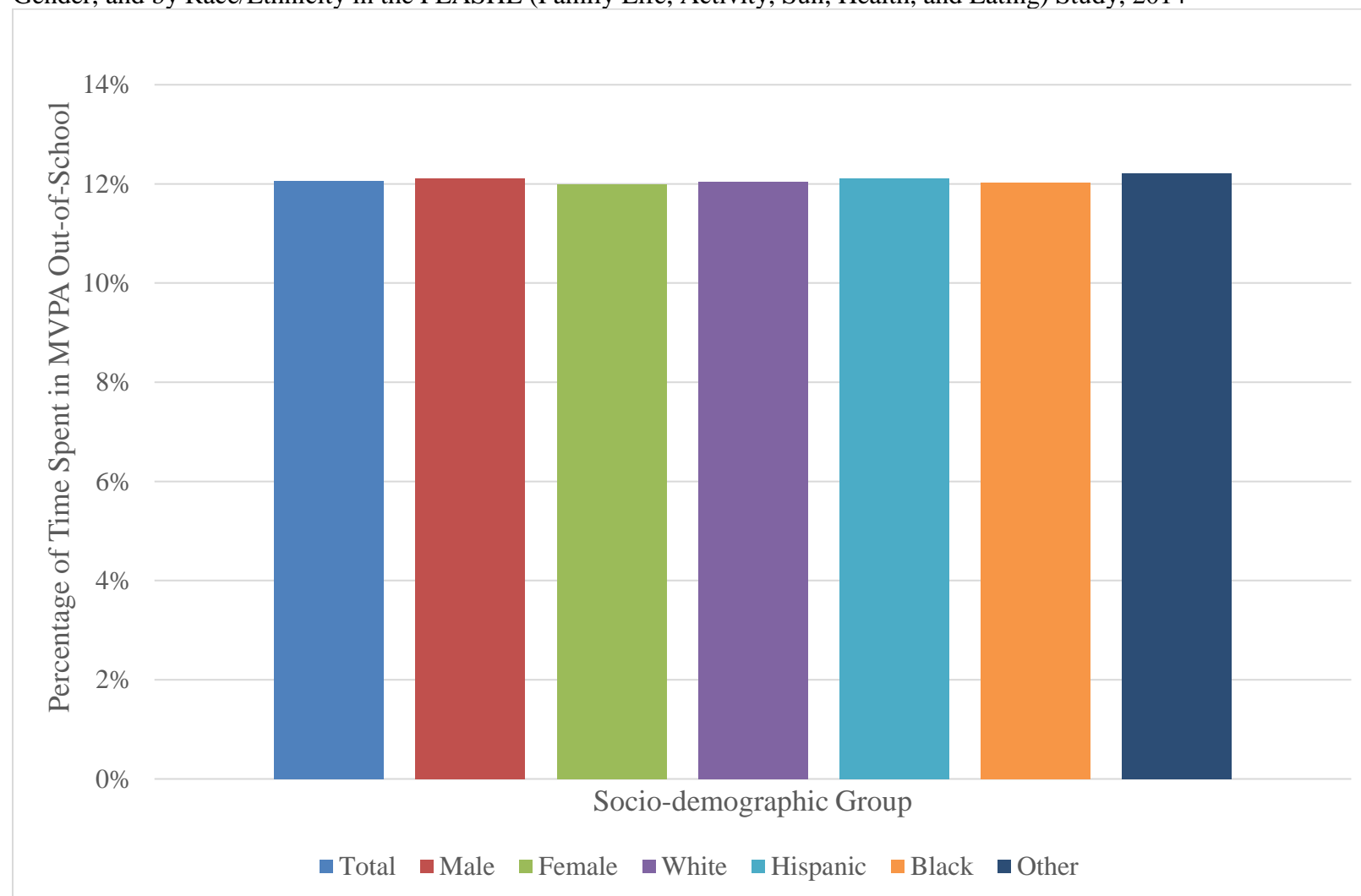
Figure 1.1. Unadjusted Proportion\* of Time Spent in Moderate to Vigorous-Intensity Physical Activity In-School Overall, by Gender, and by Race/Ethnicity in the FLASHE (Family Life, Activity, Sun, Health, and Eating) Study, 2014



\*Derived from total time spent in-school

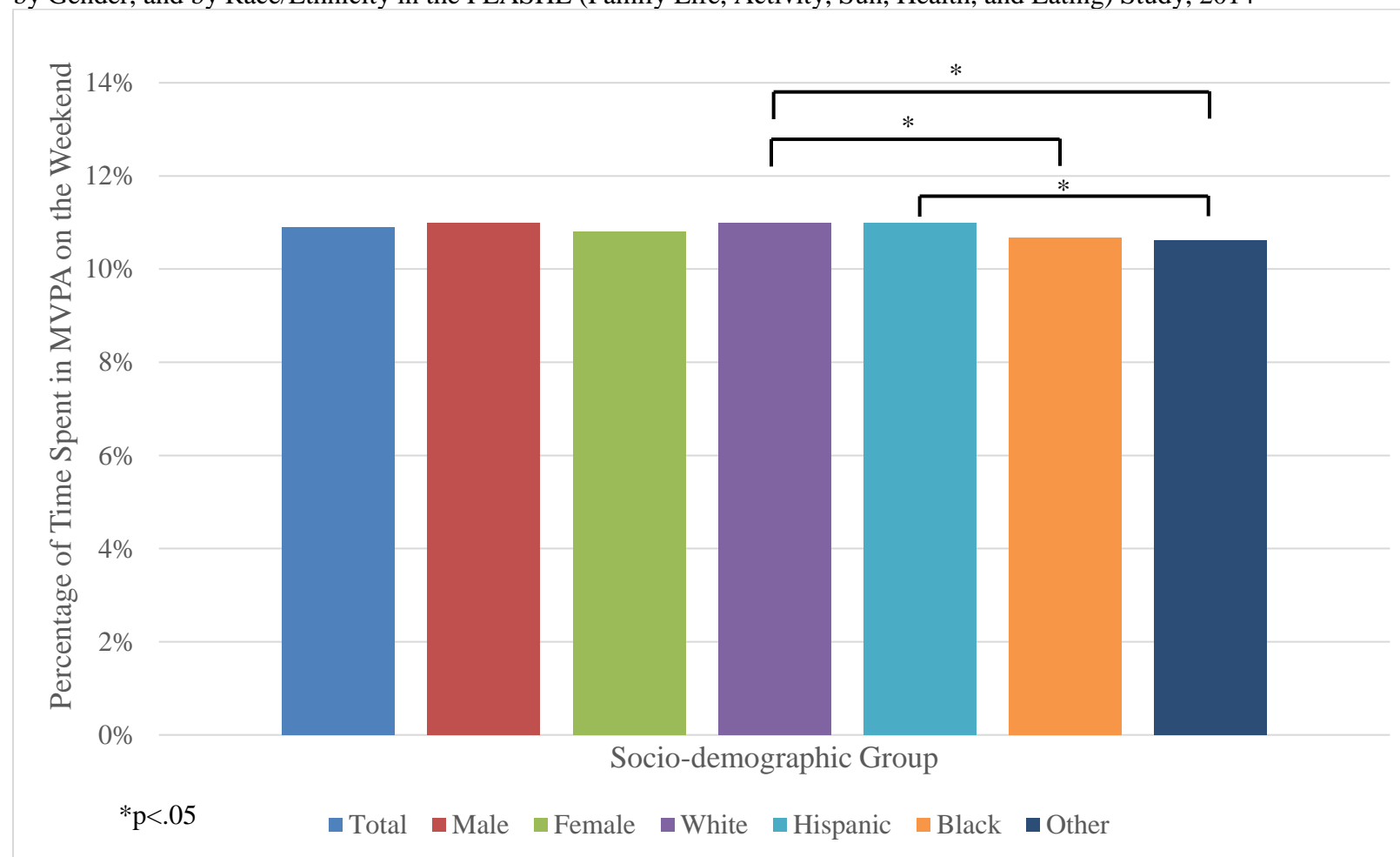


Figure 1.2. Unadjusted Proportion\* of Time Spent in Moderate to Vigorous-Intensity Physical Activity Out-of-School Overall, by Gender, and by Race/Ethnicity in the FLASHE (Family Life, Activity, Sun, Health, and Eating) Study, 2014



\*Derived from total time spent out-of-school

Figure 1.3. Unadjusted Proportion\* of Time Spent in Moderate to Vigorous-Intensity Physical Activity on the Weekend Overall, by Gender, and by Race/Ethnicity in the FLASHE (Family Life, Activity, Sun, Health, and Eating) Study, 2014



\*Derived from total time spent on the weekend

## **PAPER 2: EMPLOYMENT AND ADOLESCENT PHYSICAL ACTIVITY AMONG U.S. PARENT-ADOLESCENT DYADS**

### **Background**

Accumulating sufficient physical activity to meet guidelines is associated with numerous health benefits, including a reduced risk of overweight and obesity, improved muscular and cardiovascular fitness, and reduced lifetime risk of cardiovascular disease, type II diabetes mellitus, and breast cancer.<sup>10,62</sup> However, only 26.1% of U.S. high school students report engaging in sufficient physical activity to meet aerobic physical activity guidelines, defined for youth as at least 60 minutes of moderate- to vigorous-intensity physical activity per day.<sup>10,85</sup>

Adolescents with a typical school and sleep schedule have limited discretionary time (e.g., non-school/homework hours) during which they can choose either to be physically active or sedentary. For adolescents who work, the time available for engaging in health promoting physical activity during these discretionary periods of the day is even more limited. And although employment has been reported to be a perceived barrier to physical activity engagement,<sup>37,38</sup> few studies have examined the relation between adolescent employment with adolescent physical activity.<sup>45-47,86</sup> Further, these limited studies have reported conflicting relations depending on the cut points used for adolescent employment. For example, one study showed lower physical activity levels among non-working adolescents versus those working 15-20 hours/week, while those working >20 hours/week had lower activity levels compared to those working only 15-20 hours/week.<sup>45</sup>

There is also evidence to suggest that parent employment is associated with youth physical activity levels.<sup>43,49,50</sup> Employment can affect a parent's availability,<sup>39,40</sup> which can be particularly influential when adolescents are not in school.<sup>41</sup> For example, a parent's work schedule (e.g., weekly hours worked, night-shifts) may limit availability to provide transportation for their child, as well as their ability to model physical activity behavior.<sup>87-89</sup> However, few studies have examined the relation of parent employment with adolescent physical activity, and although an association has been suggested, both positive and negative associations have been reported.<sup>43,49,50</sup> Further, the findings are limited in their generalizability to parent employment because they include only maternal hours worked per week.<sup>43,49,50</sup> No known studies have examined the relation of paternal employment with adolescent physical activity, despite evidence suggesting paternal employment is associated with an adolescent's overall health<sup>90</sup> and behavior.<sup>91</sup>

Given the mixed findings on the association of adolescent employment and adolescent physical activity, as well as the limitations of previous research on parental employment with adolescent physical noted above, there is a need to consider the relation of adolescent and parent employment, both paternal and maternal, with adolescent physical activity. Therefore, the purpose of this study is to examine the association of 1) adolescent weekly hours worked, 2) parent weekly hours worked (both maternal and paternal), and 3) combined parent weekly hours worked (summed by dyad) with adolescent-reported physical activity, operationalized as MET/times/week, before and after adjusting for adolescent age, gender, race/ethnicity, parent availability, and socioeconomic status (SES) among a nationally representative sample of U.S. adolescents.

## **Methods**

### *Overview*

This study used data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), a longitudinal study funded by the National Institute of Child Health and Human Development (NICHD) to examine factors that may influence adolescents' health and risk behaviors.<sup>92</sup> Add Health utilized a multi-survey, multi-wave design to follow participants from adolescence into adulthood.

A multistage, stratified, school-based, clustered sampling design was used in the Add Health Study to generalize to U.S. high school population. Schools served as the primary sampling unit, and were selected from the Quality Education Database (QED) with probability of selection proportional to school size (i.e., high schools with higher enrollments had a greater chance of selection).<sup>92</sup> Schools were eligible if they 1) included an 11<sup>th</sup> grade and 2) enrolled more than 30 students. Schools were stratified by region, urbanicity, school type (public, private, parochial), racial/ethnic diversity, and size.<sup>92</sup> More information on the Add Health sampling and study design is provided elsewhere.<sup>92</sup>

### *Data Collection Overview*

Data for the Add Health study were collected from adolescents, their parents, and other members of their social network (e.g., fellow students, friends, siblings) through multiple data collection components, including four respondent in-home interviews (Waves I-IV), an in-school questionnaire, and parent in-home interviews. This study focused on baseline (Wave I; April – December 1995) in-home interviews for adolescents and their parents. Although adolescent employment has seen changes over time, Add Health data were

used in this study due the limited availability of nationally representative datasets of employment and adolescent physical activity.

Only adolescents with complete data for the primary independent and dependent variables of interest were included. For this study, only participants aged 16-18 years were included due to U.S. Department of Labor laws that limit the hours that U.S. adolescents younger than 16 years can work for pay.<sup>93</sup> Adolescents were excluded if they reported difficulty using their hands, arms, legs, or feet because of a physical condition or if they reported using a mechanical device (e.g., cane, brace, wheelchair) for the past 12 months or more.

