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Influences of Parent Physical Activity Support and Physical Activity Modeling on Adolescent Physical Activity Engagement and Weight Status

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INFLUENCES OF PARENT PHYSICAL ACTIVITY SUPPORT AND PHYSICAL ACTIVITY MODELING ON ADOLESCENT PHYSICAL ACTIVITY ENGAGEMENT AND WEIGHT STATUS

by

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DEDICATION

This work is dedicated to everyone who has supported me during my time at the University of Memphis School of Public Health. To my immediate family, thank you all for your prayers and encouraging words as I have journeyed through this process. Special thanks to my mother for always being a listening ear and a constant reminder that God did not bring me to this place to forsake me. To my sister, many thanks for your numerous texts of uplifting words. I am glad to know that I have made you all proud.

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ABSTRACT

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Childhood obesity rates continue to rise with adolescents (12-19 years old) having the highest prevalence (20.6%) across all age groups. Previous studies have indicated the importance of physical activity (PA) to assist with reducing obesity rates among adolescents. Parents influence their adolescent's PA as they are typically adolescents' first exposure and gatekeepers to both direct and indirect PA behaviors through their support and modeling of PA. This dissertation used parent-adolescent dyads from the Family Life, Activity, Sun, Health, and Eating (FLASHE) study to examine the associations between parent PA support and PA modeling and adolescent moderate-to-vigorous physical activity (MVPA) engagement and weight status. The study hypothesized that parent factors (parent PA support and parent PA modeling) and adolescent psychosocial constructs (i.e., PA self-efficacy, perception of parent PA support) would positively influence adolescent PA-related behaviors and health outcomes (more adolescent MVPA engagement and lower adolescent weight status). Structural equation modeling (SEM) was used to examine the pathways and associations between these factors. Adolescent MVPA engagement did not mediate the pathway between parent factors and adolescent weight status (parent PA support- Estimate=-0.002, p=0.687; parent PA modeling - Estimate=0.001, p=0.775), although this was hypothesized. Also, adolescent MVPA engagement was not statistically associated with adolescent weight status. The pathways from parent PA support to adolescent MVPA engagement and weight status were not positively influenced by the inclusion of the adolescent psychosocial constructs. Parent PA support was directly associated with adolescent weight status in an unexpected direction (Est.=0.117; p=0.007). As

hypothesized, there was an inverse association between parent PA modeling and adolescent weight status (Est.=-0.036; $p = 0.001$) as mediated by adolescent PA self-efficacy and a positive association between parent PA modeling and adolescent MVPA engagement (Est.=0.040; $p < 0.001$) as mediated by adolescent PA self-efficacy. Additionally, adolescent PA self-efficacy was positively associated with adolescent MVPA engagement (Est.=0.035; $p < 0.001$) and negatively associated with adolescent weight status (Est.=-0.105; $p < 0.001$) while adolescent perception of parent PA support was not statistically associated with either dependent variable. Overall, findings suggest adolescent PA self-efficacy appropriately influences the relationship between parent PA modeling and adolescent PA-related behaviors and health outcomes (weight status). By targeting both parent factors and adolescent psychosocial constructs related to PA in behavioral interventions, future researchers could have a greater impact on increasing adolescent MVPA engagement and lowering adolescent weight status.

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CHAPTER 1: INTRODUCTION

The prevalence of childhood obesity continues to be an issue in the United States (Skinner, Perrin, & Skelton, 2016) with the prevalence of obesity in youth aged 2-19 years old steadily rising (17.2% in 2011-2014 vs. 13.9% in 1999-2000) (Ogden, Carroll, Fryar, & Flegal, 2015). With the potential for childhood obesity to lead to obesity in adulthood and the development of chronic diseases, it is important to understand the factors that contribute to childhood obesity (Deckelbaum & Williams, 2001). The issue of childhood obesity is multifactorial with genetic, behavioral, and environmental factors contributing to the problem (Andrews, Silk, & Eneli, 2010; Centers for Disease Control and Prevention; Karnik & Kanekar, 2012).

Largely, childhood obesity is attributed to the combination of calorie dense and low nutrient diet and low physical activity (PA) (Andrews et al., 2010; Centers for Disease Control and Prevention; Karnik & Kanekar, 2012). However, the focus for this dissertation is on PA. Previous research indicates there is an inverse relationship between weight status and PA in youth suggesting that more PA indicates a lower weight status (Belcher et al., 2010; Reichert, Menezes, Wells, Dumith, & Hallal, 2009). The relationship between PA and weight is influenced by factors at the individual, interpersonal, and community levels. However, given that parents and caregivers are typically youth's first exposure to PA-related behaviors (Taylor, Baranowski, & Sallis, 1994; Trost et al., 2003), they are representative of an important aspect worth considering in the approach for increasing PA and ultimately lowering weight.

With parents being the first form of social influence, they have the potential to impact their children's attitudes and behaviors related to engagement in physical activity (PA) (Taylor et al., 1994; Trost et al., 2003). This influence can come in various forms including parent PA support and parent PA modeling. Parent PA support has been defined as the encouragement, involvement, and facilitation of child's PA in both tangible and intangible ways (Gustafson & Rhodes, 2006; Peterson, Lawman, Fairchild, Wilson, & Van Horn, 2013; Yao & Rhodes, 2015; Zecevic, Tremblay, Lovsin, & Michel, 2010). Previous studies have shown that parent PA support can increase children's engagement in PA (Mitchell et al., 2012; Van der Horst, Paw, Twisk, & Van Mechelen, 2007; Xu, Wen, & Rissel, 2015; Yao & Rhodes, 2015). Parental PA modeling also has been shown to be associated with children's engagement in PA (Craig, Cameron, & Tudor-Locke, 2013). Parent PA modeling is defined as one's interest in engaging in PA and efforts to be actively involved in PA with or without a child present (Loprinzi, Schary, Beets, Leary, & Cardinal, 2013; Zecevic et al., 2010).

While parent PA support and modeling have been examined in various studies (Gustafson & Rhodes, 2006; Sallis, Prochaska, & Taylor, 2000; Trost et al., 2003; Yao & Rhodes, 2015), there have been inconsistencies with regards to their associations with youth PA and the effect size of these associations (Trost et al., 2003; Van der Horst et al., 2007; Yao & Rhodes, 2015). In particular, parent PA modeling has been less consistently associated with increased youth PA than parent PA support (Yao & Rhodes, 2015). Additionally, there is a gap in the literature as it pertains to the influence of parent PA support and parent PA modeling on other outcomes such as their child's weight status (Beets, Cardinal, & Alderman, 2010; McLean, Griffin, Toney, & Hardeman, 2003).

The aims of this study were to examine associations between parent PA support and PA modeling with adolescent MVPA engagement and weight status (Hypothesis 1a: Adolescent MVPA engagement will mediate the pathway between parent PA support and weight status;

hypothesis 1b: Adolescent MVPA engagement will mediate the pathway between parent PA modeling and adolescent weight status) as well as examine how adolescent-level psychosocial constructs (i.e., PA self-efficacy, perception of parent PA support) influence the association between parent factors and adolescent MVPA engagement and weight status (Hypothesis 2a: The association between parent PA support and adolescent MVPA engagement and adolescent's weight status will be positively influenced by adolescent self-efficacy and adolescent's perception of parent PA support; Hypothesis 2b: The association between parent PA modeling and adolescent MVPA engagement and adolescent's weight status will be positively influenced by adolescent PA self-efficacy and adolescent's perception of parent PA support). These study aims were examined using data from the Family Life, Activity, Sun, Health, and Eating (FLASHE) study. The study was conducted by the National Cancer Institute (NCI) and includes over 1,500 parent-child dyads with demographic, diet, and physical activity behavior data from both parents and adolescents.

By conducting path analyses using structural equation modeling, this study provides further insight into the complex relationship between parent PA support and PA modeling and adolescent MVPA engagement and weight status. Adolescent MVPA engagement did not mediate the relationship between either parent factor and adolescent weight status (Study Aim 1). Adolescent psychosocial constructs did not have any statistically significant association between parent PA support and the dependent variables (Study Aim 2). Adolescent PA self-efficacy was a statistically significant mediator between parent PA modeling and higher adolescent MVPA engagement and lower adolescent weight status (Study Aim 2).

Inclusion of adolescent psychosocial constructs, specifically adolescent PA self-efficacy in the final model, may better explain the nuances that exist between parent factors, specifically parent PA modeling, and adolescents in regard to PA-related behavior and weight status. Findings from this dissertation inform the design of future behavior interventions with parents and adolescents by suggesting PA modeling and adolescent PA self-efficacy should be targeted to increase adolescent MVPA engagement and lower weight status.

CHAPTER 2: LITERATURE REVIEW

Background on Childhood Obesity

The prevalence of childhood obesity remains high in the United States (U.S.) (Skinner et al., 2016) despite efforts to reduce it over time. The prevalence of obesity among youth aged 2-19 years old in the U.S. was 18.5% in 2015-2016 (Hales, Carroll, Fryar, & Ogden, 2017) compared to 13.9% in 1999-2000 (Ogden et al., 2015). According to the Centers for Disease Control and Prevention (CDC), obesity currently affects about 13.7 million U.S. youth in this age range (Centers for Disease Control and Prevention, 2017). The percentage of obese youth ranges from 13.9% to 20.6% across different age groups with adolescents (12-19-year-old) having the highest prevalence (Centers for Disease Control and Prevention, 2017).

Complications of Childhood Obesity

Childhood obesity is a problem in the U.S not just because of the number of youth it affects (Skinner et al., 2016), but also because of its long-term effects on the health of youth. Childhood obesity leads to youth experiencing medical conditions previously exclusive to adults (Salvy, de la Haye, Bowker, & Hermans, 2012; Sinha et al., 2002), such as Type II diabetes (diabetes) and cardiovascular disease (I'allemand et al., 2008). Additionally, childhood obesity is associated with obesity in adulthood as well as chronic diseases such as hypertension, diabetes, and cancer (Deckelbaum & Williams, 2001). With childhood obesity leading to morbidity and mortality issues in childhood and adulthood, it is important to begin addressing obesity in youth.

Biological Cause of Childhood Obesity

At its root, obesity is due to an imbalance between high caloric intake and low energy expenditure, causing an increase in weight and most often calculated as body mass index (BMI;

kg/m^2) (Andrews et al., 2010; Centers for Disease Control and Prevention; Karnik & Kanekar, 2012). Among youth, weight and height are used to calculate BMI, and using an age- and sex-specific percentile, youth's BMI z-score can be compared to others in the same age and sex group (Centers for Disease Control and Prevention, 2017). The BMI percentiles are used to categorize youth as underweight (≤5th percentile), normal weight (5th to <85th percentile), overweight (85th to <95th percentile), and obese (≥95th percentile) (Centers for Disease Control and Prevention, 2017).

While biologically a higher BMI is attributed to an imbalance between diet and physical activity (PA), there is still debate about the relative role of each behavior in the development of obesity within youth (Bleich, Ku, & Wang, 2011). Despite the intuitive notion that obesity is fueled primarily by excesses in caloric intake (U.S. Department of Health and Human Services, 2001; Herman et al., 2015), some literature indicates obesity is increasing among youth due to energy expenditure (i.e., PA) going down while caloric intake has remained constant over the past two decades (Bleich et al., 2011; Wang, Gortmaker, Sobol, & Kuntz, 2006; Weinsier, Hunter, Heini, Goran, & Sell, 1998). A systematic review of seven longitudinal studies examining weight gain in youth, was unable to confirm whether increases in energy intake or reductions in PA contributes more to weight gain (Bleich et al., 2011). Therefore, it is important to continue evaluating the relative contributions of diet and PA to weight status as well as the factors influencing diet and PA behaviors.

Diet

With childhood obesity being caused by an imbalance in caloric intake and energy expenditure, diet and PA play a major role (Karnik & Kanekar, 2012). According to national dietary guidelines, it is recommended that youth consume 1,000-2,200 calories daily and eat 5-7 servings of fruits and vegetables, depending on age and sex (American Heart Association, 2018; U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015). When discussing youth's diet, it is important to consider both the amount of calories being consumed as well as the type of calories being consumed (Iannotti & Wang, 2013).

Obese youth are likely to have a diet that contains energy dense and low nutrient foods such as junk food, sugar-sweetened beverages, and fast food (Iannotti & Wang, 2013). Factors such as low socioeconomic status, being of minority race, and living in a inadequate physical environment (e.g., limited availability and accessibility of healthy foods) are associated with energy dense and low nutrient diet (Blanchett & Brug, 2005; Cassady, Jetter, & Culp, 2007; Fahlman, McCaughtry, Martin, & Shen, 2010; Van der Horst et al., 2006). The consumption of a diet high in calories but low in nutrients has been directly associated with less ideal health outcomes including high adiposity, large waist circumference, high cholesterol, hypertension, and diabetes (Iannotti & Wang, 2013; Taveras et al., 2005). On the other hand, fruit and vegetable consumption is frequently used as a measure of youth's healthier eating behaviors and habits (Kim et al., 2014; Pearson, Timperio, Salmon, Crawford, & Biddle, 2009), and meeting recommendations for fruit and vegetable consumption is associated with a reduction in obesity (Albani, Butler, Traill, & Kennedy, 2017). In addition, this research indicates youth consuming less fruits and vegetables are more likely to be obese and have higher rates of chronic disease (Hung et al., 2004; Kunin-Batson et al., 2015; Pearson, Biddle, & Gorely, 2009; van't Veer, Jansen, Klerk, & Kok, 2000). Previous research also has shown youth with less ideal dietary behaviors often also exhibit less physical activity engagement (Leech, McNaughton, & Timperio, 2014).

Physical Activity

Previous research indicates there is an inverse relationship between weight status and physical activity in youth (Belcher et al., 2010; Reichert et al., 2009). Due to this relationship, national recommendations have been created for the amount and intensity of PA needed to reduce the risk of adverse health outcomes and maintain a normal weight status (Physical Activity Guidelines Advisory Committee, 2008). In 2005, 60 minutes of moderate or vigorous activity per day was designated as the PA recommendation for youth (Strong et al., 2005). Moderate-to-vigorous physical activity (MVPA) is defined as activities that make one sweat or breathe hard, such as running, swimming, or bicycling (National Physical Activity Plan Alliance, 2016). Additionally, the recommendation designated youth should participate in activities that were varied, developmentally appropriate, and enjoyable (National Physical Activity Plan Alliance, 2016; Physical Activity Guidelines Advisory Committee, 2008).

In 2008, the most recent Physical Activity Guidelines Advisory Committee agreed with the 2005 recommendation and added that youth aged 6-17 years old should incorporate muscle and bone strengthening activities at least 3 days per week (Physical Activity Guidelines Advisory Committee, 2008). Muscle strengthening exercises cause one's muscles to work harder than in normal everyday activities, and bone strengthening exercises enhance bone growth and strength through activities such as in jumping rope (National Physical Activity Plan Alliance, 2016). Despite the development of guidelines, engagement in PA among youth is still low (Physical Activity Guidelines Advisory Committee, 2008).

It has been proposed that historical declines in active transport, organized sports, school physical education, and school play may be responsible for the current low rates in overall PA among youth (Booth, Rowlands, & Dollman, 2015). Additionally, declines in MVPA occur over the lifespan of youth with significant changes occurring during the transition from childhood to adolescence (Whitt-Glover et al., 2009). Understanding the historical and lifespan changes in PA engagement could help researchers determine ways youth can incorporate PA in their typical day to achieve recommended PA amounts. While diet and PA work together to affect childhood obesity, the focus of this dissertation is the role of PA in childhood obesity.

Factors that Influence Childhood Obesity and PA Behaviors

Childhood obesity cannot be attributed to only one factor or even a cluster of similar factors; therefore, a socioecological approach is needed to understand how individual, social, and physical environment factors influence the health behaviors that contribute to youth's weight status (Karnik & Kanekar, 2012).

Individual level favors

Age

There is a general increase in weight status as youth age with a higher percentage of older youth (adolescents) being obese (8.9% in 2-5- year-old vs. 17.5% in 6-11-year-old vs. 20.5% in 12-19-year-old) (Ogden et al., 2015). Age is not only associated with differences in weight status but is also associated with differences in PA engagement.