#### Adolescent In-Home Interview

Adolescent in-home interviews for Add Health Wave 1 consisted of 40 sections with up to 1,387 closed-ended items (depending on respondent's experiences) that covered topics such as employment experience and health behaviors. The sample of students was selected from a list of enrolled students (obtained from school rosters) and students not on rosters who completed the Add Health in-school questionnaires.<sup>92</sup> A majority of interviews were conducted in respondents' homes, and lasted one to two hours, depending on respondent's age and experiences. Data were recorded on laptop computers. Less sensitive questions were read aloud by interviewers, who entered the respondent's answers. For more sensitive questions (e.g., sexual partnerships, substance use), Computer-Assisted Self-Interview (CASI) was used, in which respondents listened to pre-recorded questions through earphones and entered their responses directly.

#### Parent In-Home Interview

A parent of each adolescent respondent also completed a 30-minute, interviewer-assisted interview for Add Health Wave 1 that consisted of 4 sections with up to 158 closed-ended items (depending on respondent's experience). Although it was preferred to capture maternal data, paternal data were collected if he was available. The parent questionnaire collected information on a variety of topics, including health conditions, health-related behaviors, marriage and marriage-like relationships, employment, and household income.

### *Variables*

Add Health variables included adolescent employment, parent employment, physical activity, and socio-demographic variables, and are presented in Table 2.1.

### *Employment*

The primary independent variables were adolescent and parent employment, collected via the adolescent in-home interview. For adolescent employment, adolescents were asked “*How many hours do you spend working for pay in a typical non-summer week?*” and “*How many hours do you spend working for pay in a typical summer week?*”. Summer employment was included for descriptive purposes only. For parent employment, adolescents were asked, “*Approximately how many hours a week does she [resident mother] work for pay?*” and “*Approximately how many hours a week does he [resident father] work for pay?*”. Resident mother included “Mother/Adoptive Mother/Stepmother/Foster Mother, etc.”, and resident father included “Father/Adoptive Father/Stepfather/Foster Father/etc.”. To account for resident mothers and fathers who do not work, those for whom “*Does she [resident mother] work for pay?*” and “*Does he [resident father] work for pay?*” are reported as *No* were counted as 0 hours worked per week. Adolescents who reported  $\geq 0$  hours worked per week (versus missing) for both the resident mother and father were considered to be in a two-

parent (versus single-parent) household. For this study, variables were created for combined parent employment (hours per week summed for resident mother and father) in two-parent households. Employment categories were also created for different levels of adolescent, parent, and combined parent employment (e.g., 0 hours/week, >0-20 hours/week, >20 hours/week). Although evidence of reliability and validity for these measures are not provided by Add Health, similar measures of adolescent and parent employment in similar age groups have been found to have moderate test-retest reliability over a one month period<sup>94,95</sup> and criterion validity compared to parent-reported employment.<sup>94</sup>

#### Physical activity

The primary dependent variable was adolescent physical activity, operationalized as metabolic equivalent task (MET)/times/week, collected via the adolescent in-home interview. Three items assessed leisure-time physical activity using a standard 7-day recall period,<sup>96-98</sup> for which adolescents were asked about the times per week spent in various activities. The first item assessed “exercise”, the second item assessed “wheel sports”, and the third item assessed “active sports”. Although evidence of reliability and validity for this measure is not provided by Add Health, similar single item 7-day recall measures of physical activity among similar age groups have been found to have moderate test-retest reliability over a one-week period<sup>99</sup> and criterion validity compared to device-based measures.<sup>98,99</sup>

For this study, each activity type included in the question prompt (i.e., grouping) was assigned a standardized MET value using the Youth Compendium of Physical Activity,<sup>100</sup> which was used to create a median MET value for each item grouping. Response options were used to create average times per week (“*not at all*” = 0, “*1-2 times*” = 1.5, “*3-4 times*” = 3.5, and “*5 or more*” = 6), which were then multiplied by the MET value assigned to each



item grouping. The Add Health physical activity questions did not include items to quantify the duration of these activities. These values were summed to create an estimate of leisure-time moderate to vigorous intensity physical activity expressed as a continuous (MET/times/wk) and categorical [tertiles of activity level (low, medium, high)] score.

#### Covariates

Adolescent age, gender, race/ethnicity, parent availability, and SES were included as potential confounders. Age, gender, race/ethnicity, and parent availability were collected during the adolescent in-home interview. Age (in years) was continuous, and constructed using the interview completion date (month, day, year) and date of birth (month, year) variables, with 15 being used as the day of birth.<sup>101</sup> Gender was confirmed by the interviewer, and categorized as either male or female. Race/ethnicity was categorized as Hispanic, non-Hispanic Black or African American, non-Hispanic Asian or Pacific Islander, non-Hispanic American Indian or Native American, non-Hispanic other, and non-Hispanic White; Black Hispanics were classified as Hispanic. Parent availability (yes/no) was derived from two items each for both resident mother and father examining availability outside of school time: “*How often is [resident mother]/[resident father] at home when you leave for school?*” and “*How often is [resident mother]/[resident father] at home when you return from school?*” (*always=1, most of the time=2, some of the time=3, almost never=4, never=5, takes me to/from school=6*). For this study, adolescents who reported *almost never* or *never* for the resident mother and father both before and after school were considered to have no parent availability. Household income, collected during the parent in-home interview, was used as a proxy for SES. For this variable, parents were asked, “*About how much total income, before taxes did your family receive in 1994? Include your own income, the income*

*of everyone else in your household, and income from welfare benefits, dividends, and all other sources”*. Quintiles were then created for income level (top, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, bottom).

#### *Protection of Human Subjects*

Ethical review and approval for the original Add Health study was provided by the Human Subjects Review Committee of the University of North Carolina at Chapel Hill. Data are de-identified and publicly available. For this study, Institutional Review Board exemption status was sought from the University of Texas Health Science Center Committee for the Protection of Human Subjects (HSC-SPH-19-0675).

#### *Statistical Analysis*

Data management and statistical analyses were performed using STATA 15.1 (StataCorp, College Station, TX). Descriptive statistics were calculated for employment, physical activity, and socio-demographic variables. Categorical variables were presented as frequencies and proportions, and continuous variables were presented as means with standard deviations. Differences in employment, physical activity, and socio-demographic variables by gender were assessed using chi-square test for categorical variables and t-test for continuous variables.

Multiple regression was used to describe and examine adolescent physical activity (MET/times/week) by employment levels (hours worked per week), before and after adjusting for adolescent age, gender, race/ethnicity, parent availability, and household income. Adolescent (non-summer), mother, father, and combined parent (mother and father summed) were examined overall and at different employment levels, with consideration for different cut points for hours worked per week (e.g.,  $\pm 20$  hours/week,  $\pm 40$  hours/week, etc.) upon examination of the data. Models were stratified by single- and two-parent households.

Multinomial logistic regression was used to examine the association between adolescent and parent employment categories with adolescent physical activity tertiles (low, medium, high), using the lowest tertile of physical activity (MET/times/week) as reference, before and after adjusting for adolescent age, gender, race/ethnicity, parent availability, and household income.

Linear regression was used to further explore the relation of adolescent (non-summer and summer), mother, and father employment as a binary variable (yes/no) with adolescent physical activity. Multiple linear regression was used to explore the relation of adolescent non-summer employment and parent employment with adolescent physical activity, with an interaction term for employment type (adolescent\*parent) to allow examination of independent and joint effects of adolescent and parent employment on adolescent physical activity. Sampling weights are available within the Add Health study, but no significant differences were found when the weighted and unweighted regressions were compared, so all regressions in this study were left unweighted.<sup>102</sup>

## **Results**

The final analytic sample was 2,985 adolescents with a mean age of 17.4 years (SD=0.8). The sample was 50.1% male and 60.4% were non-Hispanic White (Table 2.2). Ninety one percent of adolescents reported at least some parent availability before or after school and 54.1% of adolescents were in a two-parent household. The mean household income was \$47,200 (SD=\$45,500). Adolescents were similarly distributed across males and females in age, race/ethnicity, household income, parent availability, and household type (single versus two-parent) ( $p>.05$ ).

Mean adolescent hours worked per week was 11.0 (SD=12.2) for non-summer employment and 20.7 (SD=17.1) for summer employment (Table 2.3). Mean parental hours worked per week was 34.4 (SD=15.4) for mothers and 43.8 (SD=12.8) for fathers. Mean employment hours for both adolescents and parents included those who were reported to work 0 hours/week. Significant differences by gender were found for adolescent summer employment, with males reporting more hours worked per week overall (22.1, SD=17.6 versus 19.2, SD=16.5;  $p<.01$ ), in single-parent households (22.1, SD=18.2 versus 17.8, SD=16.8;  $p<.01$ ), and in two-parent households (23.0, SD=17.1 versus 20.5, SD=16.1;  $p<.01$ ). Significant differences by gender were also found for mothers in single parent households, with more maternal hours worked per week reported by males (37.9, SD=13.2) compared to females (35.6, SD=14.8) ( $p=.03$ ). Significant employment category differences by gender were found only for adolescent summer employment ( $p<.01$ ) (Table 2.4)

Mean adolescent MET/times/week was 42.3 (SD=29.6), with males reporting significantly more MET/times/week (48.3, SD=31.1) compared to females (36.4, SD=26.7) ( $p<.01$ ) (Table 2.5). The lowest tertile of adolescent physical activity ranged from 0-23.1 MET/times/week, the medium tertile ranged from 26.6-53.9 MET/times/week, and the highest tertile ranged from 54.9-124.8 MET/times/week, with significant differences by gender ( $p<.01$ ). No significant socio-demographic differences were found between those who reported 0 MET/times/week and those reporting >0-23.1 MET/times/week (data not shown), so these adolescents remained grouped together within the lowest tertile of physical activity.

### *Multiple Regression*

Multiple regression was conducted to describe and examine adolescent physical activity (MET/times/week) by adolescent and parental hours worked per week before and

after adjusting for adolescent age, gender, race/ethnicity, parent availability, and household income. In single-parent households, adolescents who worked >20 hours/week reported significantly less MET/times/week (36.4, SD=1.7) compared to those not working (41.8, SD=1.2;  $p<.05$ ) and those working >0-20 hours/week (45.2, SD=1.4;  $p<.01$ ) (Figure 2.1). These findings remained significant in the adjusted models for adolescents working >20 hours/week versus those working >0-20 hours/week ( $p<.01$ ). Similar findings were seen in two-parent households, with adolescents who worked >20 hours/week reporting significantly lower MET/times/week (36.2, SD=1.7) compared to those not working (44.9, SD=1.2;  $p<.01$ ) and those working >0-20 hours/week (43.8, SD=1.1;  $p<.01$ ). These findings remained significant in the adjusted models ( $p<.01$ ).

Significant associations of adolescent physical activity with paternal employment were also found, although only for two-parent households. Adolescents whose father worked >40 hours/week reporting significantly more MET/times/week compared to those whose fathers worked >0-40 hours/week (45.2, SD=1.1 versus 41.2, SD=1.0;  $p<.05$ ) (Figure 2.2). These differences remained significant in the adjusted models (44.8, SD=1.1 versus 41.2, SD=1.0,  $p<.05$ ). A similar pattern was also seen for combined parental employment (maternal and paternal summed by dyad). Adolescents who reported >80 hours/week for combined parental employment reported significantly more MET/times/week compared to those whose combined parent employment was  $\leq 40$  hours/week (45.2, SD=1.2 versus 41.9, SD=1.0,  $p<.05$ ) (Figure 2.3). However, these differences were no longer significant in the adjusted models. In addition, although adolescents whose mothers worked >40 hours/week reported more physical activity compared to those whose mothers worked >0-40 hours/week in both single (45.5, SD=2.4 versus 42.3, SD=1.2,  $p=.21$ ) and two-parent (44.2, SD=1.8

versus 42.7, SD=0.9,  $p=.47$ ) households, these findings were not statistically significant (Figure 2.4).

### *Multinomial Logistic Regression*

Multinomial logistic regression was used to examine the unadjusted and adjusted association between adolescent and parent employment (weekly hours worked) with adolescent physical activity tertiles (low, medium, high), using the lowest tertile of physical activity (MET/times/week) as reference. Adolescents working >20 hours/week (vs 0 hours/week) had significantly lower odds of being in the highest tertile of physical activity (vs low tertile) in both single- (OR: 0.60, 95% CI: 0.42, 0.86) and two-parent households (OR: 0.58, 95% CI: 0.41, 0.82) (Table 2.6). These odds remained significant in the adjusted models for single-parent households (AOR: 0.65, 95% CI: 0.44, 0.96), and were close to significance in two-parent households ( $p=.051$ ).

Significant associations of adolescent physical activity with parental employment were also found. In single-parent households, adolescents whose mother worked >40 hours/week (vs 0 hours/week) had significantly higher odds of being in the highest tertile of physical activity (vs low tertile) (OR: 3.30, 95% CI: 1.13, 7.99). These findings remained significant in the adjusted model (AOR: 3.50, 95% CI: 1.21, 10.17). In two-parent households, adolescents whose mother worked >0-40 hours/week and >40 hours/week (vs 0 hours/week) had significantly higher odds of being in the highest tertile of physical activity (vs low tertile) (OR: 1.63, 95% CI: 1.09, 2.44 and OR: 1.85, 95% CI: 1.16, 2.98, respectively). These findings remained significant in the adjusted models.

Although no significant findings were found for paternal employment in single-parent households, in two-parent households, adolescents whose father worked >0-40 hours/week

and >40 hours/week (vs 0 hours/week) had significantly higher odds of being in the highest tertile of physical activity (vs low tertile) (OR: 2.50, 95% CI: 1.04, 5.96 and OR: 3.30, 95% CI: 1.37, 7.90, respectively). These odds remained significant in the adjusted models only for >40 hours/week (AOR: 2.46, 95% CI: 1.00, 6.05). For combined parent employment, adolescents whose parents worked a combined >40-80 hours/week and >80 hours/week (vs  $\leq$ 40 hours/week) had significantly higher odds of being in the highest tertile of physical activity (vs low tertile) (OR: 1.81, 95% CI: 1.09, 3.03 and OR: 2.36, 95% CI: 1.39, 4.00, respectively). These odds remained statistically significant in the adjusted models.

#### *Employment as Binary Variable*

Linear regression was used to explore the relation of adolescent (non-summer), mother, and father employment as a binary variable (yes/no) with adolescent physical activity, operationalized as MET/times/week, and potential interaction of adolescent and parent employment. Significant associations were found for adolescent employment with adolescent physical activity among two-parent households only ( $p < .05$ ) (Data not shown). No significant associations were found for parental employment with adolescent physical activity, and no significant interactions were found for adolescent and mother or father employment with adolescent physical activity.

#### **Discussion**

The purpose of this study was to examine the associations of adolescent self-reported physical activity with adolescent and parental hours worked, among a nationally representative sample of adolescents, and to examine if these associations varied across single-parent and two-parent households. Overall, adolescent physical activity was inversely associated with adolescent hours worked. Adolescents working >20 hours/week reported

significantly lower physical activity than both those not working and those working >0-20 hours/week, and were 40% less likely to be in the highest tertile of physical activity (vs low tertile) compared non-working adolescents. On the other hand, greater hours of parental employment was associated with higher physical activity among adolescents, across both two-parent and single-parent (mother only) households. In two-parent households, both adolescents whose mother and whose father worked >40 hours/week (vs not working) had significantly higher odds of being in the highest tertile of physical activity (vs low tertile). In addition, adolescents whose combined parental employment was >80 hours/week reported significantly higher physical activity and had over twice the odds of being in the highest tertile of physical activity (vs low tertile) compared to those whose parents worked a combined  $\leq 40$  hours/week. In single-parent households, adolescents whose mother worked >40 hours/week (vs not working) had over three times higher odds of being in the highest tertile of physical activity (vs low tertile).

The results of lower physical activity levels among adolescents working over (vs less than) 20 hours/week align with findings in the literature<sup>86</sup> and suggest that adolescents who work over 20 hours/week during the school year, regardless of household type (single- versus two-parent), may have limited time to engage in physical activity. Therefore, although higher physical activity levels have been seen among adolescents who engage in low levels of work (<20 hours/week),<sup>45</sup> there is a need to consider how higher levels of employment can affect an adolescent's time use and their ability to be physically active. This is particularly important given the increase in employment during adolescence,<sup>103</sup> which these findings suggest may be contributing to the overall decline in physical activity levels during this life stage.



Conversely, higher physical activity levels were reported by adolescents whose mothers and fathers worked more than 40 hours/week, compared to those with non-working parents, suggesting a direct relationship of parental employment with adolescent physical activity. Although literature on parental (and particularly paternal) employment and adolescent physical activity is very limited, research focused on the impact of parental employment on adolescents suggest differences based on the education and income levels of parents, with outcomes that can affect physical activity engagement (e.g., parent-adolescent relationships, adolescent self-care abilities) better among higher levels of parental education and family income (versus lower levels).<sup>104-108</sup> However, the findings for parental employment in this study remained significant after adjusting for such factors that may otherwise account for potential variation in opportunities for physical activity (e.g., race/ethnicity, household income). This suggests that there may be other unmeasured factors, outside of income, associated with non-working parents that result in lower adolescent physical activity levels compared to those with working parents.

Future research is needed to examine the reasons for increases in adolescent physical activity with hours of parental employment. One potential explanation, not examined in this paper, is the substitution of at-home time with physical activity time, during the hours when parents are working and not available at home. Adolescents with working parents may be involved in activities outside of school that provide opportunities for physical activity, such as organized sports or after-school programs. In addition, if adolescents are unsupervised while their parents are working, they may have more autonomy to engage in activities outside of the home compared to those with a parent at home, particularly considering the sample focuses on older (versus younger) adolescents (16-18 years). Furthermore, given the

year in which data were collected (1995), when there was significantly less screen time among this age group,<sup>109</sup> adolescents with working parents may have spent more time with friends engaged in active transport or other types of physical activity. Another change since 1995 is the large increase in work-from-home options for parents. Parental availability at home, even while working, could potentially be related to adolescent choice of leisure activities.

It should also be noted that significant findings for paternal employment were found among two-parent households only, which may be due in part to the relatively small sample size for employment categories among fathers in single-parent households. It is also possible (as noted earlier) that there are other SES-related factors, not adjusted for, that affect single-parent households differently than two-parent households, particularly for single-parent fathers. However, these findings further support the importance of looking at parental employment separately (maternal and paternal), and considering the relation of paternal employment with adolescent physical activity.

### *Strengths and Limitations*

This study has numerous strengths. Add Health was conducted among a large, nationally representative sample of U.S. adolescents, which provides external study validity with sufficient statistical power to examine both adolescent and parent employment with adolescent physical activity, as well as potential variations by different levels of employment stratified by household type. This study also addresses multiple gaps in the literature, as previous research on employment and adolescent physical activity has been very limited. Few studies examining adolescent physical activity have considered adolescent or parent employment, and no known studies have considered both. However, this study includes

adolescent and parent (separately and combined) employment, and examines the association with adolescent physical activity at different levels of employment (i.e., hours worked per week). There were also considerations for both single-parent and two-parent households, for which there has been limited research in regards to employment and adolescent physical activity.

The limitations of this study must also be noted. Analyses were conducted using Add Health Wave I data only, which were collected in 1995 and limit the ability to make causal inferences about adolescent and parent employment and adolescent physical activity.

However, given the limited research regarding the relation of adolescent and parent employment with adolescent physical activity, the Add Health data provided the opportunity to fill a notable gap in the literature and strongly suggest the need for future research in this area. Another limitation is that the measures for employment and physical activity were adolescent-reported, and therefore prone to recall and reporting bias, as well as possible social desirability bias. Furthermore, the physical activity measures are limited because they do not account for activity duration, so it is not possible to examine dose. Therefore, median MET values (intensity) and average times per week (frequency) were used due to the physical activity item/response structures, which may not fully quantify physical activity dose or volume. Also, there were no measures for adolescents' occupational physical activity or type of employment, so it was not possible to examine if adolescents were engaging in physical activity as part of their employment, which would contribute to meeting guidelines. Additionally, if adolescents have a very active job, they may be less inclined to also be highly active in their leisure time. Therefore, future research should also examine the types of adolescent employment in regards to physical activity levels. Finally, although parent

availability before and after school were considered, it cannot be determined whether unavailability was due exclusively to parent employment.

## **Conclusions**

Few studies have examined the relation of adolescent and parent employment with adolescent physical activity, despite evidence suggesting that employment can be a barrier to physical activity among adolescents and affect a parent's availability. This study suggests that working over 20 hours/week can limit an adolescent's ability to engage in physical activity, and that there is a direct relation of parental employment with adolescent physical activity. Given that over 20% of adolescents are currently working in the U.S. during the school year,<sup>110</sup> future research on the association between adolescent employment and physical activity may provide further insights into the large proportion of adolescents who are not meeting guidelines. There are additional concerns regarding youth who find out their work schedule on a week by week basis, and who have more difficulty engaging in organized physical activity. Future research should examine the relation of employment and adolescent physical activity among more recent data to take changes in adolescent time use into account, with additional consideration for type of employment and physical activity - as well as potential differences by gender.

Table 2.1. Paper 2 Add Health (National Longitudinal Study of Adolescent to Adult Health) Study Variables

Construct	Variable	Survey	Type
Physical Activity: MET/times/week			
Adolescent Physical Activity	Total sum of individual item values: <ul style="list-style-type: none"><li>Median MET Value x Average Times per Week</li></ul>	Adolescent	Dependent
	Tertiles of activity based on sum of individual item values <ul style="list-style-type: none"><li>Low, Medium, High</li></ul>	Adolescent	Dependent
	<i>During the past week, how many times did you exercise, such as jogging, walking, karate, jumping rope, gymnastics or dancing?</i> <i>During the past week, how many times did you go roller-blading, roller-skating, skate-boarding, or bicycling?</i> <i>During the past week, how many times did you play an active sport, such as baseball, softball, basketball, soccer, swimming, or football?</i>		
Employment: Hours worked for pay/week			
Adolescent Employment	Non-Summer <i>How many hours do you spend working for pay in a typical non-summer week?</i>	Adolescent	Independent
	Summer <i>How many hours do you spend working for pay in a typical summer week?</i>	Adolescent	
Parent Employment	Resident Mother <i>Does she [resident mother] work for pay? Approximately how many hours a week does she [resident mother] work for pay?</i>	Adolescent	Independent
	Resident Father <i>Does he [resident father] work for pay? Approximately how many hours a week does he [resident father] work for pay?</i>	Adolescent	
	Parent Combined <ul style="list-style-type: none"><li>Parent employment summed for resident mother and resident father</li></ul>	Adolescent	
Socio-demographics			

Gender	<i>Interviewer, please confirm that respondent's sex is</i> <ul style="list-style-type: none"> <li>Male, Female</li> </ul>	Adolescent	Covariate
Age	Interview completion date [month][day][year] – respondent date of birth [month] 15 [year]	Adolescent	Covariate
Race/ethnicity	<i>Are you of Hispanic or Latino origin? What is your race?</i> <ul style="list-style-type: none"> <li>Hispanic, non-Hispanic Black or African American, non-Hispanic Asian or Pacific Islander, non-Hispanic American Indian or Native American, non-Hispanic other, non-Hispanic White</li> </ul>	Adolescent	Covariate
Parent Availability	<i>How often is she/he [resident mother]/[resident father] at home when you leave for school?</i> <ul style="list-style-type: none"> <li>always, most of the time, some of the time, almost never, never, She/He takes me to school</li> </ul> <i>How often is she/he [resident mother]/[resident father] at home when you return from school?</i> <ul style="list-style-type: none"> <li>always, most of the time, some of the time, almost never, never, She/He brings me from school</li> </ul>	Parent	Covariate
Household Income	<i>About how much total income (in thousands of dollars), before taxes did your family receive in 1994?</i>	Parent	Covariate

Table 2.2. Paper 2 Add Health (National Longitudinal Study of Adolescent to Adult Health) Study Adolescent Participant Characteristics

<b>Characteristics</b>	<b>Total Sample (N=2,985)</b>	<b>Male (n=1495, 50.1%)</b>	<b>Female (n=1,490, 49.9%)</b>	<b>Differences by gender</b>
<b>Age</b> (n=2,985)	Mean (SD)	Mean (SD)	Mean (SD)	p-value
Age (years)	17.4 (0.8)	17.4 (0.8)	17.4 (0.8)	0.50
<b>Race/ethnicity</b> (n=2,982)	% (n)	% (n)	% (n)	p-value
Hispanic	11.7% (350)	11.6% (173)	11.9% (177)	0.92
Non-Hispanic Black or African American	22.8% (681)	23.3% (348)	22.4% (333)	
Non-Hispanic Asian or Pacific Islander	3.4% (101)	3.3% (49)	3.5% (52)	
Non-Hispanic American Indian or Native American	0.9% (27)	0.7% (11)	1.1% (16)	
Non-Hispanic Other	0.8% (23)	0.7% (11)	0.8% (12)	
Non-Hispanic White	60.4% (1,800)	60.4% (902)	60.4% (898)	
<b>Household Income<sup>a</sup></b> (M <sub>income</sub> = 47.2, SD=45.5) (n=2,146)	Range % (n)	Range % (n)	Range % (n)	p-value
Top Quintile	66-600 14.1% (420)	66-600 14.1% (211)	67-600 14.0% (209)	0.66
2 <sup>nd</sup> Quintile	48-65 14.3% (426)	48-65 15.0% (224)	48-65 13.6% (202)	
3 <sup>rd</sup> Quintile	31-47 14.7% (440)	31-47 15.3% 229	31-47 14.2% (211)	
4 <sup>th</sup> Quintile	19-30	19-30	19-30	

	14.3% (426)	13.9% (208)	14.6% (218)	
Bottom Quintile	0-18 14.5% (434)	0-18 14.7% (219)	0-18 14.4% (215)	
<b>Parent Availability</b> (n=2,985)	% (n)	% (n)	% (n)	p-value
No	8.6% (258)	8.1% (121)	9.2% (137)	0.28
Yes <sup>b</sup>	91.4% (2,727)	91.9% (1,374)	90.8% (1,353)	
<b>Household Type</b> (n=2,985)	% (n)	% (n)	% (n)	p-value
Single Parent	45.9% (1,370)	44.6% (666)	47.3% (704)	0.14
Two-Parent <sup>c</sup>	54.1% (1,615)	55.5% (829)	52.8% (786)	

SD=Standard Deviation

<sup>a</sup>In thousands of dollars

<sup>b</sup>Resident mother and/or father available at least some of the time before and/or after school

<sup>c</sup>Hours worked per week ( $\geq 0$ ) available for both resident mother and resident father



Table 2.3. Paper 2 Add Health (National Longitudinal Study of Adolescent to Adult Health) Study Adolescent and Parent Employment (Hours Worked per Week)