Research has shown older youth are less active than younger youth, regardless of other factors (Whitt-Glover et al., 2009). One reason for this association is that as youth get older they are more autonomous and able to make their own decisions regarding behaviors such as engaging in PA (Van Sluijs, McMinn, & Griffin, 2007; Vasques et al., 2014). In addition to total time reducing, the intensity of PA declines as youth progress from childhood to adolescence (Craggs, Corder, Van Sluijs, & Griffin, 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). In a 4-year study of youth who were tracked from 9-10 years old to 13-14 years old, both youth's moderate PA and vigorous PA declined with age (Corder et al., 2015) such that about 40 minutes of daily PA was replaced with sedentary time due to more media use such as playing video games, watching television, and personal computing (Corder et al., 2015). These findings are in line with previous research suggesting the decline in PA levels likely occurs at the start of puberty (Belcher et al., 2010; Brodersen, Steptoe, Boniface, & Wardle, 2006). One study found that for adolescents aged 12-17 years old PA, as measured by pedometers, decreased about 3% over 5 years (Duncan, Duncan, Strycker, & Chaumeton, 2007) while another study found that for youth aged 8-16 years old the decline in PA, as measured by self-report, was closer to 8% over 7 years (McMurray, Harrell, Bangdiwala, & Hu, 2003; Pate et al., 2009). Results from a multi-site cohort study confirmed the decline in MVPA as youth get older showing that between the ages of 9 to 15, youth decrease from about three hours of MVPA to 49 minutes of MVPA (Nader et al., 2008).

This dissertation focuses on adolescents (age 12-17 years old), which are an important population to study given their autonomy but infrequent and lower engagement in PA. Ideally PA promotion research would focus on youth as early as possible (Caspersen, Pereira, & Curran, 2000); however, there is evidence that behaviors initiated or corrected during adolescence can set the pattern for behaviors into adulthood (Hallal, Victora, Azevedo, & Wells, 2006). Discovering how to keep adolescents engaged in PA, at the recommended amount and level, could lead to increases in PA and reductions in obesity rates.

Gender

Based on results from the National Health and Nutrition Examination Survey 2015-2016 (NHANES), boys have higher obesity rates than girls until they reach adolescence (12-19 years old) (Hales et al., 2017). Research indicates this difference is due to changes in a child’s body once they begin puberty. Boys gain greater amounts of fat free mass and skeletal mass with their weight generally staying the same while girls gain significantly more fat mass (Lee et al., 2007; Loomba-Albrecht & Styne, 2009). Differences by gender also influence PA behaviors among youth (Ogden et al., 2015; Plotnikoff, Costigan, Karunamuni, & Lubans, 2013).

Previous studies indicate girls typically engage in lower intensity PA and spend significantly more time in sedentary behavior (Belcher et al., 2010) than boys overall (Gorely, Marshall, Biddle, & Cameron, 2007; Pate et al., 2009; Plotnikoff et al., 2013). Girls also show greater declines over time in PA compared to boys (Craggs et al., 2011; Neumark-Sztainer, Story, Hannan, & Rex, 2003; Plotnikoff et al., 2013). With lower intensity PA and more time being sedentary, girls were less likely to meet PA guidelines compared to boys (Belcher et al., 2010).

Race

Overall, there are differences in youth PA engagement and weight status by race (Belcher et al., 2010; Fradkin et al., 2015; Hales et al., 2017). In 2015-2016, Hispanic youth had the highest prevalence of obesity (25.8%) followed by Black youth (22.0%) (Hales et al., 2017). White and Asian youth had lower prevalence of obesity with 14.1% and 11.0%, respectively (Hales et al., 2017).

In reviewing self-reports of PA, Black youth report lower amounts of time spent in MVPA compared to White youth (Belcher et al., 2010; Sirard, Pfeiffer, Dowda, & Pate, 2008). However, in reviewing studies using accelerometer data, White youth engage in less MVPA than minority youth (Belcher et al., 2010; Whitt-Glover et al., 2009). Belcher et al. (2010) suggests differences in MVPA by race may be due to differences in types of PA by racial group (Belcher et al., 2010). For example, White youth may engage in activities that accelerometers are unable to read such as swimming or bicycling (Belcher et al., 2010), while minority and lower socioeconomic status (SES) youth may engage in activities that are easily read by the accelerometer such as running or basketball (Belcher et al., 2010). While there are inconsistencies in reports of MVPA, minority youth consistently have higher rates of obesity compared to their White counterparts (Hales et al., 2017).

For example, studies of minority youth indicate youth with normal weight status engage in the same amount or less MVPA than minority youth with an obese weight status (Belcher et al., 2010; Byrd-Williams, Kelly, Davis, Spruijt-Metz, & Goran, 2007; Whitt-Glover et al., 2009), suggesting environmental stressors beyond PA are responsible for racial and ethnic differences in weight status. Studies have shown minority youth eat less healthy foods (e.g., fruits and vegetables) and more energy dense foods (e.g., sweets and junk food) than their White counterparts (Harding, Maynard, Cruickshank, & Teyhan, 2008; Piernas & Popkin, 2011; Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2013), suggesting diet is a significant factor in weight differences seen across racial and ethnic groups.

Socioeconomic Status

Socioeconomic status (SES) intersects with race such that White families are more likely to be above the poverty level compared to Black or other minority families (Belcher et al., 2010; Janz, Burns, & Levy, 2005; Ogden et al., 2010). Youth in low income households are more likely to be obese compared to youth in households with higher incomes (Ogden, Lamb, Carroll, & Flegal, 2010). Previous research has determined almost 50% of youth living in households below the poverty line are overweight/obese (Levi, Segal, St Laurent, Lang, & Rayburn, 2012). In a similar way, education of the head of the household, often a proxy for socioeconomic status, is associated with child weight status (Galvez et al., 2013). SES contributes to youth's weight status in a multifaceted way as it determines what types of food a family can afford, their proximity of fresh produce, and accessibility of PA facilities (Bukman et al., 2014). Parents of low-income families may also battle against hectic work schedules, limited discretionary time or money, and lack of car ownership making it hard for parents and caregivers to engage youth in sports or recreational activities (Kumanyika & Grier, 2006).

Physical Environment Factors

Youth's physical environment can affect their weight status and contribute to childhood obesity (Nelson, Gordon-Larsen, Song, & Popkin, 2006). The physical environment refers to various settings such as school, neighborhoods, and home (Karnik & Kanekar, 2012). School is considered a prominent physical environment and contributor to childhood obesity as youth spend at least 8 hours of their day at school (Morton, Atkin, Corder, Suhrcke, & Van Sluijs, 2016). The amount of time spent at school provides opportunity to promote healthy behaviors as exhibited by the large number of school interventions targeting youth (Amini, Djazayery, Majdzadeh, Taghdisi, & Jazayeri, 2015; Morton et al., 2016).

The neighborhood in which a child lives can affect their weight status and PA engagement based on the accessibility and affordability of farmer's markets and health conscious eateries as well as PA resources/facilities such as sidewalks, bike paths, and safe parks (Karnik & Kanekar, 2012; Whitt-Glover et al., 2009). In addition, use of these resources is dependent on the amount of crime, street connectivity, and traffic in the neighborhood (Gordon-Larsen, McMurray, & Popkin, 2000; Nelson et al., 2006). The home environment also can influence youth's health behaviors based on interactions with family members within the home as well as the availability of healthy foods (Rosenkranz & Dzewaltowski, 2008) and PA equipment (Crossman, Sullivan, & Benin, 2006) influencing food choices, participation in PA, and engagement in an overall healthy lifestyle (Karnik & Kanekar, 2012).

Social Level Factors

Social level factors include the people youth and adolescents interact with on an interpersonal level (Glanz, Rimer, & Viswanath, 2008). For most youth and adolescents, these interactions are with friends, siblings, and parents. Research has shown social norms, enacted by youth's social networks (e.g., friends and parents), may influence obesogenic behaviors such as dietary intake and time spent in PA (Baker, Little, & Brownell, 2003; Maximova et al., 2008; Salvy et al., 2012).

Friends

Previous research has suggested parents provide the strongest influence on youth's health behaviors; however, there is growing evidence that friends strongly impact those same behaviors (Fitzgerald, Fitzgerald, & Aherne, 2012; Hesketh, Lakshman, & van Sluijs, 2017; Lau, Quadrel, & Hartman, 1990; Salvy et al., 2012). Friends can influence weight status and PA behaviors through social norms established at school and extracurricular activities (Fitzgerald et al., 2012; Salvy et al., 2012; Salvy et al., 2009). One study found the number of friends affects PA engagement such that youth with more friends engaged in more PA (Salvy et al., 2012; Salvy et al., 2009). Additionally, a systematic review of social networks of youth found similar PA behaviors within friend groups such that friends' PA was a positive predictor of an individual's PA (de la Haye, Robbins, Mohr, & Wilson, 2010, 2011; Macdonald-Wallis, Jago, & Sterne, 2012). This previous research suggests the need to consider friends, in addition to parents, as social influencers of PA behaviors among youth.

Parents

Parents have the potential to impact their youth's behaviors related to childhood obesity as parents are typically youth's first exposure, or gatekeeper, to direct and indirect health behaviors (Taylor et al., 1994; Trost et al., 2003; Welk, Wood, & Morss, 2003). A parent's role within their youth's life is important, as youth are dependent upon parents to provide and structure a home environment that is conducive to a healthy lifestyle (Faith et al., 2012). Results from a study of PA in parent-child dyads revealed that, on average, youth increased their number of steps by almost 423 on days a parent met their step goal (Holm, Wyatt, Murphy, & Hill, 2012). Another study found parent PA engagement was inversely associated with their youth's weight status with children of active parents less likely to be overweight or obese (Erkelenz, Kobel, Kettner, Drenowatz, & Steinacker, 2014). This parental influence can occur through multiple mechanisms including but not limited to eliminating barriers to healthy behaviors, directly modeling behaviors, and supporting youth's participation in behaviors that reduce obesity and increase PA (Taylor et al., 1994; Trost & Loprinzi, 2011).

Parents' Role in Childhood Obesity Interventions

As previously stated, parents are a part of the social environment that can contribute to childhood obesity-related behaviors. Although we know parents have an influence on their youth's PA behaviors, public health practitioners must determine the most feasible and acceptable ways to help parents and youth adopt healthy behaviors.

The literature on increasing PA engagement and reducing childhood obesity includes a mix of interventions aimed towards parents only, youth only, or both (family-based) (Baranowski et al., 2003; Morton et al., 2016; Vasques et al., 2014). While having separate child-based and parent-based interventions has been effective in changing behaviors, combined interventions with parents and youth, or family-based interventions, have also been successful

(O'Connor, Jago, & Baranowski, 2009; Sallis, Prochaska, & Taylor, 2000; Timperio, Salmon, & Ball, 2004). Frameworks like the Family-centered Action Model of Intervention Layout and Implementation (FAMILI) have been developed to reinforce the notion that childhood obesity programs should be family-centered, culturally sensitive, and address contextual factors within the family that delve deeper than just including family in an intervention (Davison, Lawson, & Coatsworth, 2012). Additionally, a review of studies focused on correlates of parent PA and youth PA found it is important to have family-based coactivity interventions to impact PA behaviors, especially in the early years of child development (Yao & Rhodes, 2015).

The premise of the family-based intervention reiterates the importance of parents' roles in affecting change in youth PA engagement and weight status through efforts to change behaviors for all parties. Previous family-based interventions have examined how parent PA engagement directly affects youth PA engagement or weight status with little consideration for how other factors may influence these association. However, psychosocial factors such as PA support and PA modeling have been shown to be associated with youth's PA engagement and weigh status (Craig, Cameron, & Tudor-Locke, 2013; Trost et al., 2003; Van der Horst et al., 2007; Yao & Rhodes, 2015).

Parent Physical Activity Support

General social support from parents has been noted as an important interpersonal factor related to a variety of positive health behaviors (Beets et al., 2010). Previous research on the relationship between general parent social support and youth suggests parents who provide support have children with fewer psychological and physical health problems (Paradis et al., 2011; Shaw, Krause, Chatters, Connell, & Ingersoll-Dayton, 2004; Wickrama, Lorenz, & Conger, 1997). Given the benefits of general social support by parents, specific measures of parent support have been created to examine relationships between social support for specific health behaviors and health outcomes among youth (Biggs et al., 2019; Hanna, DiMeglio, & Fortenberry, 2005; Prochaska, Rodgers, & Sallis, 2002; Sallis, Grossman, Pinski, Patterson, & Nader, 1987; Wills, Resko, Ainette, & Mendoza, 2004).

Parent PA support is social support specific to parent's support of their youth's PA. Parent PA support has been described as actions that assist youth in adopting or maintaining active PA behaviors (Mendonça, Cheng, Mélo, & de Farias Júnior, 2014). While the operationalization of parent PA support has varied in the literature, this study operationalizes it as encouragement, involvement, and facilitation of youth's PA in both tangible and intangible ways (Gustafson & Rhodes, 2006; Peterson et al., 2013; Yao & Rhodes, 2015; Zecevic et al., 2010). Parent PA support has been positively associated with youth PA engagement in several studies (Bauman et al., 2012; Mendonça et al., 2014; Van der Horst et al., 2007). Overall parent PA support has positive effects on youth PA engagement although there are variation in how much of an effect depending on the measurement of parent PA support used (Mendonça et al., 2014). Regardless of the differences in the effect, studies consistently observe that more parent PA support yields higher youth PA engagement (Mendonça et al., 2014).

Parent Physical Activity Modeling

Similar to general parent support, general parent modeling, has been noted as a factor contributing to positive health behaviors among youth, especially substance use, diet intake, and physical activity related behaviors (Gibson et al., 2012; Pyper, Harrington, & Manson, 2016; Shakya, Christakis, & Fowler, 2012). With these behaviors, parent's modeling of a behavior is consistently associated with a higher prevalence of the behavior in their youth whether the behavior is positive or negative. Parents modeling substance use increases the likelihood their youth will engage in similar substance usage (Engels & Bot, 2006; Shakya et al., 2012). Similarly, parent modeling of particular food choice influences the t food choices and caloric intake for youth (Pyper et al., 2016).

With PA, parent PA modeling is associated with youth PA engagement (Craig et al., 2013). In the past, PA modeling was defined as a form of parental PA support because of the intention to motivate a child with one's own behavior (Raudsepp, 2006). However, over the years, the definition of parent PA modeling has evolved. For the purpose of this study, parent PA modeling has been operationalized as the parent's interest in engaging in PA and efforts to be actively involved in PA with or without the youth present (Loprinzi et al., 2013; Zecevic et al., 2010). While parent PA modeling has previously been examined, it has been less consistently associated with youth PA engagement compared to parent PA support (Yao & Rhodes, 2015). In addition, parent PA modeling has not been examined with other outcomes such as youth weight status. Much like parent PA support, more closely examining parent PA modeling will enhance our knowledge and fill gaps in the literature related to factors influencing youth's PA engagement and weight status.

Gaps in the Literature

Parent PA Support and PA Modeling

While evidence of the relationship between parental factors such as PA support and modeling with youth PA behaviors exist, there are inconsistencies in the literature (Trost et al., 2003; Van der Horst et al., 2007; Yao & Rhodes, 2015). In addition, the effects of parent PA support has been examined more frequently than parent PA modeling (Yao & Rhodes, 2015). This study will assist in determining how parent PA support and parent PA modeling are associated with each other and with the dependent variables youth PA and weight status. By doing so, future researchers will better understand how these parental factors work together to influence youth PA engagement and weight status.

Adolescent Weight Status as an Outcome

Most studies to-date examining parental influences have used youth PA engagement as the dependent variable of interest. Parental PA support and PA modeling have rarely been examined with other outcomes such as youth weight status (Beets et al., 2010; McLean et al., 2003). This dissertation research will examine pathways from parental factors through youth PA engagement to adolescent weight status. By filling this gap in the literature, future researchers can move the field beyond behaviors and recognize other potential youth outcomes that could be associated with parent PA support and PA modeling.

Psychosocial Constructs Affecting the Relationship Between Parent Factors and Adolescents Behaviors

Social Cognitive Theory (SCT) suggests constructs such as modeling (observational learning) and self-efficacy are influential in changing health behaviors for youth and adults (Bandura, 1977, 1986; Plotnikoff et al., 2013). However, in previous research, the relationship between parent PA support and youth PA engagement has typically been measured as a direct association, with few studies considering how other psychosocial constructs may affect the relationship (Gustafson & Rhodes, 2006; Yao & Rhodes, 2015). This study will examine whether psychosocial constructs such as youth PA self-efficacy and youth perception of their parents' PA support affect the direction or strength of the association between parent PA support and youth PA engagement and weight status.

With limited research on parent PA modeling and inconsistent findings related to its effect (Yao & Rhodes, 2015), the same psychosocial constructs used in examinations of parent PA support will be examined to determine their effect on parent PA modeling and youth PA engagement and weight status. Incorporating these psychosocial constructs may assist in determining the pathways through which parent PA support and parent PA modeling are influential, ultimately shaping what constructs to address in future interventions.

Purpose of Dissertation and Study Aims and Hypotheses

Given the review of the literature above, the purpose of this dissertation is to examine associations between parent PA support and parent PA modeling with adolescents' engagement in MVPA (minutes/weekday) and weight status (BMI z-score). The purpose of this dissertation will be achieved through the following aims and hypotheses:

Study Aim 1: Examine associations between parent factors (i.e., parent PA support, parent PA modeling) and adolescent MVPA engagement and weight status.

Hypothesis 1a: Adolescent MVPA engagement will mediate the pathway between parent PA support and adolescent weight status.

Hypothesis 1b: Adolescent MVPA engagement will mediate the pathway between parent PA modeling and adolescent weight status.

Study Aim 2: Examine adolescent-level psychosocial constructs (i.e., PA self-efficacy, perception of parent PA support) in the association between parent factors and adolescent MVPA engagement and weight status.

Hypothesis 2a: The association between parent PA support and adolescent MVPA engagement and adolescent's weight status will be positively influenced by adolescent self-efficacy and adolescent's perception of parent PA support.

Hypothesis 2b: The association between parent PA modeling and adolescent MVPA engagement and adolescent's weight status will be positively influenced by adolescent self-efficacy and adolescent's perception of parent PA support.

CHAPTER 3: METHODS

Theoretical Approach to Study Design

The conceptual model (see Figure 1) and proposed pathways build upon previously tested models that used structural equation modeling (SEM) to determine the direct and indirect associations of parental factors on adolescent MVPA engagement and weight status (Beets, Pitetti, & Forlaw, 2007; Beets, Vogel, Forlaw, Pitetti, & Cardinal, 2006; Heitzler et al., 2010; Trost et al., 2003; Wu, Pender, & Noureddine, 2003). The pathways within the model were proposed based on theory and a review of the literature.

Parent PA Support → Adolescent MVPA Engagement

Parent PA support has demonstrated positive effects on adolescent's PA-related behaviors, including PA engagement and PA intensity (M.W. Beets et al., 2010). In a review of 71 studies that examined the relationship between parent PA support and youth PA engagement, 69% of the studies reported positive statistically significant results (Trost & Loprinzi, 2011). Almost 7 out of 10 times parent PA support positively influenced PA engagement (Trost & Loprinzi, 2011). Being a specific type of social support, parent PA support is rooted in the reciprocal exchange of environmental factors (parents) and behavior (adolescent PA engagement) as described within SCT.

Parent PA Support → Adolescent Weight Status

Given PA engagement has been shown to influence weight status in various populations (Fogelholm & Kukkonen-Harjula, 2000; Lee, Djoussé, Sesso, Wang, & Buring, 2010), a pathway from parent PA support to adolescent weight status is included. In a study assessing social support among both normal weight and overweight youth, there was no statistically significant difference in PA support between the groups, but normal weight adolescents reported receiving more support from all family members compared to the overweight group (De Bourdeaudhuij et al., 2005). Among overweight and obese youth, the involvement aspect of parent PA support appears to have the strongest influence on weight status compared to normal weight youth (Beets et al., 2010). Despite inconsistencies in findings about how parent PA support is associated with adolescent weight status (Beets et al., 2010) studies to-date indicate parent PA support is influential.

Parent PA Modeling → Adolescent MVPA Engagement

Within this dissertation, parent PA modeling is equivalent to the construct of observational learning found within SCT and Social Learning Theory (Bandura, 1986; Kirby, Levin, & Inchley, 2011). Parent PA modeling both teaches and modifies youth engagement in PA through the observation of a parent enacting PA behaviors (Bandura, 1986; Kirby et al., 2011). While the effects of parent PA modeling on adolescent PA engagement have been studied less often than the effects of parent PA support, parental PA modeling has been positively associated with youth PA engagement (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008; Smith et al., 2010; Trost & Loprinzi, 2011; Xu et al., 2015; Zecevic et al., 2010). Specifically, a review of 36 studies found that parent PA modeling and youth PA engagement associations were approaching a medium effect size of r=.29, using fixed effects models (Yao & Rhodes, 2015). This result suggests a relationship, but also that more research is needed to confirm the association.

Parent PA Modeling → Adolescent Weight Status

There is limited literature on the effects of parent PA modeling on adolescent weight status. However, as previously established, adolescent weight status is associated with adolescent PA behaviors (Sallis et al., 2000). Considering this latter association and the theoretical impact of parent PA modeling (Bandura, 1986), it is assumed that parent PA modeling is inversely associated with adolescent weight status with more parent PA modeling being associated with lower adolescent weight status. Testing this pathway adds to the literature and our understanding of the association between parent PA modeling and adolescent weight status.

Adolescent PA Self-Efficacy → Adolescent MVPA Engagement/Weight Status

Self-efficacy, defined as the confidence in one's ability to perform an action and conquer any barriers that may arise, has been considered the most powerful predictor of behavior within SCT (Bandura, 1986; Motl, 2007). In general PA literature, self-efficacy has been shown to be strongly and consistently associated with increased PA (McAuley & Blissmer, 2000; Rhodes & Nigg, 2011; Young, Plotnikoff, Collins, Callister, & Morgan, 2014). When psychosocial constructs are included in such examinations, the effect of parent PA support on adolescent PA engagement has been found to be mediated through psychosocial constructs, such as PA self-efficacy (Beets et al., 2010; Ornelas, Perreira, & Ayala, 2007; Trost et al., 2003). In addition, previous research provides evidence that youth PA self-efficacy positively affects PA engagement (Luepker, 1999; Rutkowski & Connelly, 2012). Not only does adolescent PA self-efficacy determine one's current PA, but it is a strong predictor of future PA (Rutkowski & Connelly, 2012; Schwarzer & Luszczynska, 2006), further suggesting the need for it to be examined within the context of this model.

Adolescent Perception of Parent PA Support → Adolescent MVPA engagement

Given the interplay between an individual's personal, social, and environmental dynamics as described in SCT, adolescent MVPA can be influenced not only by parent PA support but also the adolescent's perception of their parents' PA support (Bandura, 1986; Lee et al., 2010). An adolescent may perceive parent PA support through tangible and intangible ways with a previous study finding that increased perception of parent PA support by the youth was positively correlated with increased youth PA engagement and co-physical activity between the parent and youth (Lee et al., 2010).

Data Source and Sampling

This study was based on a secondary data analysis of the Family Life, Activity, Sun, Health, and Eating (FLASHE) study, which was sponsored by the National Cancer Institute (NCI) (National Cancer Institute, 2014). The overall purpose of FLASHE was to assist researchers in understanding the lifestyle behaviors that may relate to cancer risk, specifically among parent-adolescent dyads (National Cancer Institute, 2014). Survey questions focused mostly on diet and physical activity behaviors with additional questions related to sleep, sun safety, and tobacco use (Oh et al., 2017). The study design was a cross-sectional, internet-based study in which each participant completed a diet, physical activity, and demographics survey. A subset of participants were selected to participate in the motion study, which consisted of the participants wearing an accelerometer for seven days to obtain an objective measure of physical activity (Oh et al., 2017). For the purpose of this study, only data from the survey portion of the study was used.

Data Collection

Recruitment

The participants in the FLASHE study were recruited using an online survey portal, Ipsos Consumer Opinion Panel (Ipsos), which included more than 700,000 active members (Oh et al., 2017). Members of Ipsos were originally invited to join the panel through print advertising, internet banner ads, recruitment during Random Digit Dial omnibus surveys, and panelist referrals (National Cancer Institute, 2015). The FLASHE sampling procedure focused on reaching adult members of Ipsos who matched the U.S. on variables such as gender, census division, household income, and race/ethnicity (Oh et al., 2017). Since characteristics of children in the household were not available, only parent factors were used to determine the initial sample of Ipsos members (National Cancer Institute, 2015). Using this sampling procedure, the Ipsos membership was reduced to 19,000 potentially eligible members who were sent the FLASHE screener to determine eligibility (National Cancer Institute, 2015; Oh et al., 2017). Of those 19,000 members, 5,027 individuals met eligibility criteria and were invited to participate in the FLASHE study (National Cancer Institute, 2015).

Study Participants

Eligibility Criteria

To be eligible for FLASHE, parents had to be at least 18 years of age and live in a household with at least one adolescent between the ages of 12 and 17 for at least 50% of the time (Oh et al., 2017). These adults did not have to be a biological parent of the adolescent, but had to be a primary caregiver (Oh et al., 2017). Additionally, parents had to agree to be contacted by the study team and were responsible for providing a full household roster. From the roster, an adolescent was randomly selected. Eligible adolescents were selected until a quota for each age range (i.e., 12–13, 14–15, 16–17 years old) was full. This quota was based on one-third of adolescents being in each age group and each group being evenly split by gender (Oh et al., 2017).

Consent/Enrollment/Survey Distribution

Once all eligible parent-adolescent dyads were determined, an invitation to participate in the study was sent to the parent via email, which included a website where participants could complete consent forms and questionnaires. On the website, parents were asked to complete the consent form for both their participation as well as for their adolescent's participation. If no consent was received for the parent's own participation or for that of their adolescent, the adolescent was not invited to enroll in the study. Once consent was received, an email was sent to the adolescent for them to complete the assent form for his or her participation (Oh et al., 2017). Once the enrollment process for the parent and adolescent was complete, they were able to begin the surveys. Half of the dyads were randomly selected to receive the diet survey first while the other half were selected to receive the PA survey first (Oh et al., 2017). Upon completion of each survey (two surveys per participant), each participant was sent a $5 incentive for a total of $10 each. However, to encourage completion, there were two "bonus" periods in which participants would receive $10 for each survey completed during that time for a maximum total of $20 for each participant (Oh et al., 2017). Data collection began in April and lasted until October 2014. All surveys were conducted through the online portal.

Enrollment Rate/Completion Rate

There were 5,027 dyads who completed consent/assent forms and 38.7% (n=1,945) returned surveys (Oh et al., 2017). Surveys were deemed complete if the participant responded to at least 80% of the questions on the survey (National Cancer Institute, 2015; Oh et al., 2017).

Dyad completion rates for the survey only group were based on dyads completing all four surveys (2 surveys per member of dyad) (Oh et al., 2017). Those enrolled in the survey + motion study were deemed complete if all four surveys were completed and the accelerometer was worn for 18 hours on at least one of the seven days (Oh et al., 2017). The final response rate for the survey only group was 32.1% (n=1,072) and 24.1% for the survey + motion study group (n=407) with an overall response rate of 29.4% (n=1,479). Dyads where both parent and adolescent had complete demographic and physical activity surveys were included in this analysis.

Study Population Recruited

All states, except Alaska, were represented in the study population. While the study attempted to oversample African Americans by recruiting 25% of the total sample, they were only successful in recruiting 16.5%; therefore, the majority of the study population was White (69.4%) (Oh et al., 2017). Parent participants were mostly female (73.6%) between 35 and 59 years old and 46% received a college degree or higher (Oh et al., 2017). Ninety percent of parents were the biological parent of the adolescent. The study team was able to successfully recruit approximately one-third of adolescent participants in each age range (12–13, 14–15, 16–17 years) and they were almost equally split by gender (49.1% female) (Oh et al., 2017).

Measures

The measures below were used to exam the study's aims and determine associations between parent PA support and parent PA modeling with adolescent MVPA engagement and adolescent weight status.

Dependent Variables

The study's dependent variables were adolescent MVPA engagement and adolescent weight status. The Youth Activity Profile (YAP) was used by the FLASHE study to determine adolescent PA in the past 7 days (Saint-Maurice et al., 2017; Saint-Maurice & Welk, 2015). The YAP consists of 15-items divided into three sections of activity: at school, activity outside of school, and sedentary behaviors (i.e., “How many days BEFORE SCHOOL (6:00-8:00 am) did you do some form of physical activity for at least 10 minutes?”, “How much physical activity did you do last SATURDAY?”, “How much time did you spend PLAYING VIDEO GAMES outside of school time?”) (Saint-Maurice & Welk, 2015). The measure was developed to quantify MVPA and sedentary behaviors for youth in the 4^{th} to 12^{th} grades in a way that was not previously done in other youth activity questionnaires such as the Physical Activity Questionnaire and Youth Risk Behavior Surveillance Survey (Saint-Maurice et al., 2017; Saint-Maurice & Welk, 2015). Adolescent MVPA engagement was derived by adding the number of minutes of MVPA in-school and out-of-school and was expressed as minutes of weekday MVPA (continuous variable). The use of minutes of weekday MVPA instead of total minutes of MVPA per day for seven days was in line with the way MVPA was operationalized in previous literature using the FLASHE dataset (D’Angelo, Fowler, Nebeling, & Oh, 2017). This operationalization still allows for findings to be compared to current PA recommendations that children and adolescents engage in 60 minutes of MVPA each day (Physical Activity Guidelines Advisory Committee, 2008).

Adolescent weight status was defined using BMI z-scores. Adolescents’ self-reported their weight and height, which FLASHE researchers used to calculate BMI z-scores and percentiles using age and sex adjusted CDC growth charts (Centers for Disease Control and Prevention, 2013). BMI z-scores were also converted to the categories of underweight ($\leq 5^{th}$ percentile), normal (5^{th} to $<85^{th}$ percentile), overweight (85^{th} to $<95^{th}$ percentile), and obese

(≥95th percentile) for descriptive purposes. Continuous BMI z-scores were used in analyses for this study.

Independent Variables

Based on the literature, parent PA support is defined as the encouragement, involvement, and facilitation of child's PA in both tangible and intangible ways (Gustafson & Rhodes, 2006; Peterson et al., 2013; Yao & Rhodes, 2015; Zecevic et al., 2010). FLASHE researchers used a six-item scale to assess parent practices for being physically active. This scale included items from the Parenting Eating and Activity Scale (PEAS) (one item) (Larios, Ayala, Arredondo, Baquero, & Elder, 2009), Activity Support Scale (two items) (Davison, Li, Baskin, Cox, & Affuso, 2011), Comprehensive Feeding Practices Questionnaire (CFPQ) (one item) (Musher-Eizenman & Holub, 2007), and Legitimacy of Parental Authority (two items) (Darling, Cumsille, & Martínez, 2008) that were all modified to include an aspect of being physically active and slight wording change to include "teenager." Based on the content of these items and their ability to capture each category of parent PA support (i.e., encouragement, involvement, and facilitation), they were defined as parent PA support for the purpose of this dissertation. Encouragement was assessed using the following two statements: "I make my teenager exercise or go out and play" and "I have to make sure my teenager gets enough physical activity" (National Cancer Institute, 2014). Involvement was assessed using the following two statements: "I try to be physically active when my teenager is around" and "My teenager and I decide together how much physical activity he/she has to do" (National Cancer Institute, 2014). Facilitation was assessed using the following two statements: "I take my teenager places where he/she can by physically active" and "It's okay for me to make rules about how much time my teenager spends being physically active/playing" (National Cancer Institute, 2014). The six items used for parent PA support were measured using a 5-point Likert scale assessing how strongly parents agreed or disagreed with the statements. The scores were averaged and used as a continuous variable within the analysis with higher scores indicating higher parent PA support.

Parent PA modeling was defined as one's interest in engaging in PA and efforts to be actively involved in PA with or without a child present (Loprinzi et al., 2013; Zecevic et al., 2010). The FLASHE researchers used the four-item Treatment Self-Regulation Questionnaire (TSRQ) (Levesque et al., 2006) to assess parent's motivation for exercising. These questions along with parent's engagement in MVPA as measured by the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003) were used to define parent PA modeling in this dissertation. The four items used from the TSRQ included a 5-point Likert scale assessing how strongly parents agree with statements about why they would exercise most days of the week (i.e., "I would feel bad about myself if I didn't" and "I have thought about it and decided that I want to exercise"). The IPAQ, used to assess parent's MVPA, has been used and validated against accelerometer data in 12 countries (Craig et al., 2003). Additionally, the IPAQ consistently reproduced data that clustered around a Spearman's correlation of 0.80 (Craig et al., 2003). Parent MVPA was expressed as total minutes of MVPA per day for the past 7 days. These variables were used in a confirmatory factor analysis to create the continuous latent variable parent PA modeling.