Employment Type	Hours Worked per Week						
	Total		Male		Female		Differences by gender
	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	p-value
<b>Total Sample</b>							
<b>Adolescent (Non-Summer)</b>	2,985	11.0 (12.2)	1,495	11.3 (12.5)	1,490	10.7 (11.9)	0.22
<b>Adolescent (Summer)</b>	2,944	20.7 (17.1)	1,464	22.1 (17.6)	1,480	19.2 (16.5)	<0.01
<b>Resident Mother</b>	2,369	34.4 (15.4)	1,176	34.7 (15.2)	1,193	34.0 (15.6)	0.28
<b>Resident Father</b>	1,946	43.8 (12.8)	1,011	44.0 (12.3)	935	43.6 (13.4)	0.51
<b>Single Parent Household</b>							
<b>Adolescent (Non-Summer)</b>	1,370	10.7 (12.5)	666	10.8 (12.6)	704	10.7 (12.5)	0.66
<b>Adolescent (Summer)</b>	1,352	19.4 (17.6)	652	22.1 (18.2)	700	17.8 (16.8)	<0.01
<b>Resident Mother</b>	754	36.7 (14.1)	347	37.9 (13.2)	407	35.6 (14.8)	0.03
<b>Resident Father</b>	331	44.2 (14.0)	182	44.5 (14.5)	149	43.9 (13.4)	0.69
<b>Two-Parent Household</b>							
<b>Adolescent (Non-Summer)</b>	1,615	11.2 (11.9)	829	11.7 (12.4)	786	10.8 (11.3)	0.12

<b>Adolescent (Summer)</b>	1,592	21.7 (16.6)	812	23.0 (17.1)	780	20.5 (16.1)	<0.01
<b>Resident Mother</b>	1,615	33.3 (15.8)	829	33.4 (15.8)	786	33.2 (15.9)	0.82
<b>Resident Father</b>	1,615	43.8 (12.6)	829	43.9 (11.7)	786	43.6 (13.4)	0.61
<b>Combined Parent</b>	1,615	77.0 (20.9)	829	77.3 (20.9)	786	76.8 (21.0)	0.63

SD=Standard Deviation

Table 2.4 Paper 2 Add Health (National Longitudinal Study of Adolescent to Adult Health) Study Adolescent and Parent Employment Categories (Hours Worked per Week)

Employment (Hours worked per week)	Total	Male	Female	Differenc es by gender
	% (n)	% (n)	% (n)	p-value
Adolescent (Non-Summer)				
0 hours	39.4% (1,175)	38.5% (575)	40.3% (600)	0.07
>0-20 hours	40.6% (1,212)	39.8% (595)	41.4% (617)	
>20 hours	20.0% (598)	21.7% (325)	18.3% (273)	
Adolescent (Summer)				
0 hours	27.5 % (821)	24.7% (369)	30.3% (452)	<0.01
>0-20 hours	22.6% (675)	21.7% (325)	23.7% (350)	
>20 hours	49.2% (1,448)	52.6% (770)	45.8% (678)	
Resident Mother				
0 hours	7.5% (224)	9.1% (107)	7.9% (117)	0.67
>0-40 hours	57.8% (1,726)	72.6% (854)	73.1% (872)	
>40 hours	17.7% (419)	18.3% (215)	17.1% (204)	
Resident Father				

0 hours	2.0% (60)	1.7% (25)	2.4% (35)	0.18
>0-40 hours	34.6% (1,033)	52.4% (530)	53.8% (503)	
>40 hours	43.8% (853)	45.1% (456)	42.5% (397)	
Combined Parent				
≤40 hours	8.1% (131)	7.7% (64)	8.5% (67)	0.76
>40-80 hours	56.7% (916)	56.5% (468)	57.0% (448)	
>80 hours	35.2% (568)	35.8% (297)	34.5% (271)	

Table 2.5. Paper 2 Add Health (National Longitudinal Study of Adolescent to Adult Health) Study Adolescent-Reported Physical Activity

<b>Adolescent Physical Activity (MET<sup>a</sup>/times/week)</b>	<b>Total Sample (N=2,985)</b>	<b>Male (n=1,495)</b>	<b>Female (n=1,490)</b>	<b>Differences by gender</b>
<b>Total Physical Activity</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>Mean (SD)</b>	<b>p-value</b>
Total Sum	42.3 (29.6)	48.3 (31.1)	36.4 (26.7)	<0.01
<b>Physical Activity Tertiles</b>	<b>Range % (n)</b>	<b>Range % (n)</b>	<b>Range % (n)</b>	<b>p-value</b>
Lowest Tertile	0-23.1 34.2% (1,021)	0-23.1 28.2% (420)	0-23.1 40.3% (601)	p<0.01
Medium Tertile	26.6-53.9 34.8% (1,040)	26.6-53.9 32.1% (480)	26.6-53.9 37.6% (560)	
Highest Tertile	54.9-124.8 31.0% (924)	54.9-124.8 39.8% (595)	54.9-124.8 22.1% (329)	

SD=Standard Deviation

<sup>a</sup>Metabolic equivalent task

Table 2.6. Paper 2 Add Health (National Longitudinal Study of Adolescent to Adult Health) Study Multinomial Logistic Regression Models for the Association between Adolescent and Parent Employment (Hours Worked per Week) with Adolescent Physical Activity<sup>a</sup> Level (Tertile)

Employment (Hours Worked per Week)	Model 1 Physical Activity Tertiles OR (95% CI)			Model 2 <sup>b</sup> Physical Activity Tertiles AOR (95% CI)		
	Low	Medium OR (95% CI)	High OR (95% CI)	Low	Medium AOR (95% CI)	High AOR (95% CI)
Single Parent Household						
	n=1,370			n=1,368		
Adolescent Employment (Non-Summer)						
>0 & ≤20 hours (vs 0 hours)	ref	0.96 (0.72, 1.29)	1.14 (0.85, 1.54)	ref	0.97 (0.72, 1.30)	1.16 (0.85, 1.59)
>20 hours (vs 0 hours)	ref	0.73 (0.52, 1.01)	0.60** (0.42, 0.86)	ref	0.74 (0.53, 1.05)	0.65* (0.44, 0.96)
Resident Mother						
>0 & ≤40 hours (vs 0 hours)	ref	1.03 (0.50, 2.12)	2.02 (0.81, 5.02)	ref	1.00 (0.48, 2.07)	2.38 (0.88, 6.43)
>40 hours (vs 0 hours)	ref	1.27 (0.57, 2.84)	3.01* (1.13, 7.99)	ref	1.22 (0.53, 2.78)	3.50* (1.21, 10.17)
Resident Father						
>0 & ≤40 hours (vs 0 hours)	ref	1.69 (0.50, 5.67)	3.65 (0.72, 18.43)	ref	1.52 (0.42, 5.48)	3.30 (0.61, 5.74)
>40 hours (vs 0 hours)	ref	1.59 (0.48, 5.31)	3.37 (0.67, 16.98)	ref	1.55 (0.43, 5.60)	3.03 (0.55, 16.53)
Two-Parent Household						
	n=1,615			n=1,614		
Adolescent Employment (Non-Summer)						

>0 & ≤20 hours (vs 0 hours)	ref	1.05 (0.80, 1.37)	0.97 (0.74, 1.27)	ref	1.18 (0.89, 1.56)	1.10 (0.83, 1.47)
>20 hours (vs 0 hours)	ref	0.74 (0.53, 1.03)	0.58** (0.41, 0.82)	ref	0.88 (0.63, 1.24)	0.70 (0.48, 1.00)
<b>Resident Mother</b>						
>0 & ≤40 hours (vs 0 hours)	ref	1.12 (0.78, 1.60)	1.63* (1.09, 2.44)	ref	1.10 (0.76, 1.59)	1.69* (1.11, 2.58)
>40 hours (vs 0 hours)	ref	1.03 (0.66, 1.60)	1.85* (1.16, 2.98)	ref	0.99 (0.63, 1.56)	1.81* (1.10, 2.97)
<b>Resident Father</b>						
>0 & ≤40 hours (vs 0 hours)	ref	1.17 (0.61, 2.25)	2.50* (1.04, 5.96)	ref	1.04 (0.53, 2.02)	1.89 (0.77, 4.61)
>40 hours (vs 0 hours)	ref	1.17 (0.61, 2.26)	3.30** (1.37, 7.90)	ref	1.04 (0.53, 2.05)	2.46* (1.00, 6.05)
<b>Combined Parent</b>						
>40 & ≤80 hours (vs ≤40 hours)	ref	0.85 (0.56, 1.28)	1.81* (1.09, 3.03)	ref	0.81 (0.53, 1.24)	1.90* (1.11, 3.26)
>80 hours (vs ≤40 hours)	ref	0.90 (0.58, 1.38)	2.36** (1.39, 4.00)	ref	0.85 (0.54, 1.33)	2.34** (1.34, 4.10)

\*p<.05, \*\*p<.01

<sup>a</sup>MET/times/week

<sup>b</sup>Adjusted for adolescent age, gender, race/ethnicity, parent availability, and household income

Figure 2.1. Paper 2 Regression-Estimated Adolescent Physical Activity Levels (MET/times/week) by Adolescent Employment Levels Before and After Adjusting for Age, Gender, Race/Ethnicity, Parent Availability, and Household Income in the Add Health (National Longitudinal Study of Adolescent to Adult Health) Study, 1995

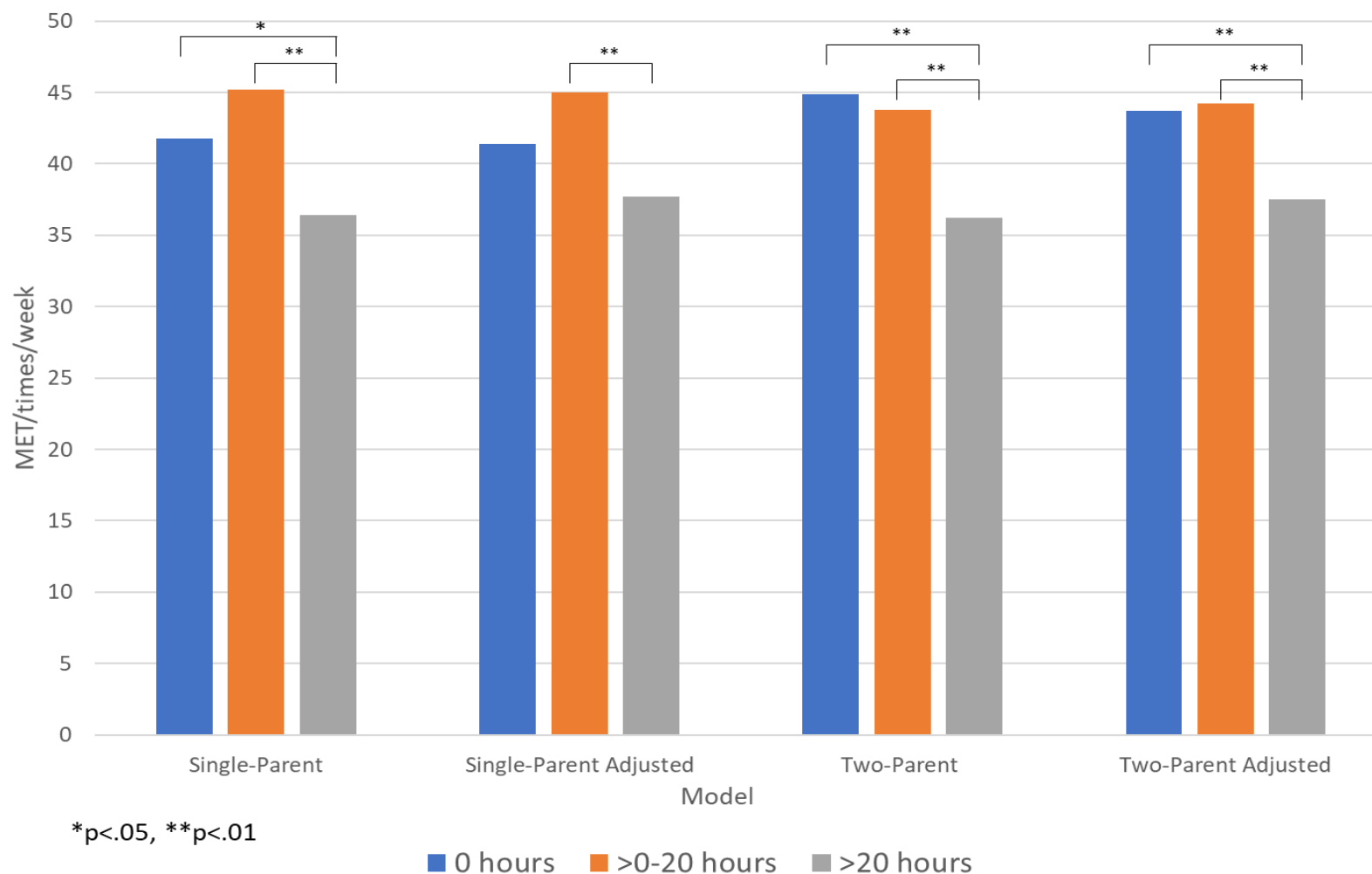




Figure 2.2. Paper 2 Regression-Estimated Adolescent Physical Activity Levels (MET/times/week) by Paternal Employment Levels Before and After Adjusting for Age, Gender, Race/Ethnicity, Parent Availability, and Household Income in the Add Health (National Longitudinal Study of Adolescent to Adult Health) Study, 1995