Psychosocial Constructs

In addition to the main predictor variables, two psychosocial constructs (i.e., adolescent PA self-efficacy and adolescent perception of parent PA support) were included in the models to assess associations with the independent and dependent variables. Adolescent PA self-efficacy was assessed using a 1-item measure (i.e. "I feel confident in my ability to exercise regularly"

(Deci & Ryan, 1985; Ryan & Deci, 2000; Silva et al., 2010). Adolescent PA self-efficacy used a continuous variable within the analysis with a higher score indicating higher PA self-efficacy.

Adolescent perception of parent PA support was assessed using the same six-items used to assess parent PA support (see description above). The questions were modified by FLASHE researchers to assess the adolescent's perception of their parent's encouragement, involvement, and facilitation of PA (i.e. "My parent(s) and I decide together how much physical activity I have to do" and "My parent(s) take me places where I can be physically active") (National Cancer Institute, 2014). The six items used for adolescent perception of parent PA support was measured using a 5-point Likert scale assessing how strongly adolescents agreed or disagreed with the statements. The scores were averaged and used as a continuous variable within the analysis with higher scores indicating a higher perception of support.

Covariates

Demographic variables from adolescents and parents were included in this study as covariates. Demographic variables for the adolescents included: age (continuous variable), gender (male and female), and race (Hispanic, Non-Hispanic Black or African American, Non-Hispanic White, and Non-Hispanic Other). Demographic variables for the parents included: age (18 – 34 years, 35 – 44 years, 45 – 59 years, ≥60 years), gender (male and female), and race (Hispanic, Non-Hispanic Black or African American, Non-Hispanic White , and Non-Hispanic Other), education (Less than a high school degree, a high school degree or GED, some college but not a college degree, a 4-year college degree or higher), marital status (married, divorced/widowed/separated, never married, and member of an unmarried couple), and income ($0-$99,999 and $100,000 or more). All of the response options for the above demographic characteristics were determined by the FLASHE researchers.

Data Analysis

SEM has been used in other studies examining the relationships between parental influences and adolescent MVPA engagement as a way to simultaneously estimate and test the relationships between multiple predictors, mediating, moderating, and outcome variables (Heitzler et al., 2010; Kline, 2016). Specifically, as it pertained to parental influences and adolescent MVPA engagement and weight status, SEM was used to calculate the direct, indirect, and total effects of the predictor variables on the dependent variables (Heitzler et al., 2010; Kline, 2016; Motl et al., 2005; Trost et al., 2003). The detailed analytical procedures used to examine the study aims are described below. For all analytical procedures, statistically significant associations were determined by p-values ≤ 0.05.

Demographic Data

Categorical variables were examined using frequencies and expressed using the number and percentage of participants. Continuous variables were examined by calculating the mean value and standard deviation.

Covariates

Bivariate analyses were used to determine which covariates should be included in the full model based on their associations with the study's dependent variables (i.e., adolescent MVPA engagement and adolescent weight status). The following covariates were examined: adolescent age, adolescent race, adolescent sex, parent age, parent sex, parent education, parent employment status, parent income, parent marital status. Based on the results of the bivariate analyses, covariates that were statistically significant ($p \leq 0.05$) were included in the SEM analyses.

Missing Data

During preliminary analyses, missing patterns of the dependent variables were examined (Graham & Coffman, 2012; Little & Rubin, 2014). There were 158 missing data points (9.6%) for adolescent MVPA engagement and 70 missing data points (4.3%) for adolescent weight status. Regular full information maximum likelihood (FIML) was used in the analysis to account for missing data in the dependent variables because FIML uses all of the available data without the need to discard cases (Enders & Bandalos, 2001; Kline, 2016).

Missing patterns for the predictor variables also were examined. Missing data for these variables ranged from 0.6% to 2.9% with adolescent race having the most missing data points. Little's Missing Completely at Random (MCAR) test was performed for all independent variables and covariates in SPSS to determine whether the missing values are randomly distributed across the observations (Little, 1988; Little & Rubin, 2014). When performing Little's MCAR test, data are assumed to be MCAR if the p-value is not statistically significant ($p \geq 0.05$) (Little, 1988). The results of Little's MCAR test was used to further justify FIML, which usually assumes MCAR or Missing at Random (MAR) (Garson, 2015).

Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) was used to determine the best indicators for creating parent PA modeling, a latent variable not pre-identified by the FLASHE researchers. CFA was used instead of exploratory factor analysis (EFA) as the operational definition for parent PA modeling was theory-based and not data driven (Kline, 2016). It was hypothesized there would only be one-factor. Based on literature and data available in the FLASHE dataset, parent PA modeling was constructed using four items measuring interest in engaging in PA (i.e., TSRQ) and total minutes of MVPA per day. A transformation of the total minutes of MVPA per day was performed by multiplying total minutes of MVPA by .01 to be on a similar scale as the four TSRQ items.

Previous research has defined parent PA modeling as a form of parent PA support (Raudsepp, 2006); therefore, an additional CFA was performed using the parent PA modeling indicators plus the six-item scale used to measure parent PA support. This CFA was used to confirm parent PA modeling and parent PA support emerged as two distinct variables. Standardized estimates were used in interpreting the CFA models.

Given that no single index can fully determine goodness of fit, multiple indices were considered based on Kline's recommendations: model chi-square (X^2) and degrees of freedom, Steiger-Lind root mean square error of approximation (RMSEA) with 90% confidence intervals, Bentler comparative fit index (CFI), and standardized root mean square residual (SRMR) (Kline, 2016). The model chi-square assesses the discrepancy between the model implied and the sample variance/covariance matrix and "badness of fit" as a higher value indicates worse fit (Hooper, Coughlan, & Mullen, 2008). RMSEA is included to measure error of approximation, which is the lack of fit of the model to the population covariance matrix with a value of 0 representing the best fit. A range of 0 to $\leq$ 0.05 indicates a close approximate fit and anything above 0.10 a poor fit (Browne, Cudeck, Bollen, & Long, 1993). CFI is included to assess the "goodness of fit" as it assesses the relative improvement in fit in a proposed model compared with the baseline model (Hu & Bentler, 1999). A CFI greater than 0.95 indicates a good fit of the proposed model. SRMR measures the mean of the absolute correlation residual (Byrne, 2013; Hooper et al., 2008). A SRMR value of less than 0.08 is considered a good fit (Hu & Bentler, 1999).

Evaluation of fit indexes was used to determine the structure of parent PA modeling in the remainder of the analyses. CFA analyses were conducted using MPlus Combo Editor 8 (Muthen & Muthen, 2017).

Data Analysis Plan for Study Aim 1

To address hypotheses 1a (i.e., Adolescent MVPA engagement will mediate the pathway between parent PA support and weight status) and 1b (i.e., Adolescent MVPA engagement will mediate the pathway between parent PA modeling and adolescent weight status), a simple mediation analysis was performed in MPlus Combo Editor 8 (Muthen & Muthen, 2017). Mediation analysis was used to determine the extent to which adolescent MVPA engagement accounted for the relationship between parent PA support and adolescent weight status as well as the relationship between parent PA modeling and adolescent weight status. MVPA engagement was considered to mediate the association if the indirect effect was statistically significant at the alpha level of ≤ 0.05.

Data Analysis Plan for Study Aim 2

To examine the association between parent PA support with adolescent MVPA engagement and adolescent's weight status with the inclusion of adolescent self-efficacy and adolescent perception of parent PA support (Hypothesis 2a) and the same associations between parent PA modeling with adolescent MVPA engagement and adolescent's weight status (Hypothesis 2b), data were analyzed using path analysis (SEM) in MPlus Combo Editor 8 (Muthen & Muthen, 2017) and standardized parameter estimates were derived using maximum likelihood ratio (MLR) (Kline, 2016). A path diagram of the original model is depicted in Figure 1. Variables enclosed in squares represent observed variables while the variable enclosed in a circle represents a latent variable. The original model was examined with and without covariates.

Alternative Model

Given the possibility the original model would not be a good fit based on the indexes assessed above (X^2 and degrees of freedom, RMSEA with 90% confidence intervals, CFI, and SRMR), an alternative model was created as a comparison (see Figure 2). This model tested whether parent PA modeling was along the pathway between parent PA support, adolescent MVPA engagement, and adolescent weight status. Previously, the concept of parent PA modeling has been included within the parent PA support construct (Raudsepp, 2006); however, recently parent PA modeling has been hypothesized to be its own construct (Loprinzi, Schary, Beets, Leary, & Cardinal, 2013; Zecevic et al., 2010). Social Cognitive Theory suggests that there is a reciprocal and dynamic relationship between personal factors, behaviors, and the environments that help explain how parent PA support may influence parent PA modeling and vice versa (Bandura, 1986, 1989). However, given the nature that parent PA modeling was derived from parent PA support, the pathway of parent PA support to parent PA modeling was examined. The alternative model provides a statistical model that takes into consideration the possibility that parent PA support and parent PA modeling are distinct constructs with parent PA support contributing to parent PA modeling and thus adolescent MVPA engagement and weight status. The alternative model also was examined with and without covariates.

Post-hoc analyses

After conducting the proposed analytic plan above, post-hoc analyses were completed to further explore the relationship between parent PA support and PA modeling with adolescent MVPA engagement and weight status based on findings that have varied in the literature (gender and weight categories). Data were stratified by adolescent gender given differences seen in MVPA engagement with female adolescents typically engaging in fewer minutes of MVPA

(Belcher et al., 2010; Nader et al., 2008). Data were stratified by weight categories (normal vs. overweight/obese) given differences seen in MVPA engagement and perceived parent PA support (Belcher et al., 2010; Reichert et al., 2009; Taylor et al., 2002). Additionally, an analysis was conducted using minutes of MVPA per day for seven days versus just weekday MVPA. While previous FLASHE studies have not included results using the full seven days of MVPA, most literature that examines youth MVPA includes MVPA engagement over a seven-day period. Therefore, an analysis of both seven day and weekday MVPA were conducted to assess whether the inclusion of a 5-day or 7-day period affects the pathways and their associations.

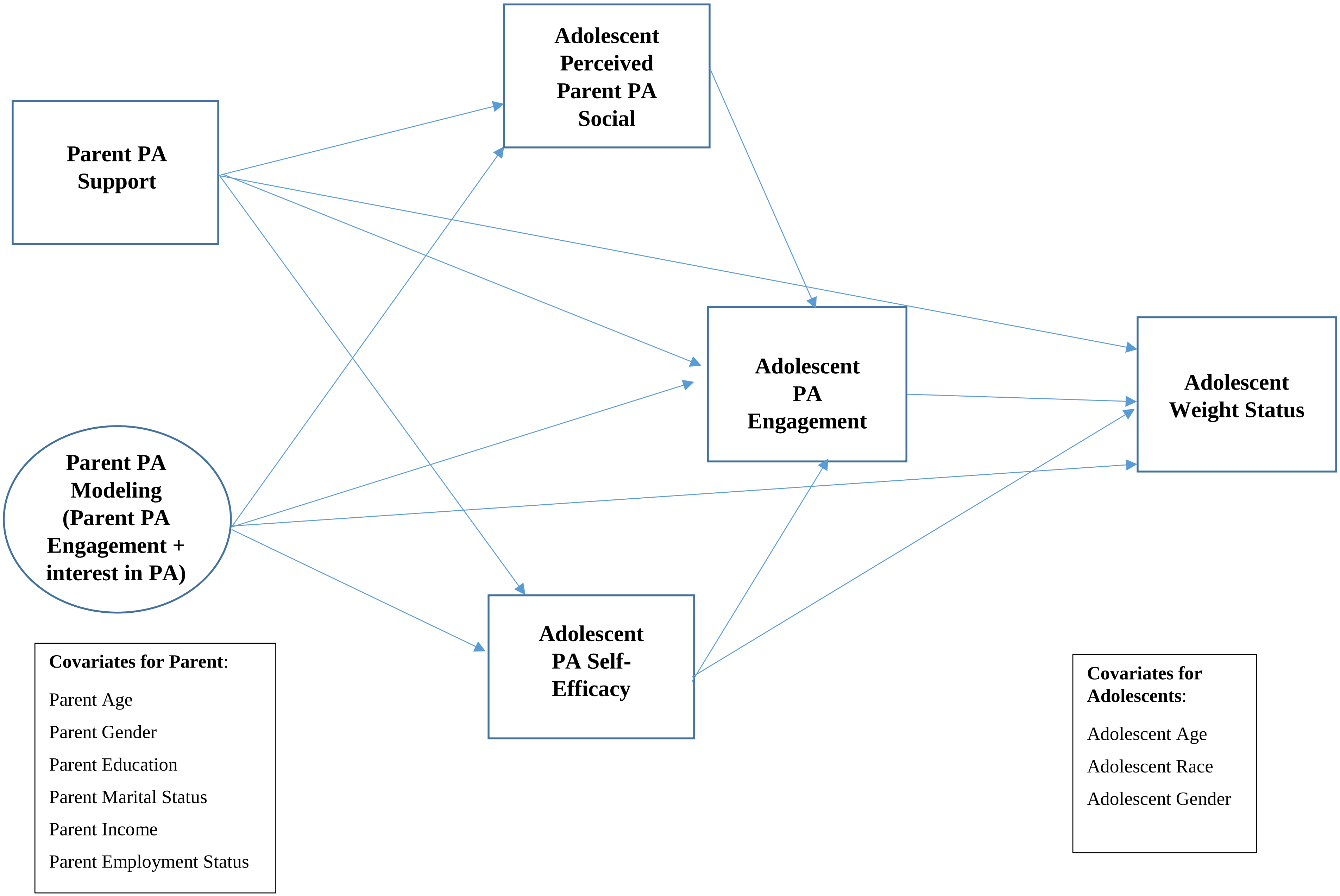

Figure1: Conceptual Model of Pathways between Parent Physical Activity Support and Parent Physical Activity Modeling Through Adolescent Physical Activity Engagement and Adolescent Weight Status

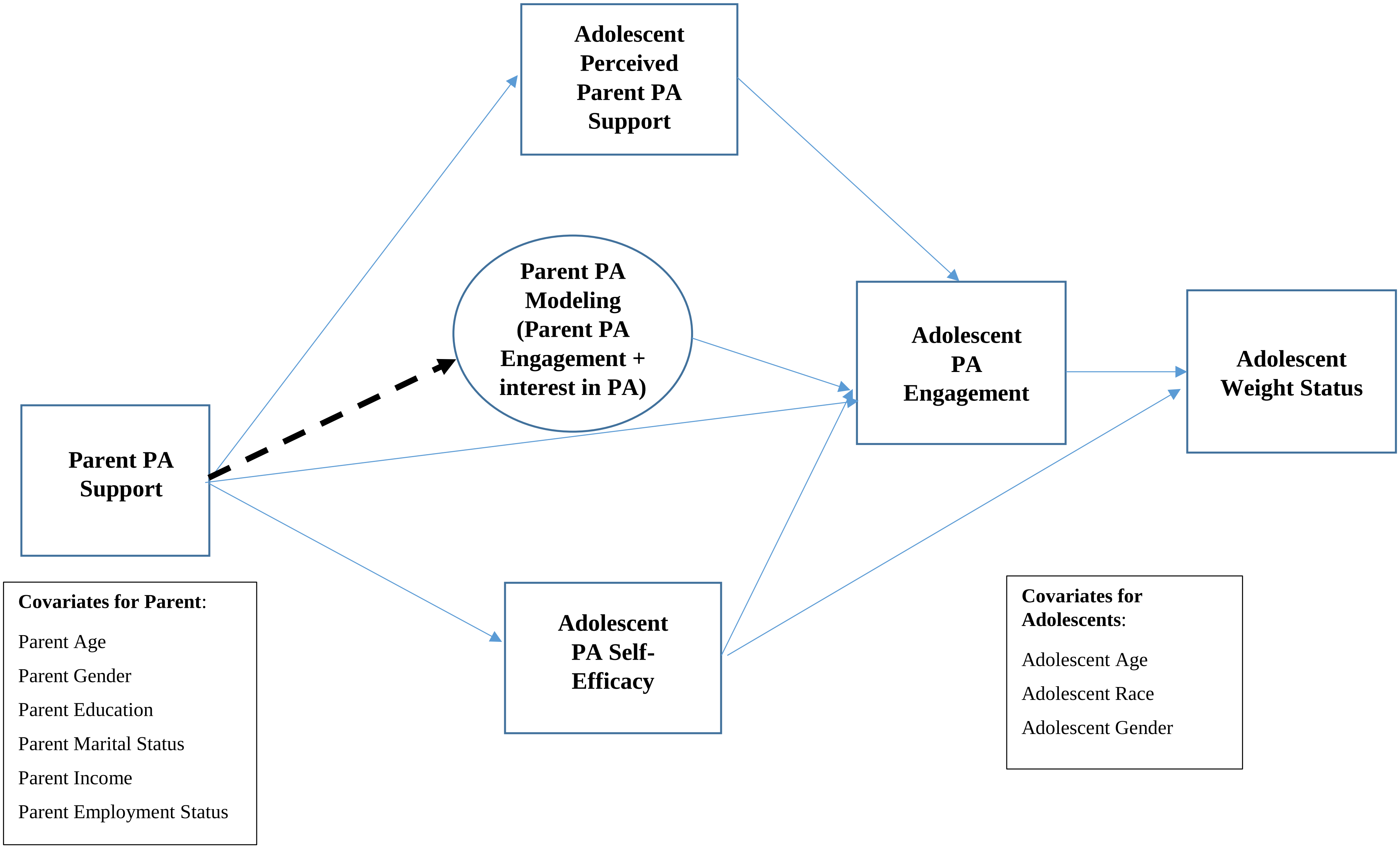

Figure 2: Alternative Conceptual Model of Pathways between Parent Physical Activity Support Through Adolescent Physical Activity Engagement and Adolescent Weight Status