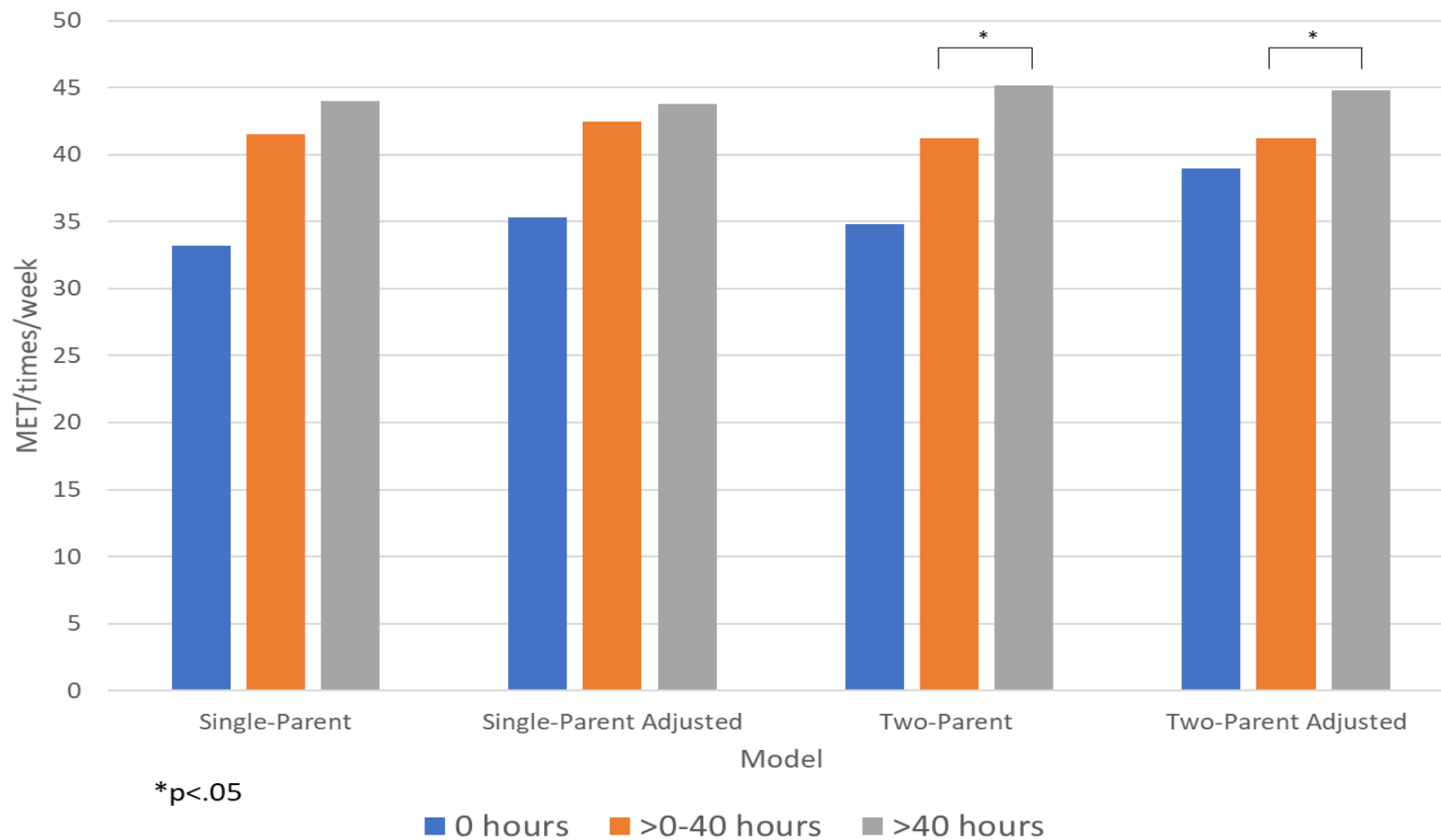


Figure 2.3. Paper 2 Regression-Estimated Adolescent Physical Activity Levels (MET/times/week) by Combined Parental Employment Levels Before and After Adjusting for Age, Gender, Race/Ethnicity, Parent Availability, and Household Income in the Add Health (National Longitudinal Study of Adolescent to Adult Health) Study, 1995

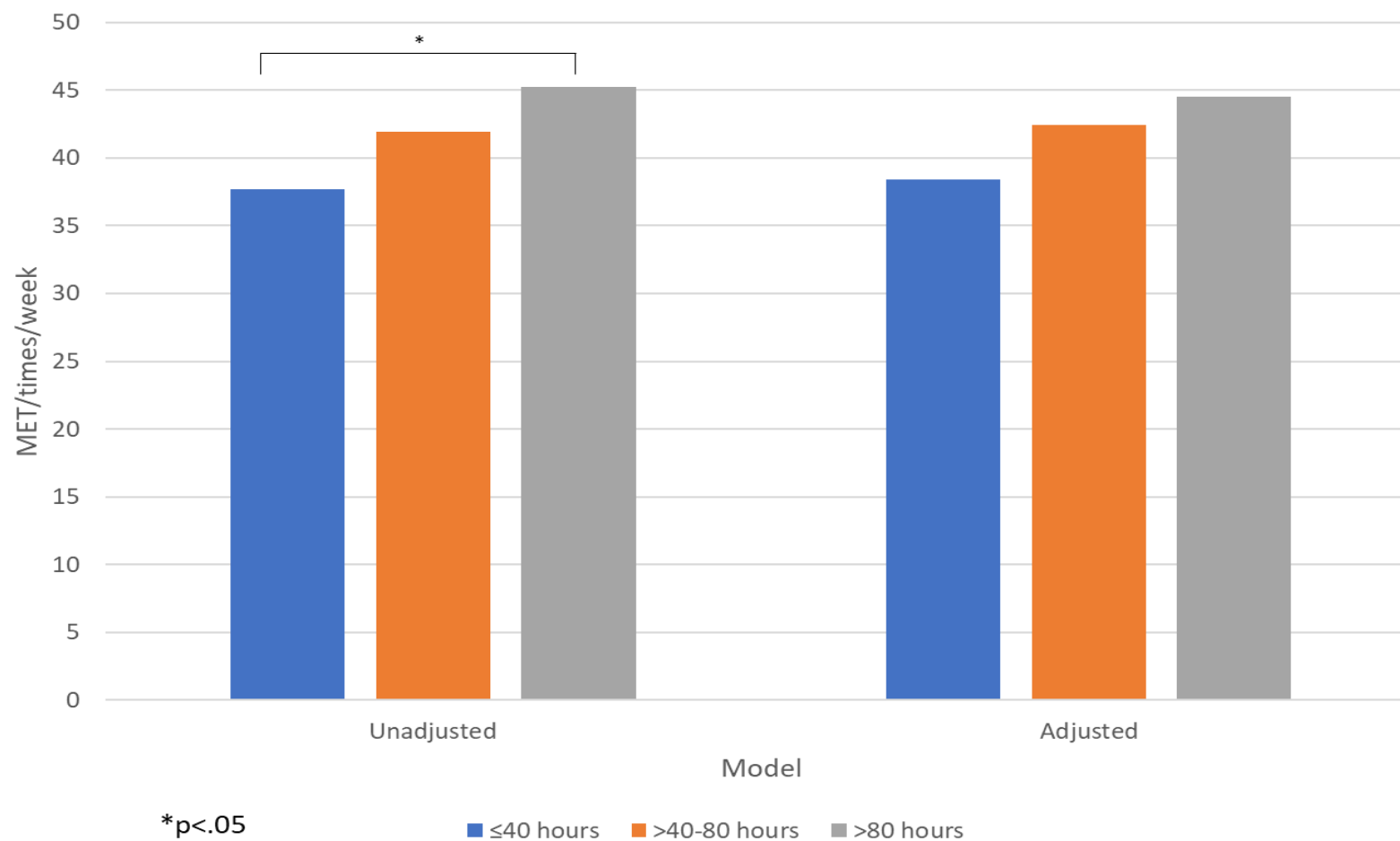
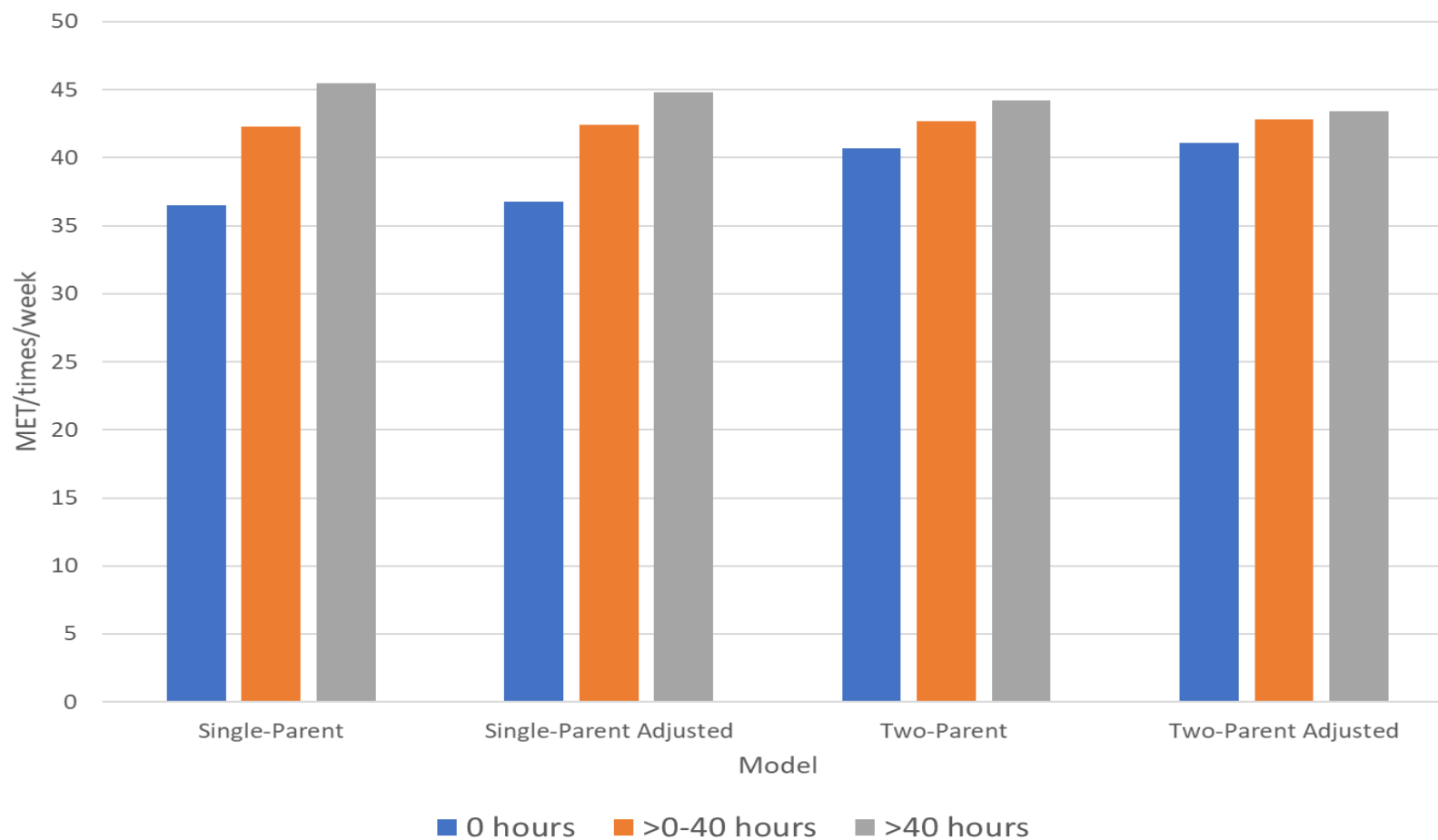


Figure 2.4. Paper 2 Regression-Estimated Adolescent Physical Activity Levels (MET/times/week) by Maternal Employment Levels Before and After Adjusting for Age, Gender, Race/Ethnicity, Parent Availability, and Household Income in the Add Health (National Longitudinal Study of Adolescent to Adult Health) Study, 1995



**PAPER 3 – PARENT SOCIAL SUPPORT FOR PHYSICAL ACTIVITY AND  
ADOLESCENT OUT-OF-SCHOOL AND WEEKEND PHYSICAL ACTIVITY  
AMONG U.S. PARENT-ADOLESCENT DYADS**

**Background**

Meeting aerobic physical activity guidelines, defined for adolescents as at least 60 minutes per day of moderate- to vigorous-intensity physical activity (MVPA), is associated with numerous health benefits, including improved aerobic and muscular fitness and reduced risk of overweight and obesity, as well as reduced lifetime risk of breast cancer, cardiovascular disease, and type II diabetes.<sup>10,11</sup> Despite these multiple benefits, a majority of U.S. adolescents still fail to engage in sufficient levels of physical activity, with only 26.1% of high school students reporting meeting the aerobic physical activity guidelines.<sup>13</sup>

An important influence of adolescent physical activity is parental social support,<sup>9,54,55</sup> defined as the perceived reinforcement and encouragement received from the social (e.g. parental) environment.<sup>52</sup> Social support can be divided into 1) emotional (e.g., displays of empathy, care, and love), 2) instrumental (e.g., tangible aid and services), 3) informational (e.g., suggestions and advice), and 4) appraisal (e.g. information used for self-evaluation) support.<sup>52</sup> Social support is also an important component of parenting practices for physical activity, which can include logistic support, modeling, and encouragement of physical activity.<sup>53</sup>

Studies examining the relation between parental social support and adolescent physical activity have reported direct associations, with higher levels of social support (compared to lower levels) associated with higher levels of physical activity among.<sup>9,54,55</sup> However, there are notable gaps in the literature, including many studies being limited to

one- or two-item measures for parental social support,<sup>20,57</sup> which is problematic given the multi-faceted nature of social support. Further, very few studies include both parent- and adolescent-reported social support measures despite findings of low agreement between parent- and adolescent-reported parenting practices related to physical activity, such as whether parents encourage their child to be physically active.<sup>111</sup> The low agreement of parent- versus adolescent-reported social support may lead researchers who have collected both measures of social support to present only one, based on the most interesting results. Another gap in the literature is that few studies have explored the role of other social factors that may moderate the relation between social support and physical activity. Factors such as parental employment can limit a parent's availability,<sup>39,40</sup> which can be particularly influential during out-of-school and weekend time.<sup>41</sup> For example, a parent's work schedule (e.g., weekly hours worked, night-shifts) may limit their availability to provide transportation for their child, and limit their ability to model physical activity behavior.<sup>87-89</sup>

Given these gaps in the literature, there is a need to further examine the associations of adolescent-reported versus parent-reported parental social support with adolescent physical activity, as well as the potential moderating role of social factors. The purpose of this study is to examine if associations of mean parental social support scores (parent-reported, adolescent-reported, and combined) with adolescent-reported out-of-school and weekend MVPA are modified by parental employment ( $\leq 30$  versus  $>30$  hours worked weekly), based on a nationally representative sample of U.S. adolescents.

## **Methods**

### *Overview*

This study used data from the Family Life, Activity, Sun, Health, and Eating (FLASHE) Study, a cross-sectional, internet-based survey developed by National Cancer Institute (NCI) to examine psychosocial, generational (parent-adolescent), and environmental correlates of cancer-related behaviors, including physical activity, among U.S. adolescents aged 12-17 years.<sup>67</sup> The FLASHE sample was drawn from the Ipsos' Consumer Opinion Panel, which invites people to join through a variety of methods including print advertising, panelist referral, and Internet banner ads.<sup>75</sup> Ipsos selected panelists for FLASHE screening using balanced sampling on the characteristics of race/ethnicity, household size, household income, Census division, and gender.<sup>75</sup> The target population for balancing was the U.S. population of adults in households with at least one adolescent between the ages of 12-17 years. More information on the FLASHE study design and sampling strategy is provided elsewhere.<sup>75</sup>

#### *Study participants*

The study sample includes adolescents and their caregivers. Adolescents were eligible to participate if they 1) were aged 12-17 years and 2) lived in that household for at least 50% of the time. If more than one child in the household was eligible, one child was randomly selected. Parents were eligible to participate if they 1) were 18 years or older, 2) lived with at least one child aged 12-17 years for at least 50% of the time, and 3) agreed to be contacted for participation. For this study, only adolescent-parent dyads with complete data for the primary independent and dependent variables of interest were included.

#### *Data Collection Overview*

Data for the FLASHE study were collected between April-October 2014. Data collection methods included self-administered surveys that assessed 1) diet-related behaviors

and 2) physical activity-related behaviors for both the adolescent and the parent (four web-based surveys total), and an additional accelerometer-derived physical activity assessment for a subsample of adolescents (data have yet to be released as of October 2019).<sup>76</sup> For the current study, data are based on adolescent-reported physical activity.

### *Variables*

FLASHE variables included social support, physical activity, and socio-demographic variables, and are presented in Table 3.1.

#### *Social Support*

The primary independent variables were scores for adolescent-reported and parent-reported parental social support, collected via the adolescent and parent physical activity-related surveys, respectively. Social support items were derived from items on the Parenting Eating and Activity Scale (PEAS),<sup>112</sup> the Activity Support Scale,<sup>113</sup> the Comprehensive Feeding Practices Questionnaire (CFPQ),<sup>114</sup> and the Legitimacy of Parental Authority scale,<sup>115</sup> with the inclusion of one additional item created for the FLASHE study. Survey items were modified from the original sources through cognitive testing.<sup>116</sup> The parent-reported (6-item, 5-point Likert scale) and adolescent-reported (6-item, 5-point Likert scale) measures of social support focused on what parents say and do that may influence their child's physical activity (Table 3.2). For this study, scores were created as follows: 1) parent composite (sum of parent-reported items), 2) adolescent composite (sum of adolescent-reported items), and 3) combined parent-adolescent composite (adolescent and parent composite scores summed by dyad). Items for the parent-reported and adolescent-reported parental social support scales for physical activity appeared to have good internal consistency ( $\alpha=0.81$  and  $\alpha=0.83$ , respectively).

## Physical Activity

The primary dependent variables were self-reported daily minutes of MVPA out-of-school and on the weekend, collected via the adolescent physical activity-related survey. Questions were derived from the Youth Activity Profile (YAP),<sup>78</sup> a self-administered 7-day recall questionnaire for use among students aged 9-18 years.<sup>79</sup> The YAP is a 15-item questionnaire aimed to capture 1) activity at school, 2) activity out-of-school, and 3) sedentary habits. For the FLASHE study, the YAP was adapted to provide separate estimates of activity occurring at school (five items), out-of-school (three items), and on the weekend (two items).<sup>79</sup> In order to calibrate and validate the YAP, participants wore a GT3X+ ActiGraph on the dominant wrist for 7 days and then completed the YAP.<sup>79</sup> Calibration was provided by regressing percentage time in MVPA on each YAP subsection score (in-school, out-of-school, weekend), age, and the interaction between these two factors on measured outcomes recorded by the GT3X+.<sup>79</sup> Validity (median absolute percentage error, equivalence testing) was assessed by applying the final algorithms to independent samples of adolescents. The YAP had good criterion validity and predicted values within 10%-20% of those produced by the GT3X+.<sup>79</sup>

## Covariates

Demographic questions were collected from the adolescent or parent (as applicable) via a self-administered questionnaire attached to the end of the first survey, which was randomly selected as either the diet- or physical activity-related survey. Adolescent grade, race/ethnicity, and socioeconomic status (SES) were included as potential confounders. Grade was categorized from grades 6<sup>th</sup>-12<sup>th</sup>. For this study, grade was further categorized as 6<sup>th</sup>-8<sup>th</sup> grade (middle school) and 9<sup>th</sup>-12<sup>th</sup> grade (high school). Race/ethnicity was categorized



as Hispanic, non-Hispanic White, Non-Hispanic Black or African American, and Non-Hispanic Other; Black Hispanics were classified as Hispanic. Free or reduced lunch was used as a proxy for SES, with eligibility defined as those with an annual household income  $\leq 185\%$  of the Federal Poverty Level, equating to a yearly household income of \$44,123 in 2014 for a family of four.<sup>77</sup> For this variable, parents were asked “*Does {TEEN} currently receive free or reduced price lunch at school?*”. Parental employment was included as a potential effect measure modifier. Parental employment was categorized as working 0-14, 15-30, 31-41, and over 41 hours per week. For this study, parental employment was be further categorized as  $\leq 30$  and  $>30$  hours worked per week. Adolescent age was included for descriptive purposes only.

#### *Protection of Human Subjects*

Ethical review and approval for the original FLASHE study was provided by U.S. Government’s Office of Management and Budget, NCI’s Special Studies Institutional Review Board, and Westat’s Institutional Review Board. Data are de-identified and publicly available. For this study, Institutional Review Board exemption status was sought from the University of Texas Health Science Center Committee for the Protection of Human Subjects (HSC-SPH-19-0675).

#### *Statistical Analysis*

Data management and statistical analyses were performed using STATA 15.1 (StataCorp, College Station, TX). Descriptive statistics were calculated for social support, physical activity, and socio-demographic variables. Categorical variables were presented as frequencies and proportions and continuous variables were presented as means with standard deviations. Differences in social support, physical activity, and socio-demographic variables

by gender were assessed using chi-square test for categorical variables and t-test for continuous variables. Cronbach's alpha was calculated to examine the internal consistency of the individual adolescent- and parent-reported social support items aiming to measure the latent construct of parent social support. Pearson's correlation was used to examine the correlation between adolescent- and parent-reported social support to help determine whether combining social support items was appropriate.

Weights were used in all regression analyses to allow results to be representative of the U.S. population. Linear regression was used to explore the relation of parental social support scores with out-of-school and weekend MVPA, overall and by gender. Composite parent-reported, composite adolescent-reported, and combined parent-adolescent social support scores were examined. An interaction term was then created (social support score\*employment) and tested in multiple linear regression models to explore potential modification of the relation of parental social support scores with out-of-school and weekend MVPA by parental employment ( $\leq 30$  versus  $> 30$  hours worked weekly) overall and by gender, before (Model 1) and after (Model 2) adjusting for adolescent grade, race/ethnicity, and socioeconomic status. Unweighted linear regression was used to examine the relation of adolescent grade, gender, race/ethnicity, and socioeconomic status with adolescent-reported, parent-reported, and combined social support scores in order to explore potential correlates of parent social support. T-test was used to compare social support scores of the socio-demographic subgroups by parent- versus adolescent-reported.

## **Results**

The final analytic sample was 1,395 adolescents with a mean age of 14.5 years (SD=1.6). The sample was 51.0% female and 64.1% were non-Hispanic White (Table 3.3).

Thirty percent were eligible for free or reduced-price lunch, and 49.8% of adolescents had a parent working over 30 hours a week, with 35.5% of parents reporting “Not applicable”.

Adolescents were similarly distributed across males and females in age, race/ethnicity, grade level, eligibility to receive free or reduced-price lunch, and parental employment ( $p>.05$ ).

There was a significant positive correlation between adolescent- and parent-reported parental social support scores ( $r=0.61$ ,  $p<.01$ ) (Figure 3.1). Mean parental social support for physical activity scores were 20.0 ( $SD=5.1$ ) for parent-reported (range=6-30), 18.9 ( $SD=5.6$ ) for adolescent-reported (range= 6-30), and 38.9 ( $SD=9.6$ ) for parent-adolescent combined (range=12-60). Reported mean daily minutes of MVPA were 57.8 ( $SD=19.4$ ) out-of-school and 104.6 ( $SD=19.4$ ) on the weekend. No significant differences by gender were found for reported social support scores or out-of-school MVPA. Mean daily minutes of weekend MVPA were significantly higher among males (105.8,  $SD=19.7$ ) compared to females (103.5,  $SD=19.2$ ) ( $p=.03$ ).

### *Simple Linear Regression*

Simple linear regression was conducted to examine if reported social support scores were significantly associated with mean daily minutes of adolescent out-of-school and weekend MVPA. Parent-reported, adolescent-reported, and parent-adolescent combined social support scores were all significantly associated with both out-of-school and weekend MVPA for the total adolescent sample and when examining males and females separately ( $p<.01$ ) (Table 3.4). Adolescent-reported social support explained more variance than parent-reported social support for all physical activity models. Further, adolescent-reported social support explained more variance among males compared to females in the out-of-school models ( $R^2=0.09$ ,  $p<.01$  and  $R^2=0.05$ ,  $p<.01$ , respectively), with similar variance explained in

the weekend models ( $R^2=0.05$ ,  $p<.01$  and  $R^2=0.05$ ,  $p<.01$ , respectively). In addition, reported social support scores explained more variance in the out-of-school versus weekend models among adolescent males and for the total adolescent sample.

### *Multiple Linear Regression*

Multiple linear regression was used to explore potential modification of the relation of parental social support scores with out-of-school and weekend MVPA by parental employment, before and after adjusting for adolescent grade, race/ethnicity, and eligibility for free or reduced-price lunch. No significant interactions were found for social support score\*employment for the total adolescent sample or by gender for out-of-school or weekend MVPA, in either the unadjusted or adjusted models (Table 3.5).

### *Correlates of Social Support*

In further exploring the primary findings, additional subanalyses were conducted to examine the relation of adolescent grade, gender, race/ethnicity, and socioeconomic status with reported social support scores using linear regression. Adolescent race/ethnicity and grade level were significantly associated with parental social support for physical activity scores (Table 3.6). However, race/ethnicity was only significant for parent-reported social support scores, with parents of White adolescents reporting significantly lower social support scores than parents of Hispanic ( $p<.01$ ) or Other race/ethnicity ( $p<.05$ ) adolescents. High school adolescents and parents of high school adolescents reported significantly lower social support compared to middle school adolescents ( $p<.01$ ) and parents of middle school adolescents ( $p<.01$ ), respectively. Adolescents reported significantly lower parental social support scores than parents for all gender, race/ethnicity, grade level, and socioeconomic

subgroups ( $p < 0.05$ ) except for Hispanic adolescents, although this was trending towards significance ( $p = 0.06$ ).

## **Discussion**

The purpose of this study was to examine if associations of mean parental social support scores (parent-reported, adolescent-reported, and combined) with adolescent-reported out-of-school and weekend MVPA are modified by parental employment ( $\leq 30$  versus  $> 30$  hours worked weekly), using a nationally representative sample of U.S. adolescents aged 12-17 years. All parental social support scores were significantly associated with adolescent physical activity, with more variance explained by adolescent-reported compared to parent-reported for all physical activity models. No statistically significant interactions were found between reported social support scores and parental employment within any of the physical activity regression models.

Reported parental social support was significantly associated with adolescent physical activity, aligning with previous findings.<sup>9,54,55</sup> However, adolescent-reported parental social support explained more variance in adolescent physical activity than parent-reported social support, suggesting that perceived parental support is more influential than the social support reported by parents in regards to adolescent physical activity. Although both parent- and adolescent-reported parental social support were found to be significantly associated with adolescent physical activity, underscoring their utility for assessment of parental social support, adolescent-reported social support explained more variance compared to parent-reported social support, suggesting it may be a more preferred measure than parent-reported social-support. Further, there should be considerations for gender and different periods of

physical activity, based on findings that social support accounted for more variance in physical activity among males, and during out-of-school time.