CHAPTER 4: RESULTS

Demographics

Data from 1,644 dyads were included in this analysis and a detailed description of the demographic variables is displayed in Table 1. On average, adolescents were 14.5 years old (SD=1.6) and mostly White (63.8%). Gender distributions of adolescents were equal with 50.2% being female. The majority of adolescents (68.2%) had a normal weight status and engaged on average in 113 minutes of MVPA each weekday. Most parents were between the ages of 35-44 or 45-59 years old (43.8% and 42.3% respectively), female (73.9%), and White (70.2%). The majority of parents had a college degree or higher (46.6%), were married (72.3%) and were employed for wages (58.0%). The majority of parents (68.8%) were overweight and engaged on average in 117 minutes of MVPA per day.

Table 1: Demographics of Adolescent and Parent Dyads in the FLASHE study

	Adolescent (n=1644)	**Parent (n=1644)**
Gender, n(%) [a]		
Male	802 (49.9)	414 (25.4)
Female	805 (50.1)	1218 (74.6)
Age, mean±SD [a]	14.5±1.6	
18-34 years old		181 (11.1)
35-44 years old		714 (43.8)
45-59 years old		690 (42.3)
60+ years old		47 (2.9)
Race, n(%) [a]		
White	1025 (64.2)	1136 (70.2)
African American	262 (16.4)	268 (16.8)
Hispanic	162 (10.2)	120 (7.4)
Other	147 (9.2)	94 (5.8)
Body Mass Index, n(%) [a]		
Underweight, ≤18.5	69 (4.4)	22 (1.4)
Normal Weight, 18.5-24.9	1080 (68.7)	600 (37.2)
Overweight, 25.0-29.9	228 (14.5)	491 (30.4)
Obese, ≥30.0	195 (12.5)	500 (31.0)
Daily Minutes of MVPA, mean±SD	110.1±21.2[b]	116.5±146.2[b]
Weekday	112.7±23.7	
Weekend	104.5±19.4	
Income, n(%) [a]		
$0 to $99,999		1273 (78.9)
$100,000 or more		340 (21.1)
Education, n(%) [a]		
Less than high school		21 (1.3)
High school degree		277 (17.0)
Some college		569 (35.0)
College degree or higher		760 (46.7)
Marital Status, n(%) [a]		
Married		1173 (72.5)

Table 1 (Continued)

Divorced, widowed, or separated		202 (12.5)
Never married		149 (9.2)
Member of an unmarried couple		94 (5.8)
Employment Status, n(%) [a]		
Employed for wages		939 (57.8)
Self-employed		129 (7.9)
Out of work for more than 1 year		71 (4.4)
Out of work for less than 1 year		34 (2.1)
A homemaker		407 (25.0)
A student		15 (.9)
Retired		30 (1.8)

MVPA = Moderate-to-vigorous physical activity

[a] Response total differs from sample total due to missing data

[b] Daily minutes of MVPA is across 7 days (weekday + weekend minutes of MVPA)

Missing Data and Covariates

Little's MCAR test was not statistically significant (p-value =0.276) indicating the predictor variables and covariates were Missing Completely at Random (MCAR). Given that the Little's MCAR test was not statistically significant, multiple imputations were not used to replace missing values in the analyses. After bivariate analyses, the covariates adolescent age, adolescent race, parent age, parent education, parent income, and parent marital status had a statistically significant association with at least one dependent variable and were included in analyses of the original and alternative models (see Table 2).

Table 2: Results from Bivariate Analyses of Associations between Demographic and Dependent Variables of Adolescents and Parents in the FLASHE study (n= 1644 dyads)

	Adolescent Weight Status Beta Estimates	Adolescent Physical Activity Beta Estimates
Adolescent Gender	-0.057	-0.817
Adolescent Age	-0.021	**-11.895***
Adolescent Race	**-0.116***	-0.706
Parent Gender	-0.015	-1.485
Parent Age	**-0.113***	**-4.952***
Parent Income	**-0.221***	-0.759
Parent Education	-0**.096***	0.338
Parent Marital Status	**0.129***	-0.062
Parent Employment Status	-0.016	-0.310

*** p-value ≤ .05**

Confirmatory Factor Analysis (CFA)

Results from the CFA are displayed in Table 3. The overall fit for the CFA of parent PA modeling, which included the four-item TSRQ and parent MVPA, was adequate (X^2 (df) =120.588 (5) p <0.001; RMSEA =0.119; CFI = 0.918; SRMR = 0.041; BIC = 23571.075). All of the estimates were statistically significant. However, one item measuring whether others would be upset with the parent for not participating in PA (i.e., PPAUPST) showed a poor factor loading (Estimate [Est.]= 0.362). After removing the item, the fit was improved as indicated by the non-statistically significant X^2 as well as a lower RMSEA, SRMR and CFI (X^2 (df) =0.850 (2) p=0.654; RMSEA= 0.000; CFI = 1.000; SRMR = 0.004; BIC = 18454.509). When the six-item parent PA support scale was added, the model fit worsened as indicated by a statistically significant p-value for the model chi-square, a higher RMSEA and SRMR, and a lower CFI (X^2 (df) =1347.772 (35) p <0.001; RMSEA = 0.151; CFI = 0.658; SRMR = 0.103; BIC = 48059.849).

Table 3: Summary of Fit Indices for Confirmatory Factor Analysis for Parent PA Modeling

Model	X^2 (df)	RMSEA	CFI	SRMR	BIC
Original[a]	120.588 (5) p<0.001	0.119	0.918	0.041	23571.075
Modification 1[a]: Original with no PPAUPST	**.850 (2) p=0.654**	**0.000**	**1.000**	**0.004**	**18454.509**
Modification 2: PA Support (six-item scale) + PA Modeling (Original with no PPAUPST)	1347.772 (35) p<0.001	0.151	0.658	0.103	48059.849

PA= Physical Activity; X^2 =Chi-square; df = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index; SRMR = standardized root mean square residual; BIC = Bayesian information criterion

[a]Original Model: “I would feel bad about myself if I didn’t” (PPABAD); “I have thought about it and decided that I want to exercise” (PPAWANT); “Others would be upset with me if I didn’t”

(PPAUPST); “It is an important thing for me to do” (PPAIMPT) + total minutes of moderate-to-vigorous physical activity per day (MVPA)
Bold represents the best model fit based on fit statistic recommendations

The parent PA modeling latent variable structure with the best fit (i.e., three items from TSRQ and parent MVPA) loaded onto a single factor. Estimates and standard errors are presented in Figure 3.

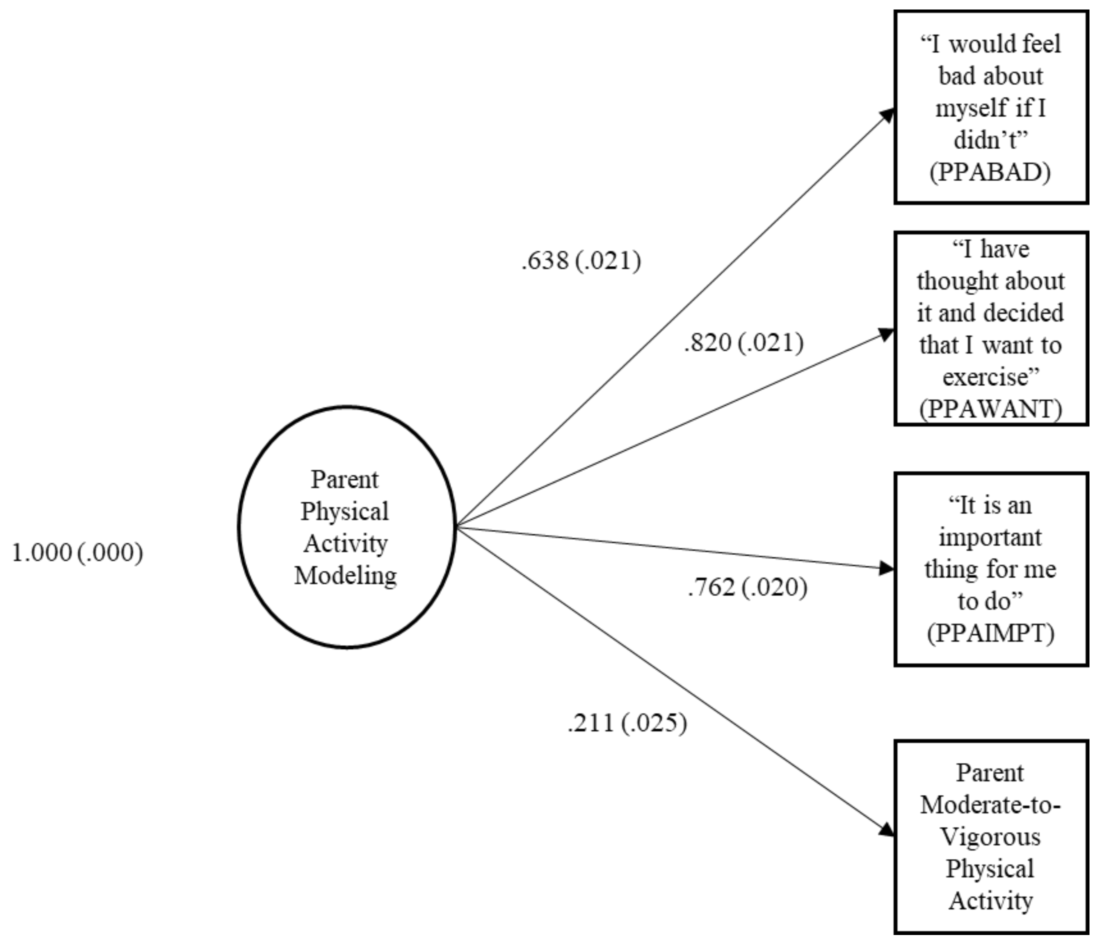

Figure 3: Confirmatory Factor Analysis for Parent Physical Activity Modeling with Three Items from the Treatment Self-Regulation Questionnaire and Parent Average Minutes of Moderate-to-Vigorous Physical Activity per Day

Path Analysis

Study Aim 1

The indirect effect of parent PA support on adolescent weight status through adolescent MVPA was not statistically significant (Est.=-0.002, p=0.687). The direct effect of adolescent MVPA engagement on adolescent weight status also was not significant (Est.=-0.011, p =0.668). The direct effect of parent PA support on adolescent MVPA was statistically significant with a positive association (Est.=0.217, p <.001). The direct effect of parent PA support on adolescent weight status also was statistically significant with a positive association (Est.=0.075, p =0.007). Results displayed in Table 4 and Figure 4. The fit statistics indicate a fully saturated model so the fit is not interpretable since it perfectly reproduced the observed covariance matrix [model chi-square (X^2 (df) =.000 (0) p<.001; RMSEA = 0.000; CFI = 1.000; SRMR = 0.000; BIC = 4784.414]. Estimates and standard errors are presented in Figure 4.

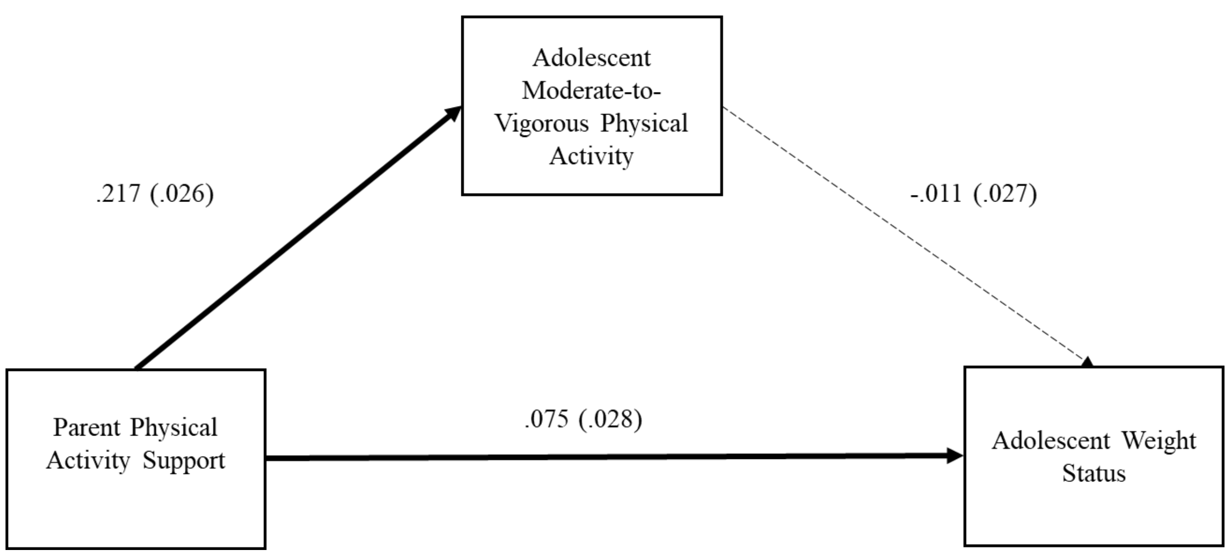

Figure 4: Mediation Analysis of Direct Pathways from Parent Physical Activity Support on Adolescent Weight Status through Adolescent Moderate-to-Vigorous Physical Activity. A solid path arrow denotes a significant path (p≤.05), and dotted path arrow denotes a nonsignificant path.

The direct effect of parent PA modeling on adolescent MVPA engagement was statistically significant with a positive association (Est.=0.084, p =0.004). However, the direct effect of parent PA modeling on adolescent weight status (Est.=-0.041, p =0.175) and the direct effect of adolescent MVPA engagement on adolescent weight status were not statistically significant (Est.=0.007, p =0.774). The indirect effect of parent PA modeling on adolescent weight status through adolescent MVPA engagement also was not significantly significant (Est.=0.001, p=0.775). Results are displayed in Figure 5. The fit statistics indicate an excellent fit, except for the model chi-square (X^2 (df) =19.146 (8) p=0.014; RMSEA = 0.029; CFI =0.991; SRMR = 0.021; BIC = 23312.39).