Relations of parental social support with adolescent physical activity were not found to be modified by parent employment. This is a positive result, suggesting that the direct association of social support and physical activity does not differ by parents' weekly hours worked, and an important finding considering the large percentage of parents who are employed.<sup>117</sup> These findings are a notable contribution to the literature, as this is the first known study to examine the role of parental employment in the association of parental social support with adolescent physical activity. Although one study found differences in parental support by employment status, it examined the relation of overall (versus physical activity-related) parental support with overall adolescent health, versus physical activity behavior.<sup>118</sup>

#### *Correlates of Parental Social Support*

Adolescents reported significantly lower parental social support scores than parents for nearly all gender, race/ethnicity, grade level, and socioeconomic subgroups. These results align with findings of low agreement between parent- and adolescent-reported parenting practices related to physical activity.<sup>111</sup> Significantly lower parental social support among adolescents in high school versus middle school may reflect increasing autonomy during this time, and is supported by findings that suggest peers take a more prominent role than parents in influencing adolescent physical activity behavior.<sup>119-121</sup> These results also emphasize the need for future research to consider grade level (middle versus high school) separately when examining parental social support and adolescent physical activity. In addition, there were parent-reported differences in parental social support by race/ethnicity, which align with findings demonstrating racial/ethnic differences in parent social support for physical

activity.<sup>122,123</sup> However, these studies measured adolescent- (versus parent-) reported parental social support only, further supporting the need for additional research examining socio-demographic correlates of parental social support (both adolescent- and parent-reported) for adolescent physical activity.

### *Strengths and Limitations*

The current study has numerous strengths. FLASHE was conducted among a large, nationally representative sample of U.S. adolescents, which provides external study validity with sufficient statistical power to examine parental social support items within each period of physical activity. This study also addresses multiple gaps in the literature, including examination of physical activity during out-of-school and weekend time only, versus overall or leisure time only. This is an important consideration, as parental social support is likely to influence an adolescent's physical activity more out-of-school and on the weekends, rather than during school time. In addition, previous research on parental social support and adolescent physical activity has primarily focused on either adolescent- or parent-reported measures, and are often limited to one- or two-items. However, this study included multiple measures of both adolescent- and parent-reported parental social support. In addition, this is the only known study to explore potential moderation of the relation of parental social support and adolescent physical activity by parental employment, an important social factor. Given findings from time-use studies that parent employment decreases time available for playing with children, playing sports with children, and supervising children,<sup>39</sup> this study provides important insights into the role employment plays in the association between parental social support and adolescent physical activity. Finally, few studies have examined

potential correlates of parent social support for physical activity, particularly when using both adolescent- and parent-reported social support.

The limitations of this study must also be noted. Analyses were conducted using cross-sectional FLASHE data, which limits the ability to make causal inferences about parental social support and adolescent physical activity. Further, although the FLASHE study sample was selected to be similar to the U.S. population and weights were used in analyses, it should be noted that recruitment was conducted through a consumer opinion panel and had an overall study response prevalence of less than 30%,<sup>75</sup> which could limit external validity of the results. Also, the measures for social support and physical activity are reported, and therefore prone to recall and reporting bias, and as well as possible social desirability bias. However, use of the FLASHE survey for self-reported physical activity allowed for distinguishing between different periods of the day and/or week (out-of-school and weekend). Mono-method bias is another potential concern, as adolescents reported both parent social support for physical activity and adolescent physical activity on the same survey.<sup>124</sup> Another limitation was that parental employment was based on a categorical - versus continuous - measure of weekly hours worked, which could limit the ability to fully explore the relation between parental employment and reported social support.

## **Conclusion**

Both parent- and adolescent-reported parental social support were associated with adolescents' out-of-school and weekend MVPA, underscoring their viability in adolescent physical activity research. However, adolescent-reported may provide greater insights into the role of parental social support given the larger variance explained. The small but significant racial/ethnic differences in parent-reported social support, as well as a dearth of



literature regarding correlates of parent social support for physical activity, calls for further examination of the relation between parent socio-demographics with parent social support, and its association with adolescent physical activity. Furthermore, although no significant interactions for social support scores and parental employment were found, future research should consider parental employment as a continuous variable to examine other potential relationships of social support with parental weekly hours worked.

Table 3.1. Paper 3 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Variables

Construct	Variable	Survey	Type
Physical Activity Periods: Minutes per day spent in moderate- to vigorous-intensity physical activity (MVPA)			
Out-of-school	(Derived) Minutes per day spent in MVPA out-of-school	Adolescent	Dependent
Weekend	(Derived) Minutes per day spent in MVPA during the weekend	Adolescent	Dependent
Parental Social Support for Physical Activity			
Parent-Reported Social Support	Composite Score: Sum of parent-reported social support items • Range = 6-30	Parent	Independent
Adolescent-Reported Social Support	Composite Score: Sum of adolescent-reported social support items • Range = 6-30	Adolescent	Independent
Combined Parent- and Adolescent-Reported Social Support	Combined Composite Scores: Sum of parent- and adolescent-reported composite scores • Range: 12-60	Parent and Adolescent	Independent
Socio-demographics			
Gender	Are you male or female? • ( <i>Male, Female</i> )	Adolescent	Covariate
Race/ethnicity	(Recoded) Are you Hispanic, Latino/a or Spanish origin? Which one or more of the following would you say is your race? • ( <i>Hispanic, Black or African American only, White only, Other</i> )	Adolescent	Covariate
Grade	(Derived) What grade are you in? • ( <i>6<sup>th</sup>-8<sup>th</sup> grade, 9<sup>th</sup>-12<sup>th</sup> grade</i> )	Adolescent	Covariate
Socioeconomic Status	Does {TEEN} currently receive free or reduced price lunch at school? • ( <i>Yes, No</i> )	Parent	Covariate
Parental Employment	(Recoded) About how many hours do you work per week at all of your jobs and businesses combined?	Parent	Covariate

	<ul style="list-style-type: none"> <li>(<math>\leq 30</math> hours, <math>&gt; 30</math> hours worked per week)</li> </ul>		
Age	What is your age? <ul style="list-style-type: none"> <li>(12 years old to 17 years old)</li> </ul>	Adolescent	Covariate

Table 3.2. Paper 3 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Parent- and Adolescent-Reported Parental Social Support for Physical Activity, Individual Items

Parent-Reported	Adolescent-Reported
I have to make sure my teenager gets enough physical activity.	My parent(s) have to make sure that I get enough physical activity.
I take my teenager places where he/she can be physically active.	My parent(s) take me places where I can be physically active.
My teenager and I decide together how much physical activity he/she has to do.	My parent(s) and I decide together how much physical activity I have to do.
I make my teenager exercise or go out and play.	My parent(s) make me exercise or go out and play.
I try to be physically active when my teenager is around.	My parent(s) try to be physically active when I'm around.
It's okay for me to make rules about how much time my teenager spends being physically active/playing.	It's okay for my parent(s) to make rules about how much time I spend being physically active/playing.

Table 3.3. Paper 3 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Adolescent Participant Characteristics

Characteristics	Total Sample (N=1,395)	Male (n= 678, 48.6%)	Female (n= 712, 51.0%)	P value for differences by gender
	% (n)	% (n)	% (n)	
Age (years) M <sub>age</sub> =14.5, SD=1.6				
12-13	33.1% (461)	32.7% (222)	33.4% (238)	0.65
14-15	34.3% (479)	33.6% (228)	35.1% (250)	
16-17	32.6% (455)	33.6% (228)	31.5% (224)	
Grade Level				
6 <sup>th</sup> -8 <sup>th</sup>	40.5% (565)	40.7% (276)	40.5% (288)	0.64
9 <sup>th</sup> -12 <sup>th</sup>	59.5% (830)	59.3% (402)	59.6% (424)	
Race/Ethnicity				
Hispanic	10.1% (141)	10.2% (69)	10.1% (72)	0.79
Non-Hispanic Black or African American Only	16.4% (229)	17.4% (118)	15.6% (111)	
Non-Hispanic White Only	64.1% (894)	62.7% (425)	65.2% (464)	
Non-Hispanic Other	8.3% (116)	8.9% (60)	7.9% (56)	
Eligibility for Free or Reduced-Price Lunch				

Yes	30.1% (420)	31.4% (213)	28.7% (204)	0.45
<b>Parental Employment</b>				
>0-30 hours/week	15.1% (210)	14.3% (97)	15.9% (113)	0.20
>30 hours/week	49.8% (694)	51.5% (349)	48.3% (344)	
	Mean (SD)	Mean (SD)	Mean (SD)	
<b>Parent Social Support for Physical Activity</b>				
Parent-Reported Score (Range=6-30)	20.0 (5.1)	19.9 (5.1)	20.0 (5.1)	0.76
Adolescent-Reported Score (Range=6-30)	18.9 (5.6)	19.0 (5.4)	18.9 (5.8)	0.78
Parent-Adolescent Combined Score (Range=12-60)	38.9 (9.6)	38.9 (9.4)	38.9 (9.6)	0.98
<b>Physical Activity Periods (minutes/day of MVPA)</b>				
Out-of-School	57.8 (10.5)	58.2 (10.7)	57.5 (10.4)	0.18
Weekend	104.6 (19.4)	105.8 (19.7)	103.5 (19.2)	0.03

Table 3.4. Paper 3 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Linear Regression Model Coefficients for Predicting Adolescent Out-of-School and Weekend Moderate- to Vigorous-Intensity Physical Activity (MVPA) from Parental Social Support Composite Scores

Parent Social Support for Physical Activity	Out-of-School MVPA		Weekend MVPA	
	$\beta$ (95% CI)	R <sup>2</sup>	$\beta$ (95% CI)	R <sup>2</sup>
<b>Total Adolescent Sample (N=1,395)</b>				
Parent-Reported	0.4** (0.3-0.6)	0.04	0.7** (0.5-0.9)	0.03
Adolescent-Reported	0.5** (0.4-0.6)	0.07	0.8** (0.6-1.0)	0.05
Parent-Adolescent Combined	0.3** (0.2-0.4)	0.07	0.5** (0.4-0.6)	0.05
<b>Adolescent Male Sample (n=678)</b>				
Parent-Reported	0.5** (0.3-0.6)	0.05	0.7** (0.4-1.0)	0.03
Adolescent-Reported	0.6** (0.5-0.8)	0.09	0.9** (0.6-1.2)	0.05
Parent-Adolescent Combined	0.3** (0.3-0.4)	0.09	0.5** (0.3-0.7)	0.05
<b>Adolescent Female Sample (n=712)</b>				
Parent-Reported	0.4** (0.3-0.6)	0.04	0.8** (0.5-1.0)	0.04
Adolescent-Reported	0.4** (0.3-0.6)	0.05	0.7** (0.5-1.0)	0.05
Parent-Adolescent Combined	0.3** (0.2-0.3)	0.06	0.5** (0.3-0.6)	0.06

\*p<0.05; \*\*p<0.01

Table 3.5. Paper 3 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Multiple Regression Models Examining Potential Modification of the Relation of Parental Social Support for Physical Activity Scores and Mean Daily Minutes of Out-of-School and Weekend Moderate- to Vigorous-Intensity Physical Activity (MVPA) by Parental Employment

	Parent-Reported Social Support		Adolescent-Reported Social Support		Combined Social Support	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
<b>Out-of-School MVPA</b>						
<b>Total Sample (n)</b>	904	879	904	879	904	879
$\beta$ (SE)	-0.1 (0.2)	-0.1 (0.1)	0.1 (0.1)	0.2 (0.1)	-0.0 (0.1)	-0.0 (0.1)
p-value <sup>a</sup>	0.40	0.42	0.33	0.18	0.78	0.99
<b>Males (n)</b>	446	435	446	435	446	435
$\beta$ (SE)	-0.4 (0.3)	-0.3 (0.2)	0.2 (0.2)	0.3 (0.2)	-0.1 (0.1)	0.3 (0.2)
p-value	0.10	0.15	0.41	0.16	0.44	0.16
<b>Females (n)</b>	457	443	457	443	457	443
$\beta$ (SE)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.0 (0.1)	0.0 (0.1)
p-value	0.77	0.76	0.58	0.64	0.79	0.81
<b>Weekend MVPA</b>						
<b>Total Sample (n)</b>	904	879	904	879	904	879
$\beta$ (SE)	-0.4 (0.3)	-0.3 (0.3)	0.1 (0.3)	0.2 (0.3)	-0.1 (0.2)	-0.0 (0.2)
p-value	0.18	0.36	0.64	0.45	0.45	0.76



<b>Males (n)</b>	446	435	446	435	446	435
$\beta$ (SE)	-0.9 (0.5)	-0.7 (0.5)	0.2 (0.4)	0.3 (0.4)	-0.3 (0.3)	-0.2 (0.3)
p-value	0.06	0.11	0.59	0.49	0.34	0.49
<b>Females (n)</b>	457	443	457	443	457	443
$\beta$ (SE)	-0.0 (0.4)	0.2 (0.4)	0.0 (0.4)	0.1 (0.3)	-0.0 (0.2)	0.1 (0.2)
p-value	0.97	0.66	0.93	0.74	0.89	0.77

Model 1: Social support composite score\*Parent hours worked weekly ( $\leq 30$  versus  $>30$ )

Model 2: Model 1 + race/ethnicity + grade level + eligibility to receive free or reduced-price lunch

<sup>a</sup>Significance of social support composite score\*parent hours worked weekly interaction

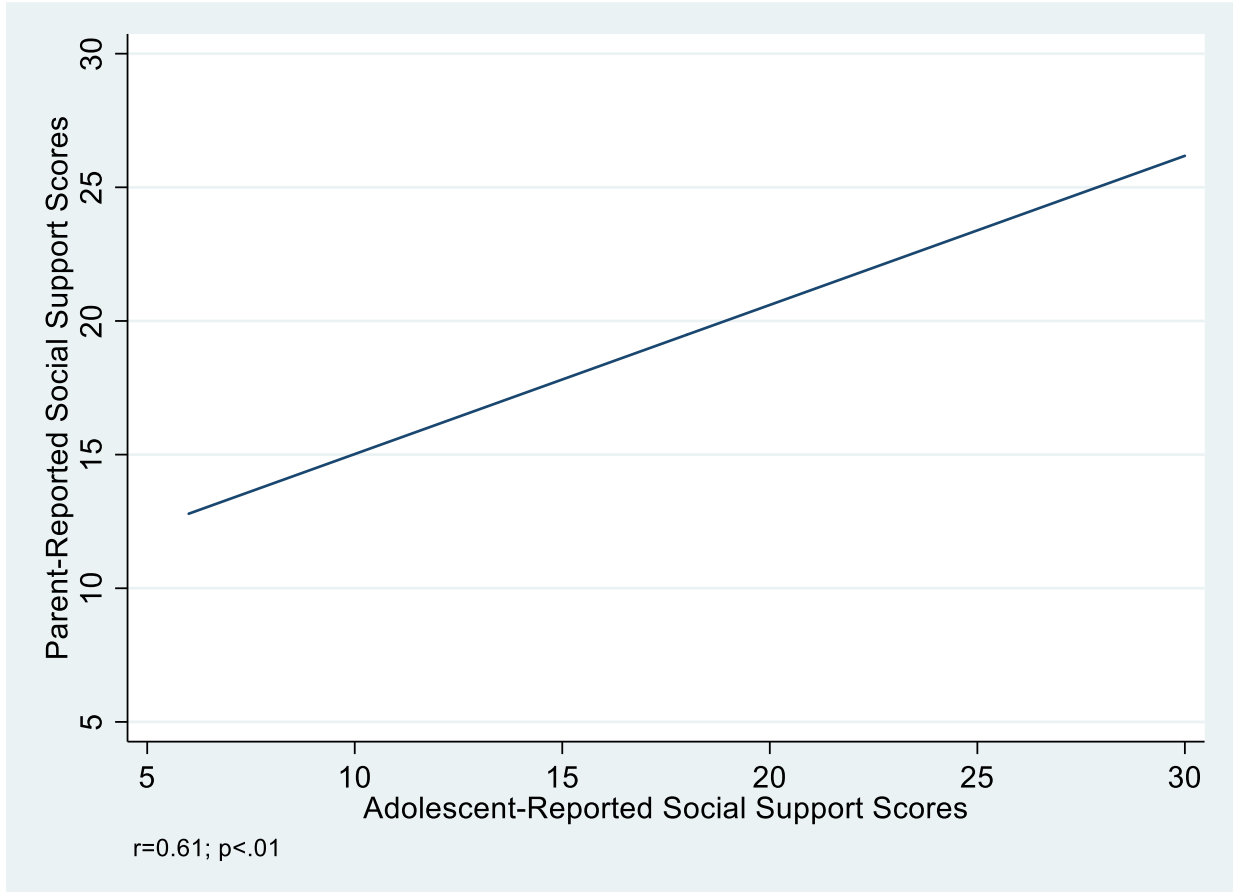
Table 3.6. Paper 3 FLASHE (Family Life, Activity, Sun, Health, and Eating) Study Parent- and Adolescent-Reported Parental Social Support for Physical Activity Scores Estimated from Multiple Regression Models

Adolescent Characteristics	Parental Social Support for Physical Activity Scores		
	Parent-Reported (Range: 6-30)	Adolescent-Reported (Range: 6-30)	Differences by reported social support
	Mean (SE)	Mean (SE)	p-value <sup>a</sup>
<b>Gender (n=1,390)</b>			
Male	19.9 (0.2)	19.0 (0.2)	<0.01
Female	20.0 (0.2)	18.9 (0.2)	<0.01
p-value	0.76	0.78	
<b>Race/Ethnicity (n=1,380)</b>			
Hispanic	20.9 (0.4)	19.7 (0.5)	0.06
Black	20.2 (0.3)	18.9 (0.4)	0.02
White	19.7 (0.2)	18.8 (0.2)	<0.01
Other	20.9 (0.5)	19.4 (0.5)	0.04
p-value	0.01	0.21	
<b>Grade Level (n=1,395)</b>			
Middle School	20.6 (0.2)	19.8 (0.2)	<0.01
High School	19.6 (0.2)	18.3 (0.2)	<0.01
p-value	<0.01	<0.01	
<b>Eligible for Free or Reduced- Price Lunch (n=1,375)</b>			
Yes	19.7 (0.2)	18.8 (0.3)	0.02
No	20.1 (0.2)	19.0 (0.2)	<0.01
p-value	0.14	0.56	

SE=Standard Error

<sup>a</sup>T-test used to compare parental social support by parent- versus adolescent-reported

Figure 3.1. Correlation of Adolescent-Reported and Parent-Reported Parent Social Support Composite Scores in the FLASHE (Family Life, Activity, Sun, Health, and Eating) Study, 2014



## CONCLUSION

This dissertation examined relations of physical activity with socio-demographic and socio-environmental factors – including employment and social support – while exploring variations in these associations by individual- (e.g., gender, race/ethnicity, grade) and family-level (e.g., socioeconomic status) factors among U.S. adolescents. The first paper examined differences in adolescent physical activity by gender and race/ethnicity, and evaluated if these relations were modified by grade and SES. The results indicated that there were significant physical activity differences by race/ethnicity, which further differed by grade, SES, and period of physical activity. At the middle school level, Hispanics had less physical activity than Whites out-of-school, while the inverse was seen for in-school and out-of-school physical activity at the high school level. In addition, Blacks and Other racial/ethnic group both had more in-school activity than Whites at the middle school level, but the inverse was seen for weekend activity at the high school level. Further, Hispanics eligible for free or reduced-price lunch were found to have more physical activity compared to ineligible Hispanics at both the middle and high school levels.

The second paper examined the association of adolescent and parent weekly hours worked with adolescent physical activity. Adolescent physical activity was inversely associated with adolescent hours worked, while greater hours of parental employment was associated with higher physical activity among adolescents, across both two-parent and single-parent (mother only) households. The third paper examined the association of parent- and adolescent-reported parental social support for physical activity with adolescent physical activity, and evaluated if these relations

were modified by parental employment. All parental social support scores were significantly associated with adolescent physical activity, with more variance explained by adolescent-reported compared to parent-reported. No significant interactions were found between reported social support scores and parental employment.

The strengths and limitations of this dissertation work should be noted. The FLASHE and Add Health studies were conducted among large, nationally representative samples, which provides external study validity with sufficient statistical power to examine the relations of physical activity with numerous socio-demographic and socio-environmental factors, while examining differences in these associations by adolescent subgroups. Additionally, each paper addresses an important gap in the literature. Few studies have considered adolescent physical activity differences by socio-demographics – and their potential moderation – within different periods of physical activity, as conducted in paper one. Furthermore, no known studies have examined the associations of adolescent and parent (maternal and paternal) employment (paper two) or adolescent- and parent-reported parental social support (paper three) with adolescent physical activity.

The limitations of this dissertation must also be discussed. All the analyses were conducted using cross-sectional data, limiting the ability to make causal inferences about the relations of interest. In addition, although FLASHE weights were used in analyses for papers one and three, and the study sample was selected to be similar to the U.S. population, the overall response percentage of less than 30% could limit the external validity of the results. Another limitation is the use of self-report

measures, which are subject to recall and reporting bias, as well possible social desirability bias. However, these data were collected among adolescents, who can provide more valid estimates of physical activity compared to children.<sup>98</sup> Another limitation for paper two is the use of data that were collected in 1995. However, Add Health was the most recent dataset that collected adolescent physical activity as well as employment information for both parents and adolescents. This provided the opportunity to fill a notable gap in the literature and create a foundation for future work.

Overall, results of these papers highlight the complexity of adolescent physical activity behavior, and the importance of considering multiple levels of influence such as those presented in the conceptual model (p. 6). As noted in paper one, there are physical activity differences by intrapersonal factors such as race/ethnicity, with further modification of these relations by grade level and SES. The importance of considering time allocation when examining these factors is further highlighted by paper one's mixed findings depending on the time period of physical activity, many of which conflict with what is typically seen in the literature. Paper two demonstrated how interpersonal influences, specifically parental employment, and behavior-level factors such as adolescent employment are associated with adolescent leisure-time physical activity. Finally, paper three demonstrated a direct association between parental social support, at the interpersonal level, and adolescent physical activity.

#### *Opportunities and Directions for Further Research*

Future research can expand on these findings to increase understanding of adolescent physical activity behavior, and potential disparities in physical activity levels. For example, additional research is needed to confirm the findings presented in paper 1 regarding socio-demographic variations in physical activity correlates while considering how these correlates may vary by in-school, out-of-school, and weekend time. Further, the results of paper 1 can be used to inform future epidemiological research and design of interventions focused on youth physical activity and potential physical activity differences by race/ethnicity, SES, grade level, and gender. Paper 2 addressed notable gaps in the literature, although future research can expand on these findings by exploring how higher levels of employment can affect an adolescent's time use and their ability to be physically active, as well as the reasons for higher adolescent physical activity levels among more hours of parental employment. In addition, this study utilized data from 1995 because Add Health was the most recent, national dataset that included adolescent employment, parent employment, and adolescent physical activity measures. Future researchers should add these measures in studies, while considering type of employment, occupational physical activity, and physical activity types - as well as potential differences by adolescent and parent demographics. Organized activities such as sports may be less likely among adolescents working an hourly job, although activities such as leisure-time running or walking may provide more flexibility since they are not as contingent on a work schedule. Further, although many adolescents need to work, policy could be implemented that requires adolescent be informed of their work schedule ahead of time, rather than on a week by week basis. Paper 3 also provides a foundation for

future examination of adolescent physical activity influences. Specifically, future research should consider parental social support differences by gender, grade level, and periods of physical activity. Paper 3 also addressed a gap in the literature regarding adolescent socio-demographic correlates of parental support, and demonstrated that both parent-reported and adolescent-reported parental social support play a role in adolescent physical activity. Although it is not feasible to enforce parental social support, future work could build opportunities for developing social support for physical activity among parents. In addition, future research could examine the relation between parent socio-demographics with parent social support, and its association with adolescent physical activity. Overall, longitudinal studies examining time use changes from childhood into adolescence could increase understanding of the declines in physical activity during this life stage. In addition to changes in adolescents' employment and social networks, longitudinal studies could examine how their ability to drive, screen time changes, physical activity types, and changes in schoolwork time (versus childhood) affect adolescent physical activity behavior.

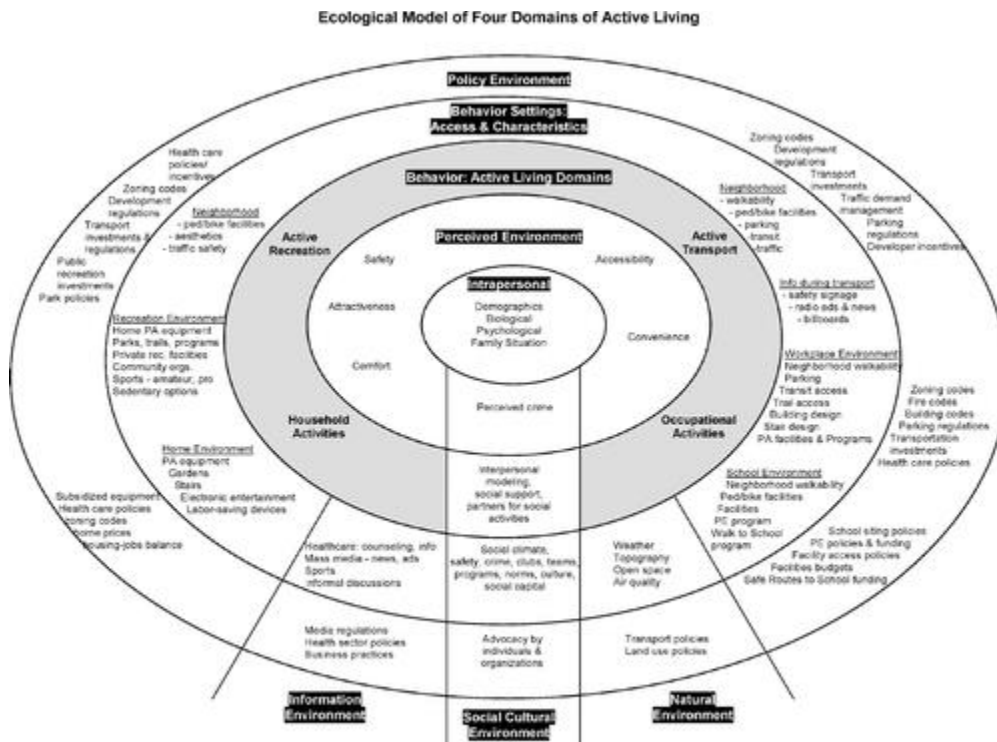
Only about 25% of adolescents report meeting U.S. aerobic physical activity guidelines, raising concerns about their physical activity behavior and overall health later in life.<sup>125</sup> The notable declines in activity levels as children enter into adolescence are likely a reflection of the numerous mental, physical, environmental, and social changes that occur, but a greater understanding of how these changes influence activity levels during this time is needed. The results of these papers have made substantial contributions to the literature, as identifying the relation of behavior-



, interpersonal-, and intrapersonal-level factors with physical activity is crucial to creating effective approaches that support physical activity behavior among adolescents.

## APPENDICES

## Appendix A: Ecological Model of Four Domains of Active Living



**AR** Sallis JF, et al. 2006.  
Annu. Rev. Public Health 27:297–322

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