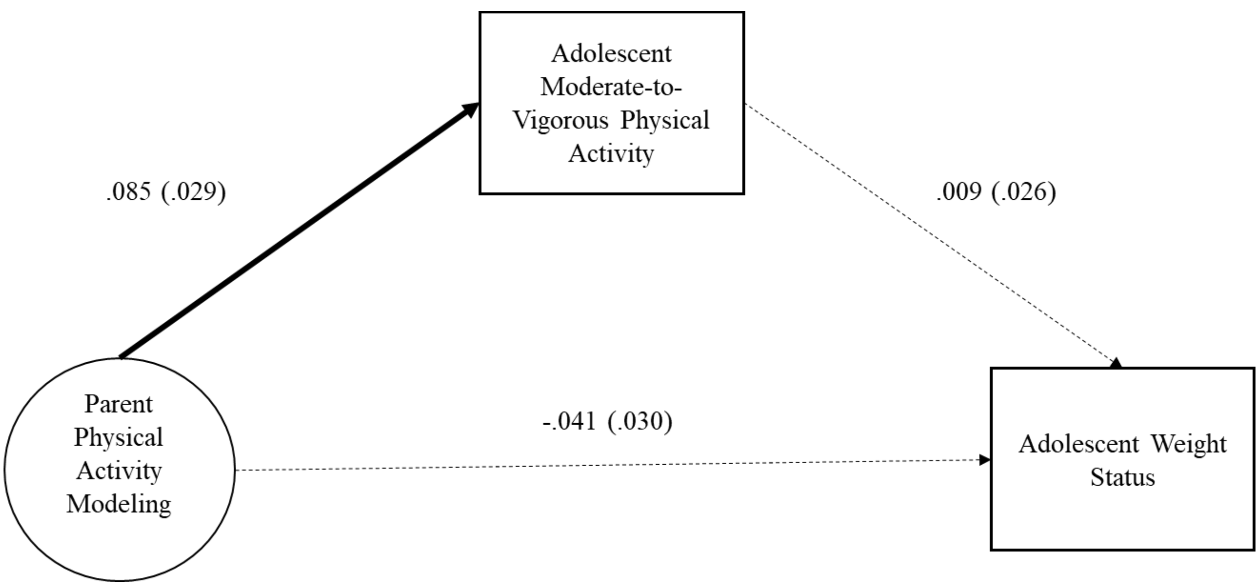

Figure 5: Mediation Analysis of Direct Pathways from Parent Physical Activity Modeling on Adolescent Weight Status through Adolescent Moderate-to-Vigorous Physical Activity. A solid path arrow denotes a significant path (p<.05), and dotted path arrow denotes a nonsignificant path.

Study Aim 2

Comparison of model fit indexes for the simple mediation, original, and alternative models are displayed in Table 4. All models had a statistically significant chi-square, indicating "bad fit," with the other fit indexes (RMSEA and SRMR) for the original model with covariates and the alternative model with covariates were the exact same (representing equivalent models) and indicated the best fit based on lower RMSEA and SRMR.

Table 4: Fit Indexes Comparing Original and Alternative Models of Associations Between Parent Physical Activity Support and Parent Physical Activity Modeling with Adolescent Moderate-to-Vigorous Physical Activity and Weight Status in the FLASHE Study (n= 1644 dyads)

Model	X^2 (df)	RMSEA	CFI	SRMR	BIC
Original model	142.804 (18) p<.001	0.065	0.950	0.038	35719.013
Original model with covariates	**246.240 (57) p<.001**	**0.047**	**0.953**	**0.027**	**32316.141**
Alternative model with Parent PA modeling along the pathway	142.076 (19) p<.001	0.063	0.950	0.039	31498.167
Alternative model with Parent PA modeling along the pathway (with covariates)	246.240 (57) p<.001	0.047	0.953	0.027	32316.141

X^2 =Chi-square; df = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index; SRMR = standardized root mean square residual; BIC = Bayesian information criterion; PA = Physical Activity
Original model variables: Parent PA Support; Parent PA Modeling; Adolescent PA Self-Efficacy; Adolescent Perception of Parent PA Support; Adolescent Moderate-to-Vigorous Physical Activity; Adolescent Weight Status
Alternative model variables are the same as the Original model variables
Bold indicates the model with the overall best fit statistics.

Covariates were included in the original and alternative models to control for adolescent and parent factors that might influence the results. As seen in the fit statistics for those models, controlling for the covariates enhanced the fit of the overall model.

Since the fit statistics and standardized estimates (see Table 5) for the original and alternative models (with covariates) were equivalent, the original model was interpreted. Figure 6 shows the standardized estimates with standard errors and the statistically significant associations found between several pathways in the model are indicated by solid lines. A one unit increase in parent PA support predicted a 0.117 increase in adolescent weight status and a 0.610 increase in adolescent perception of parent PA support. A one unit increase in parent PA modeling predicted increases in adolescent perception of parent PA support (0.905 increase) and adolescent PA self-efficacy (0.341 increase).

Statistically significant pathways between psychosocial constructs and the dependent variables also existed. A one unit increase in adolescent PA self-efficacy predicted a 0.035 increase in adolescent weekday MVPA and a 0.105 decrease in adolescent BMI z-scores. There was only one statistically significant indirect (mediated) pathway: parent PA modeling through adolescent PA self-efficacy to adolescent weight status.

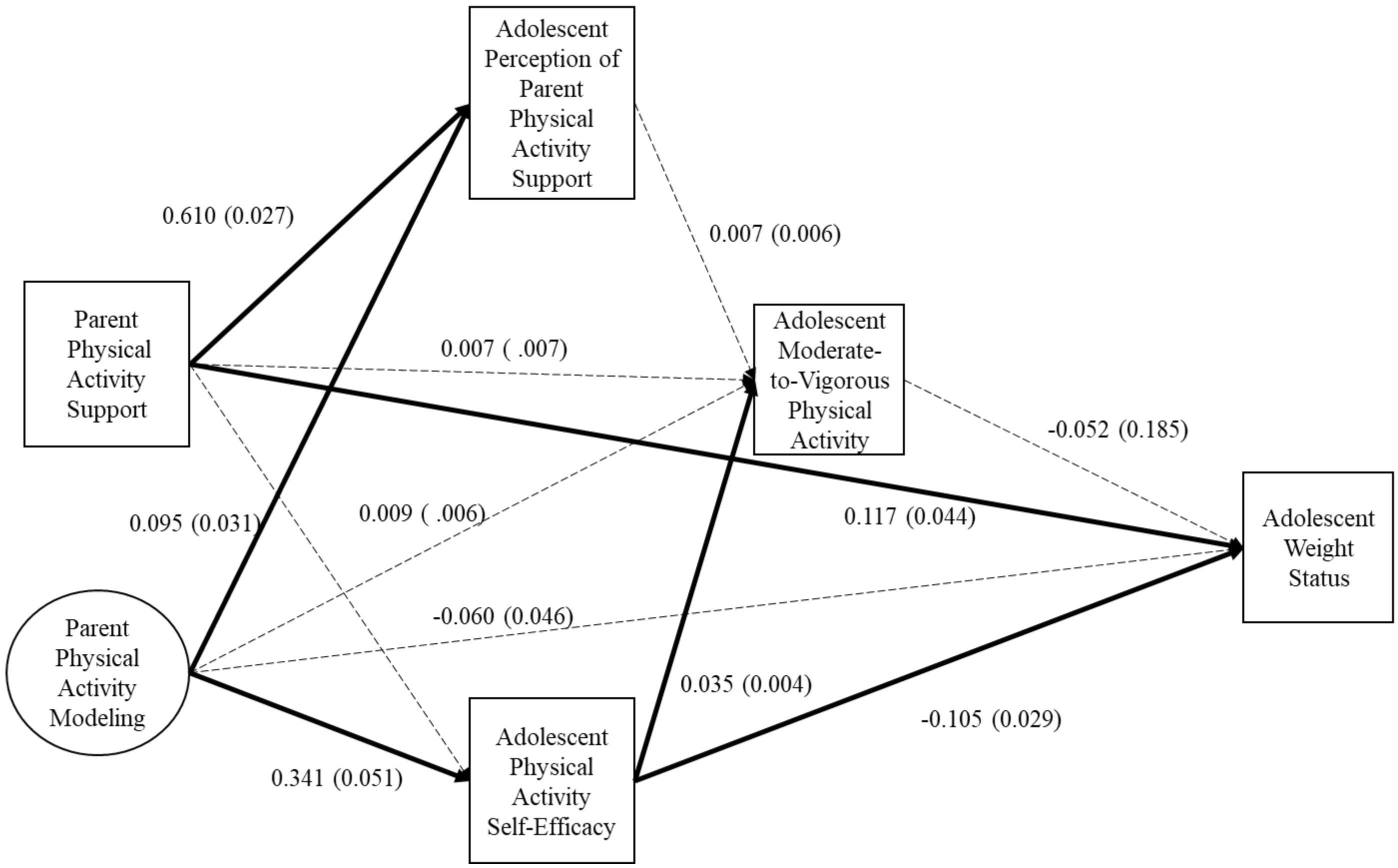

Figure 6: Original Model of the Direct and Indirect Effects of Parent Physical Activity Support and Parent Physical Activity Modeling on Adolescent Physical Activity and Adolescent Weight Status with Adolescent Psychosocial Constructs A solid path arrow denotes a significant path (p<.05), and dotted path arrow denotes a nonsignificant path.

Table 5: Comparison of the Associations between Parent PA Support and PA Modeling and Adolescent MVPA and Weight Status with Adolescent PA Self-Efficacy and Adolescent Perception of Parent PA Support in the Original and Alternative Models

	Original Model			Alternative Model		
	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value
PA Support						
PA Support → PA Model (direct)	**-**	**-**	**-**	**.353**	**.031**	**<.001**
PA Support → AMVPA (direct)	0.007	0.007	0.285	0.007	0.007	0.285
PA Support → ABMIz (direct)	**0.117**	**0.044**	**0.007**	**0.117**	**0.044**	**0.007**
PA Support → Adolescent PA Self-Efficacy (direct)	0.005	0.037	0.900	0.005	0.037	0.900
PA Support → Adolescent Perception of Parent PA Support (direct)	**0.610**	**0.027**	**<.001**	**0.610**	**0.027**	**<.001**
PASupport →AMVPA → ABMIz (indirect)	0.000	0.001	0.796	0.000	0.001	0.796
PASupport → Adolescent PA Self-Efficacy → AMVPA (indirect)	0.001	0.005	0.901	0.001	0.005	0.901
PASupport → Adolescent PA Self-Efficacy → ABMIz (indirect)	0.000	0.004	0.901	0.000	0.004	0.901
PASupport → Adolescent Perception of Parent PA Support → AMVPA (indirect)	0.017	0.012	0.171	0.017	0.012	0.171
PASupport → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.008	0.024	0.747	0.008	0.024	0.747

Table 5 (Continued)

PA Model						
PA Model → AMVPA (direct)	0.009	0.006	0.175	0.009	0.006	0.175
PA Model → ABMIz (direct)	-0.060	0.046	0.195	-0.060	0.046	0.195
PA Model → Adolescent PA Self-Efficacy (direct)	**0.347**	**0.051**	**<0.001**	**0.347**	**0.051**	**<.001**
PA Model → Adolescent Perception of Parent PA Support (direct)	**0.095**	**0.031**	**0.002**	**0.095**	**0.031**	**0.002**
PAModel →AMVPA → ABMIz (indirect)	0.000	0.002	0.781	0.000	0.002	0.781
PAModel → Adolescent PA Self-Efficacy → AMVPA (indirect)	**0.040**	**0.007**	**<0.001**	**0.040**	**0.007**	**<0.001**
PAModel → Adolescent PA Self-Efficacy → ABMIz (indirect)	**-0.036**	**0.011**	**0.001**	**-0.036**	**0.011**	**0.001**
PAModel → Adolescent Perception of Parent PA Support → ABMIz	0.002	0.002	0.207	0.002	0.002	0.207
PAModel → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.001	0.004	0.749	0.001	0.004	0.749
Additional Direct Pathways						
AMVPA → ABMIz (direct)	-0.052	0.185	0.779	-0.052	0.185	0.779
Adolescent PA Self-Efficacy → AMVPA (direct)	**0.035**	**0.004**	**<.001**	**0.035**	**0.004**	**<.001**
Adolescent PA Self-Efficacy → ABMIz (direct)	**-0.105**	**0.029**	**<.001**	**-0.105**	**0.029**	**<.001**
Adolescent Perception of Parent PA Support → AMVPA	0.007	0.006	0.277	0.007	0.006	0.277

(direct)						

AMVPA= Adolescent Moderate-to-Vigorous Physical Activity; ABMIz = Adolescent Weight Status; PAModel = Parent Physical Activity Modeling; PASupport = Parent Physical Activity Support

Bold indicates a statistically significant pathway based on a p-value ≤.05

Post-hoc Analyses

Stratification by Gender

While the majority of the pathways were similar to the full dataset, there were differences when pathways were stratified by gender (see Table 6). The association between parent PA modeling and adolescent perception of parent PA support was statistically significant for males (Est.=0.125; p=0.001), but not for females (Est.=0.046; p=0.255). Parent PA support also was not associated with weight status for females (Est.=0.074; p=0.145) but was for males (Est.=0.094; p=0.044).

Table 6: Comparison of the Associations between Parent PA Support and PA Modeling and Adolescent MVPA and Weight Status with Adolescent PA Self-Efficacy and Adolescent Perception of Parent PA Support Stratified by Adolescent Gender

	Males			Females		
	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value
PA Support						
PA Support → AMVPA (direct)	0.027	0.022	0.219	0.027	0.022	0.220
PA Support → ABMIz (direct)	**0.094**	**0.047**	**0.044**	0.074	0.051	0.145
PA Support → Adolescent PA Self-Efficacy (direct)	-0.032	0.039	0.416	0.029	0.039	0.459
PA Support → Adolescent Perception of Parent PA Support (direct)	**0.543**	**0.034**	**<.001**	**0.574**	**0.032**	**<.001**
PASupport →AMVPA → ABMIz (indirect)	0.000	0.001	0.813	0.000	0.001	0.813

Table 6 (Continued)

PASupport → Adolescent PA Self-Efficacy → AMVPA (indirect)	-0.005	0.006	0.418	0.005	0.007	0.461
PASupport → Adolescent PA Self-Efficacy → ABMIz (indirect)	0.003	0.003	0.433	-0.004	0.006	0.471
PASupport → Adolescent Perception of Parent PA Support → AMVPA (indirect)	0.007	0.015	0.624	0.021	0.017	0.222
PASupport → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.023	0.025	0.353	0.006	0.027	0.830
PA Model						
PA Model → AMVPA (direct)	0.035	0.020	0.090	0.034	0.020	0.092
PA Model → ABMIz (direct)	-0.053	0.047	0.264	-0.039	0.046	0.390
PA Model → Adolescent PA Self-Efficacy (direct)	**0.293**	**0.048**	**<0.001**	**0.198**	**0.049**	**<0.001**
PA Model → Adolescent Perception of Parent PA Support (direct)	**0.125**	**0.037**	**0.001**	0.046	0.040	0.255
PAModel →AMVPA → ABMIz (indirect)	0.000	0.001	0.802	0.000	0.002	0.802
PAModel → Adolescent PA Self-Efficacy → AMVPA (indirect)	**0.044**	**0.009**	**<0.001**	**0.034**	**0.010**	**<0.001**
PAModel → Adolescent PA Self-Efficacy → ABMIz (indirect)	**-0.025**	**0.012**	**0.038**	**-0.028**	**0.011**	**0.013**

Table 6 (Continued)

PAModel → Adolescent Perception of Parent PA Support → AMVPA (indirect)	0.002	0.003	0.621	0.002	0.002	0.415
PAModel → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.005	0.006	0.377	0.000	0.002	0.834
Other Pathways						
AMVPA → ABMIz (direct)	-0.011	0.042	0.802	-0.012	0.047	0.802
Adolescent PA Self-Efficacy → AMVPA (direct)	**0.149**	**0.021**	**<0.001**	**0.170**	**0.026**	**<0.001**
Adolescent PA Self-Efficacy → ABMIz (direct)	**-0.084**	**0.039**	**0.031**	**-0.142**	**0.044**	**0.001**
Adolescent Perception of Parent PA Support → AMVPA (direct)	0.013	0.027	0.622	0.036	0.030	0.221

AMVPA= Adolescent Moderate-to-Vigorous Physical Activity; ABMIz = Adolescent Weight Status; PAModel = Parent Physical Activity Modeling; PASupport = Parent Physical Activity Support; PA= Physical Activity

Bold indicates a statistically significant pathway based on a p-value ≤.05

Normal Weight vs. Overweight/Obese

While the majority of the pathways were similar to examinations of the full dataset, there were differences seen when the dataset was stratified by weight status of adolescent participants (see Table 7). A statistically significant association was seen between parent PA modeling and adolescent BMI z-score through adolescent PA self-efficacy (Est.=-0.040, p=0.025) in the overweight/obese group. A statistically significant association was also seen between adolescent PA self-efficacy and adolescent BMI z-scores (Est.=-0.163, p=0.007). These pathways were not statistically significant in the normal weight group.

Table 7: Comparison of the Associations between Parent PA Support and PA Modeling and Adolescent MVPA and Weight Status with Adolescent PA Self-Efficacy and Adolescent Perception of Parent PA Support Stratified by Weight Categories

	Normal			Overweight/Obese		
	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value
PA Support						
PA Support → AMVPA (direct)	0.034	0.024	0.155	0.030	0.021	0.154
PA Support → ABMIz (direct)	0.035	0.040	0.391	-0.075	0.060	0.209
PA Support → Adolescent PA Self-Efficacy (direct)	0.008	0.033	0.797	0.006	0.054	0.918
PA Support → Adolescent Perception of Parent PA Support (direct)	**0.579**	**0.028**	**<0.001**	**0.505**	**0.047**	**<0.001**
PASupport →AMVPA → ABMIz (indirect)	0.001	0.001	0.334	0.002	0.003	0.333
PASupport → Adolescent PA Self-Efficacy → AMVPA (indirect)	0.002	0.006	0.797	0.001	0.006	0.918

Table 7 (Continued)

PASupport → Adolescent PA Self-Efficacy → ABMIz (indirect)	0.000	0.000	0.897	-0.001	0.009	0.918
PASupport → Adolescent Perception of Parent PA Support → AMVPA (indirect)	0.019	0.015	0.189	0.006	0.021	0.778
PASupport → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.019	0.022	0.375	-0.008	0.030	0.788
PA Model						
PA Model → AMVPA (direct)	0.026	0.022	0.235	0.022	0.019	0.236
PA Model → ABMIz (direct)	-0.001	0.040	0.986	-0.004	0.064	0.953
PA Model → Adolescent PA Self-Efficacy (direct)	**0.227**	**0.041**	**<0.001**	**0.246**	**0.065**	**<0.001**
PA Model → Adolescent Perception of Parent PA Support (direct)	**0.072**	**0.032**	**0.025**	**0.110**	**0.052**	**0.035**
PAModel →AMVPA → ABMIz (indirect)	0.001	0.001	0.413	0.002	0.002	0.413
PAModel → Adolescent PA Self-Efficacy → AMVPA (indirect)	**0.042**	**0.009**	**<0.001**	**0.029**	**0.011**	**0.010**
PAModel → Adolescent PA Self-Efficacy → ABMIz (indirect)	0.001	0.008	0.888	**-0.040**	**0.018**	**0.025**
PAModel → Adolescent Perception of Parent PA Support → AMVPA (indirect)	0.002	0.002	0.244	0.001	0.005	0.782

Table 7 (Continued)

PAModel → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.002	0.003	0.419	-0.002	0.007	0.790
Other Pathways						
AMVPA → ABMIz (direct)	0.041	0.035	0.241	0.082	0.070	0.243
Adolescent PA Self-Efficacy → AMVPA (direct)	**0.187**	**0.020**	**<0.001**	**0.117**	**0.034**	**0.001**
Adolescent PA Self-Efficacy → ABMIz (direct)	0.005	0.033	0.888	**-0.163**	**0.060**	**0.007**
Adolescent Perception of Parent PA Support → AMVPA (direct)	0.033	0.025	0.186	0.012	0.042	0.779

AMVPA= Adolescent Moderate-to-Vigorous Physical Activity; ABMIz = Adolescent Weight Status; PAModel = Parent Physical Activity Modeling; PASupport = Parent Physical Activity Support

Final Model Using Adolescent MVPA for 7 Days (Weekday + Weekend)

When adolescent MVPA for 7 days (weekdays + weekend) was used instead of MVPA for 5 days (weekdays), the same statistically significant pathways were seen. However, all beta estimates in the 7-day MVPA model were lower than the 5-day MVPA model (i.e. PA Support → Adolescent Perception of Parent PA Support: $Est._{(MVPA7days)}$= 0.561 vs. $Est._{(MVPA5days)}$= 0.610; PAModel → Adolescent PA Self-Efficacy → ABMIz (indirect): $Est._{(MVPA7days)}$= -0.025 vs. $Est._{(MVPA5days)}$= -0.036).

Table 8: Evaluation of the Associations between Parent PA Support and PA Modeling and Adolescent MVPA across 7 Days and Weight Status with Adolescent PA Self-Efficacy and Adolescent Perception of Parent PA Support

	Estimate	Standard Error	P-value
PA Support			
PA Support → AMVPA7 (direct)	0.029	0.022	0.175
PA Support → ABMIz (direct)	**0.091**	**0.034**	**0.007**
PA Support → Adolescent PA Self-Efficacy (direct)	0.004	0.027	0.895
PA Support → Adolescent Perception of Parent PA Support (direct)	**0.561**	**0.024**	**<0.001**
PASupport →AMVPA7 → ABMIz (indirect)	-0.001	0.002	0.448
PASupport → Adolescent PA Self-Efficacy → ABMIz (indirect)	0.000	0.003	0.896
PASupport → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.006	0.018	0.723
PA Model			
PA Model → AMVPA7 (direct)	0.026	0.020	0.199
PA Model → ABMIz (direct)	-0.042	0.033	0.201

Table 8 (Continued)			
PA Model → Adolescent PA Self-Efficacy (direct)	**0.244**	**0.034**	**<0.001**
PA Model → Adolescent Perception of Parent PA Support (direct)	**0.082**	**0.027**	**0.002**
PAModel →AMVPA7 → ABMIz (indirect)	-0.001	0.001	0.412
PAModel → Adolescent PA Self-Efficacy → ABMIz (indirect)	**-0.025**	**0.008**	**0.002**
PAModel → Adolescent Perception of Parent PA Support → ABMIz (indirect)	0.001	0.003	0.726
Other Pathways			
AMVPA7 → ABMIz (direct)	-0.044	0.045	0.319
Adolescent PA Self-Efficacy → AMVPA7 (direct)	**0.198**	**0.017**	**<0.001**
Adolescent PA Self-Efficacy → ABMIz (direct)	**-0.100**	**0.030**	**0.001**
Adolescent Perception of Parent PA Support → AMVPA7 (direct)	0.029	0.021	0.167

AMVPA7= Adolescent Moderate-to-Vigorous Physical Activity across 7 days (weekday+weekend)

Bold indicates a statistically significant pathway based on a p-value ≤.05

CHAPTER 5: DISCUSSION

The purpose of this dissertation was to assess associations between parent PA support and PA modeling and adolescent MVPA engagement and weight status. How these associations were influenced by adolescent PA self-efficacy and adolescent perceptions of parent PA support also were examined. In data from the FLASHE study, adolescent MVPA engagement did not mediate the pathway between either of the parent factors and adolescent weight status, although this was hypothesized (study aim 1). Also, adolescent MVPA engagement and adolescent weight status were not statistically associated. The pathways from parent PA support to adolescent MVPA engagement and weight status were not positively influenced by the inclusion of the adolescent psychosocial constructs (study aim 2). As hypothesized, there was an inverse association between parent PA modeling and adolescent weight status as mediated by adolescent PA self-efficacy and a positive association between parent PA modeling and adolescent MVPA engagement as mediated by adolescent PA self-efficacy (study aim 2). Additionally, adolescent PA self-efficacy was positively associated with adolescent MVPA engagement and negatively associated with adolescent weight status while adolescent perception of parent PA support was statistically associated with adolescent MVPA engagement. Overall, findings suggest that only parent PA modeling influences adolescent PA-related behaviors and health outcomes (weight status) through its impact on adolescent PA self-efficacy.

Adolescent and Parent MVPA

In this study, adolescents and their parents engaged in more MVPA than the national recommendations for daily MVPA. Current recommendations are for adolescents to spend $\geq$ 60 minutes engaged in MVPA per day for at least five days per week (Physical Activity Guidelines Advisory Committee, 2008). In this study, adolescents engaged in an average of 112 minutes (almost 2 hours) of MVPA per day during weekdays. Additionally, adolescents engaged in about 105 minutes (1.75 hours) of MVPA on weekends. Other studies examining MVPA found most adolescents do not meet recommendations and engage on average in only 31-45 minutes of MVPA per day (Hearst, Patnode, Sirard, Farbakhsh, & Lytle, 2012; Physical Activity Guidelines Advisory Committee, 2008; Schneider, Dunn, & Cooper, 2009).

Parents enrolled in FLASHE also engaged in high levels of MVPA. The recommendation for adults is ≥30 minutes of MVPA per day at least five days a week (Physical Activity Guidelines Advisory Committee, 2008). However, parents in FLASHE engaged on average in 117 minutes (almost 2 hours) of MVPA per day, which included time spent in MVPA during weekdays and weekends. Previous studies found parent's engagement in MVPA is directly associated with adolescent MVPA (Mitchell et al., 2012; Trost & Loprinzi, 2011; Yao & Rhodes, 2015). Given that parent MVPA is positively associated with adolescent MVPA, it is important to try to understand the factors that might contribute to the high engagement in MVPA for parents and adolescents in the FLASHE study.

MVPA engagement for adolescents and parents may also be high in this population given MVPA was self-reported. Previous literature has noted self-report of PA creates significant reporting bias with a combination of social desirability and recall bias contributing to an overestimation of MVPA engagement (Sallis & Saelens, 2000; Troiano et al., 2008). In comparison, the use of objective measures of PA, like accelerometers, have been deemed a better techniques for attaining body movement (Ekelund, Tomkinson, & Armstrong, 2011; Hallal et al., 2013). Studies measuring MVPA using both self-report and accelerometers have found self-reported time spent in MVPA to be higher than time captured by accelerometer (LeBlanc & Janssen, 2010; Slootmaker, Schuit, Chinapaw, Seidell, & Van Mechelen, 2009). In one study of a racially diverse, population of girls and boys aged 12-19 years old, self-report MVPA was 42 minutes per day while accelerometer data only showed 15 minutes per day (LeBlanc & Janssen, 2010). However, lower MVPA as measured by accelerometers may be due in part to their inability to accurately measure biking, swimming, and other forms of PA that are not walking or running (Belcher et al., 2010; Freedson, Pober, & Janz, 2005; Rachele, McPhail, Washington, & Cuddihy, 2012). A subset of the FLASHE population wore accelerometers; however, this data is not yet available for comparison against self-reported MVPA from the YAP and IPAQ. When these data are available, it will be important to compare self-reported and accelerometer MVPA data to better understand whether the high MVPA engagement in FLASHE is due in part to self-report bias.

Other multiple factors, such as race and parent education level, likely contributed to higher MVPA engagement within the parent-adolescent dyads in this study. In previous studies, White youth were found to engage in more MVPA compared to their Black counterparts (Belcher et al., 2010; Sirard et al., 2013). However, while over 64% of adolescents and 70% of parents identified as White, bivariate analyses did not find significantly associations between adolescent or parent race and adolescent MVPA. The lack of association in the bivariate analyses suggests there is not much variation in adolescent MVPA by race. However, there was a high percentage of parents reporting their education level as a college degree or higher (47%), which may have influenced the amount of MVPA in this study. Previous studies have found parents with at least a college degree have adolescents who engage in more MVPA (Ornelas et al., 2007; Tucker et al., 2009). These factors associated with high adolescent and parent MVPA engagement also influence weight status, which in turn is associated with MVPA as outlined below.

Adolescent Weight Status

In this study, there was a higher prevalence of normal weight adolescents compared to the general population. In the U.S., almost 21% of adolescents are classified as obese (Centers for Disease Control and Prevention, 2017); however, the majority of adolescents in FLASHE were classified as having a normal weight (68.2%) with only about 12.5% classified as obese. Youth weight status is bidirectionally associated with MVPA engagement such that youth with normal weight engage in more MVPA compared to youth who are overweight and obese as well as more active youth have a lower BMI (Belcher et al., 2010; Reichert et al., 2009).

Similar to the high MVPA found in this population, multiple factors likely contributed to less overweight/obese adolescents within this dataset. Factors such as parents' high education and parent income (Eagle et al., 2012; Galvez et al., 2013) are associated with reduced prevalence of obesity among adolescents. As noted above, the parents in this dataset were highly educated. In addition, nearly one-fourth of parents (21%) reported a household income of $100,000 or greater. Therefore, the high education levels and high income seen among parents in this study likely influenced both weight status and obesity-related behaviors (i.e., diet and PA) contributing to the high proportion of adolescents with normal weight status and high engagement in MVPA. Given the cross-sectional nature of the FLASHE data, this study examined the unidirectional association of adolescent MVPA engagement on adolescent weight status. Future studies should take a longitudinal approach to examine the bidirectionality of this association.

Adolescent MVPA Engagement and Weight Status

Adolescent MVPA engagement and adolescent weight status were not significantly associated in this dataset. While previous literature indicates adolescent MVPA engagement influences weight status (Chung, Skinner, Steiner, & Perrin, 2012; Strong et al., 2005), it is likely the association was not significant in this study due to several factors. As noted above, there was a high prevalence of MVPA and normal weight status among adolescents in this study. Given most studies to-date have included a higher prevalence of overweight/obese adolescents, which might have influenced findings, FLASHE data were examined stratified by weight status (underweight/normal and overweight/obese). Adolescent MVPA engagement and adolescent weight status were still not significantly associated even among overweight/obese youth, potentially due in part to the socio-economic status (SES) factors indicated above. Additionally, the cross-sectional nature of the dataset also likely contributed to the lack of association between adolescent MVPA engagement and weight status. Given the cross-sectional nature of the data, it is not possible to determine temporal order between MVPA engagement and weight status. The association between these variables is further obscured given the bidirectional relationship between MVPA engagement and weight status and the homogenous make-up of participants, in health behaviors, outcomes, and SES status, in this dataset.

Study Aim 1: Examine associations between parent factors and adolescent MVPA engagement and weight status.

It was hypothesized that adolescent MVPA engagement would mediate the relationship between parent factors and adolescent weight status (Hypotheses 1a and 1b); however, this hypothesis was not confirmed due primarily to adolescent MVPA engagement and adolescent weight status not being associated in any model examined. Given the lack of association between these variables, it is important to examine these associations in adolescent populations that are more representative of the general population based on MVPA engagement and weight status.

While associations between parent factors and weight status were not mediated by adolescent MVPA engagement in this study, parent PA support was directly associated with adolescent weight status. There have been inconsistencies within the literature about whether parent PA support influences weight status (Beets et al., 2010) with some studies not finding any association and others finding varying associations based on weight status (M.W. Beets et al., 2010; De Bourdeaudhuij et al., 2005). There was a significant association within this dataset; however, it was a positive association suggesting more parent PA support is associated with higher adolescent weight status. When evaluating this relationship through a post-hoc analysis stratified by weight status, parent PA support did not have a significant association with either weight status category (underweight/normal and overweight/obese). However, the overweight/obese group did have a negative nonsignificant association, supporting the literature that overweight/obese youth are potentially influenced more by parent PA support than their normal weight counterparts (Beets et al., 2010). With so few studies examining the relationship between parent PA support and adolescent weight status (Yao & Rhodes, 2015), the findings of this study did not reconcile the current inconsistencies. They do indicate a need for continued inclusion of weight status in analyses of parent factors associated with PA engagement, especially in studies with more diverse populations.

Study Aim 2: Examine adolescent-level psychosocial constructs in the association between parent factors and adolescent MVPA engagement and weight status.

It was hypothesized that adding adolescent psychosocial constructs along the pathways would positively influence the associations between parent PA support and parent PA modeling with adolescent MVPA engagement and adolescent weight status (hypotheses 2a and 2b). Adolescent perception of parent PA support was not directly nor indirectly associated with either dependent variable as hypothesized. However, providing evidence for the hypothesis, adolescent PA self-efficacy was the only psychosocial construct that was a statistically significant mediator and was associated with the dependent variables.

Parent PA modeling was inversely associated with adolescent weight status and associated with adolescent MVPA engagement as mediated through adolescent PA self-efficacy in the indirect pathway. In addition, based on direct pathways, adolescent PA self-efficacy was significantly associated with higher adolescent MVPA engagement and lower adolescent weight status. These findings are supported by SCT, which theorizes modeling influences self-efficacy, which impacts behaviors and ultimately health outcomes (Bandura, 1986, 1989). Previous studies also found adolescents with elevated PA self-efficacy are more likely to engage in higher levels of MVPA (Mendonça et al., 2014; Rutkowski & Connelly, 2012). However, there is limited literature on the relationship between parent PA modeling and adolescent weight status as most studies only examine PA behaviors (Craig et al., 2013; Yao & Rhodes, 2015). Findings from this study suggest, in a highly active, normal weight adolescent population, parent PA modeling is positively associated with adolescent PA self-efficacy, which is associated with high MVPA engagement and lower BMI among adolescents. Findings from this study also inform us that adolescent PA self-efficacy is an important psychosocial construct to target in future interventions to increase adolescent PA-related behaviors and lower weight status. Additionally, future studies should examine the association of this pathway within more diverse adolescent population to confirm that adolescent PA self-efficacy is effective in all types of adolescent populations.

Additional Findings

Within this dataset, parent PA support and PA modeling are two distinct constructs. The operational definitions for this study were derived from previous studies of parent PA support and parent PA modeling (Gustafson & Rhodes, 2006; Loprinzi et al., 2013; Peterson et al., 2013; Yao & Rhodes, 2015; Zecevic et al., 2010), which suggest the individuality of the constructs. A suggestion that was confirmed using confirmatory factory analysis. Results of this analysis revealed none of the items from the parent PA support scale loaded onto the parent PA modeling latent variable. Future researchers should work to develop and validate scales that measure these constructs separately. Once validated scales are developed, especially within an adolescent population, research can begin to better understand how to intervene on parent PA support and parent PA modeling.

Parent PA support and parent PA modeling were both positively associated with adolescent perception of parent PA support. Previous studies indicate more active youth perceive their families as more supportive (Beets et al., 2010; Davison, 2004). Since the adolescents in this study reported above averaged time spent in MVPA, it is not surprising the results from this study reflect previous findings within the literature for parent PA support and adolescent perception of parent PA support. However, there is no literature examining the associations between parent PA modeling and adolescent perception of parent PA support. Given the relatively new distinction between parent PA support and parent PA modeling, the association between parent PA modeling and adolescent perception of parent PA support was expected. However, future work should be done to develop and validate a scale specifically to measure adolescent perception of parent PA modeling.

Post-hoc analyses

The main findings from the post-hoc analyses by weight status have already been discussed above. Other post-hoc analyses were also examined due to differences in measurement of PA and differences in behaviors/outcomes by gender noted in the literature.

There were no differences in the statistically significant pathways when daily minutes of weekday MVPA (5 days) versus daily minutes of MVPA per week (7 days) were used to operationalize adolescent PA engagement. This was examined as most studies of adolescent MVPA use self-report measures or accelerometers to collect MVPA over 7 days (Dumith, Gigante, Domingues, & Kohl III, 2011; Knowles, Niven, Fawkner, & Henretty, 2009; Nader et al., 2008). The FLASHE study used the Youth Activity Profile, which assesses MVPA using daily minutes in school (weekdays), daily minutes out of school (weekdays), and daily minutes on the weekend (D'Angelo et al., 2017; Saint-Maurice & Welk, 2015). In previous analyses of adolescent PA data in FLASHE, MVPA data over 5 days was used (summing minutes in school and out of school) versus all three categories of data (7 days of MVPA data) (Saint-Maurice et al., 2017). As noted above, adolescents in this dataset engaged in more than the recommended daily minutes of MVPA and this did not vary much across weekdays, weekends, or when these were combined into 7-day totals (Table 1). Therefore, using 7 days to calculate daily minutes of MVPA is a better practice than using 5 days of data for most other studies.

When the dataset was stratified by gender, a significant association between parent PA modeling and adolescent perception of parent PA support existed for males, but not for females. Literature indicates there are differences in PA modeling and perception of PA support by gender with the effects being greater for male youth (Beets et al., 2010; Gustafson & Rhodes, 2006; Jago, Fox, Page, Brockman, & Thompson, 2010). Given these differences by gender, future studies focused on the effects of parent PA modeling may need evaluate different components to better understand how parents can model PA in an impactful way for female adolescents.

Limitations of this study

This study includes limitations attributable to both the FLASHE dataset and the study's analytic approach. One of the major limitations of the FLASHE dataset is its cross-sectional design. As noted above, with this design, causality between the variables cannot be determined. Assessing these factors and associations in a longitudinal study would allow researchers to make causal inferences about the pathways and better understand the bidirectional pathways that exist and their effect on associations.

Survey measures were another limitation of the FLASHE dataset. Several survey measures either lacked validation, required more rigorous validation, were not the complete measure, or were pulled from multiple measures to create a new scale. For example, adolescent PA self-efficacy was measured using only 1-item from the general Perceived Competence Scale (Deci & Ryan, 1985; Ryan & Deci, 2000; Silva et al., 2010). While the 1-item measure was significantly associated with multiple variables in this study, a more comprehensive measure would have been more appropriate. For example, Motl and colleagues (2000) developed a measure of PA self-efficacy that not only examines self-efficacy but includes an 8-item validated measure of barriers to PA and seeking support (Robert W Motl et al., 2000). This measure of adolescent PA self-efficacy would provide better insight into why an adolescent may have had a low or high PA self-efficacy.

The parent PA support variable was created by FLASHE researchers and incorporated items from multiple measures. Therefore, there is no way to compare scores from FLASHE with other parent-adolescent populations. While not a valid scale, the FLASHE measure was associated with high perceptions of parent PA support among adolescents. In future studies, the 5-item parent PA support scale should be used (Prochaska et al., 2002). This measure incorporates all aspects of parent PA social support and demonstrated high test-retest reliability (ICC=.88) and good internal consistency with a Cronbach alpha of .77 within a population of parents of adolescents (Prochaska et al., 2002).

Of the 5,027 eligible adults invited to participate in FLASHE, there was a response rate of 38.7% (1945 dyads fully enrolled in the study) and survey completion rate of 29.4% (1479 dyads provided complete data) (National Cancer Institute, 2015; Oh et al., 2017). This rate was lower than other panel surveys, which have yielded survey completion rates between 45% and 70% (Baker, Wagner, Singer, & Bundorf, 2003; Caskey, Lindau, & Alexander, 2009; Oh et al., 2017). While web-based study designs are cost efficient, this type of methodology typically has lower recruitment and lower data collection rates compared to other survey modes such as face-to-face and telephone surveys (Manfreda, Berzelak, Vehovar, Bosnjak, & Haas, 2008; Oh et al., 2017). With face-to-face and telephone methods, participants are interacting with another person and may find it harder to decline participation or not answer survey items compared to the impersonal nature of web-based studies (Manfreda et al., 2008; Vehovar, Manfreda, & Batagelj, 2001).

Web-based study designs also may not include individuals without internet access as well as individuals who do not sign up for panel surveys (Fleming & Bowden, 2009; Hunter, 2012). These individuals without internet access and individuals who do not sign up for panel surveys are more likely to be minorities, of lower socioeconomic status and of higher age (Antoun, 2015; Fleming & Bowden, 2009). Using a web-based study design for the FLASHE study may have led to a study population not representative of the U.S. population, despite researchers' efforts. A previous study using FLASHE data also found the study population had a high SES (Oh et al., 2017), which is typical of web-based surveys (Messer & Dillman, 2011).

While BMI is traditionally used as a measure of weight status in youth and adults (Dietz, Story, & Leviton, 2009), it may not be the best indicator of how and whether weight affects health outcomes (Freedman, 2009). A limitation of BMI is its inability to distinguish between body fat, muscle mass, and skeletal mass with previous research indicat ing the accuracy of BMI varies depending on the degree of body fatness (Freedman, 2009; Prentice & Jebb, 2001). Skinfold thickness and waist circumference are two additional ways to measure and perhaps better identify youth who have excess body fat or abdominal fat, respectively (Himes, 2009; Laurson, Eisenmann, & Welk, 2011; McCarthy, 2006). Body fatness and its location, specifically in the abdominal area, is important to consider given the link between these factors and negative health outcomes such as cardiovascular disease, elevated blood pressure, and high cholesterol in youth (Laurson et al., 2011; Williams et al., 1992). Furthermore, in an adolescent population, the onset of puberty may increase BMI values as well as associations between BMI and health outcomes (Ahmed, Ong, & Dunger, 2009). Although the majority of the adolescents in this study were classified as having a normal weight status, there is no data on body fat amount or distribution, making it difficult to determine whether participants classified as normal weight were truly less likely to have negative health outcomes related to weight status.

An additional limitation of this study is the operationalization of parent PA modeling. For this study, parent PA modeling was a latent variable created by the study team using parent's engagement in daily MVPA and items from the Treatment Self-Regulation Questionnaire (TSRQ). While the items fit the literature's definition for parent PA modeling, the variable was not derived from a scale specifically designed to assess PA modeling. Additionally, parent MVPA was not limited to PA performed in the presence of the adolescent, and one-item from the TSRQ ("Others would be upset with me if I didn't [engage in PA]") had to be removed during the confirmatory factor analysis. The PA modeling subscale of the Activity Support Scale (ACTS) would have been a better measure to assess parent PA modeling (Davison et al., 2011) as it includes questions directly related to modeling in the presence of adolescents (e.g., being active with youth, parents using their own behavior to show youth how to be active) (Davison, Cutting, & Birch, 2003; Davison et al., 2011).

This study did not include variables to represent or to control for diet. At its core, obesity is due to an imbalance between calorie dense diet and low PA (Karnik & Kanekar, 2012). Diet is an important behavior that may provide insight into the associations and pathways examined, especially those related to weight status. Given the interplay between diet and PA in childhood obesity, both diet and PA should be considered in assessing how parental factors that influence adolescent PA behaviors and weight status. However, although diet was not included in this study, the findings are still valid since the behaviors and the psychosocial constructs related to the associations are somewhat PA-related behavior specific. Therefore, while weight status may be impacted by these associations with parent factors, psychosocial factors, and MVPA, they are less likely to be impacted by diet.

Strengths of this study

To my knowledge, this is the first study to examine associations between both parent PA support and parent PA modeling with adolescent MVPA engagement and adolescent weight. Given the limited literature with adolescent weight status as a dependent variable, this study suggests that parental factors not only affect adolescent health behaviors but also affect adolescent health outcomes.

Despite these limitations, this study has some notable strengths based on both the FLASHE dataset and the analytic approach. The sampling methodology and sample size of the FLASHE dataset is a strength. The National Cancer Institute was intentional in recruiting a representative sample of parent-adolescent dyads in the U.S. With a total of 1,644 parent-adolescent dyads in the study, the sample size was large compared to other studies examining parental influence on adolescent PA (94 and 349 dyads) (Rutkowski & Connelly, 2012) (Hearst et al., 2012). Using parent-adolescent dyad data allows researchers to examine more directly the behaviors of parents and adolescents as well as how each influences the behaviors of the other (Newsom, 2002).

The use of SEM in conducting the analysis is an additional strength. SEM allowed for multiple levels and facets of childhood obesity to be examined, which has been recommended by previous studies (Hendrie, Coveney, & Cox, 2012). Use of SEM allowed for the inclusion of pathways mediated by adolescent psychosocial variables. SEM takes into account the multifaceted problem of obesity and offers a way to improve the predictive ability of a model to enhance our understanding of the complexity of obesity (Hendrie et al., 2012).

Recommendations

Future studies of parental influences on adolescent PA-related behaviors and weight status can use the findings from this study to design stronger studies to investigate and intervene on important variables and associations. As noted above, examining these associations in longitudinal studies would confirm the causal inference and temporal sequencing of the pathways. Additionally, it would be important to design studies with target components based on gender and weight status to have the greater impact.

An important next step is the development of a validated scale for measuring parent PA modeling. As noted above, the variable used in this study was created using available study survey items. In the future, a validated measure that reliability assesses parents' interest in engaging in PA and efforts to be actively involved in PA, preferably with the adolescent present, would potentially lead to a better understanding of the relationship between parent PA modeling and adolescent MVPA engagement as well as weight status.

Examining the associations in this analysis with a more diverse study sample would lead to better generalizability of the findings. Results only provide insight into a highly active and normal weight adolescent population from primarily White, high SES families. Studies have found using social network sites, such as Facebook and Twitter, may provide an opportunity to recruit more adolescents who are racially/ethnically diverse, SES diverse, and generally more representative of U.S. adolescents (Lenhart, 2012; Park & Calamaro, 2013). Specifically, a recent systematic review found the digital divide is shrinking as youth from all racial/ethnic and SES backgrounds have equal access to the internet through the use of smartphones (Lenhart, 2012; Park & Calamaro, 2013), suggesting that targeting adolescents through mobile devices, instead of parents, for recruitment could lead to a more diverse population. The inclusion of these types of recruitment for adolescents in the future may contribute to a more diverse population than recruited in the FLASHE study. Using a study population that is more closely representative of the general population could lead to more statistically significant pathways than what was found in this current study, especially those pathways that generally have consistent associations (i.e. parent PA support → adolescent weight status; parent PA support → adolescent

MVPA engagement). Ultimately, a more diverse population would allow for pathways to be stratified by other factors like race and SES to provide additional information for tailoring interventions based on the need of specific populations.

Given findings that suggest parent PA modeling affects adolescent MVPA engagement and weight status through adolescent PA self-efficacy, it is necessary to include intervention components that ensure parents are modeling positive PA behaviors in order to increase adolescent's PA self-efficacy. Lots of interventions have used school and community settings to change youth PA-related behaviors but given the setting, only youth have been targeted with no inclusion of the parents (Wang et al., 2013).

Using SCT derived intervention strategies as well as frameworks like the Family-centered Action Model of Intervention Layout and Implementation (FAMILI) (Davison et al., 2012), which focuses on interventions being family-centered and culturally sensitive, are important to make sure parent factors and psychosocial constructs that affect change in adolescent PA behaviors and health outcomes are targeted. Family-based interventions are necessary to see changes in health outcomes as we know they impact PA behaviors for adolescents (Yao & Rhodes, 2015). This approach ensures the issue of adolescent obesity is addressed at the individual level (self-efficacy) and the social level (parent factors).

Conclusion

This dissertation addressed important research questions related to the effect of parent PA support and PA modeling on adolescent MVPA engagement and weight status. Although not all of the hypotheses were fully supported, the findings still provide information about how parental factors influence adolescents that can be put into practice in measurement development and family-based interventions.

In this study population, parent PA modeling was more associated with adolescent MVPA engagement and weight status than parent PA support. Although parent PA support was not appropriately associated with the dependent variables, this does not negate the previous and consistent literature that supports how parent PA support influences adolescent PA-related behaviors and weight. Additionally, the findings from this study show the impact of adolescent PA self-efficacy on adolescent MVPA engagement and weight status and the continued need to incorporate meaningful psychosocial constructs in our examinations of childhood obesity.

Overall the findings from this study can be used in multiple ways to not only assess the influence parental factors have on adolescent MVPA engagement and weight status in future studies, but to guide the type of components used in behavioral interventions. In particular, these results highlight the need to examine both adolescent health behaviors and health outcomes as dependent variables. The association of parental factors with adolescent psychosocial constructs, behaviors, and health outcomes highlights the importance of using family-based interventions to positively impact adolescent MVPA engagement and weight status. By incorporating findings from this study, future researchers can develop and implement behavioral interventions that result in overall positive health outcomes for adolescents and their families.

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Institutional Review Board APPROVAL

PRO-FY2018-427 - Admin Withdrawal: Not Human Subject Research

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February 23, 2018

PI Name: Cardella Leak
Co-Investigators:
Advisor and/or Co-PI: Brook Harmon
Submission Type: Admin Withdrawal
Title: Impact of Parent PA Support and Modeling on Child Weight and PA
IRB ID: PRO-FY2018-427

From the information provided on your determination review request for "Impact of Parent PA Support and Modeling on Child Weight and PA", the IRB has determined that your activity does not meet the Office of Human Subjects Research Protections definition of human subjects research and 45 CFR part 46 does not apply.

This study does not require IRB approval nor review. Your determination will be administratively withdrawn from Cayuse IRB and you will receive an email similar to this correspondence from irb@memphis.edu. This submission will be archived in Cayuse IRB.