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Rita Nahta, PhD

Determinants of daughters' participation in mother-daughter physical activity interventions: a systematic review

By

Rita Nahta, PhD

Degree to be awarded: MPH

Executive MPH

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By

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An abstract of a thesis submitted to the Faculty of the Rollins School of Public Health of Emory University in partial fulfillment of the requirements for the degree of Master of Public Health in Prevention Science

2023

Abstract

Determinants of daughters' participation in mother-daughter physical activity interventions: a systematic review

By: Rita Nahta, PhD

Introduction: Physical activity promotes long-term health and prevents chronic diseases. Current guidelines recommend that children and adolescents ages 6 to 17 years participate in at least one hour of moderate to vigorous physical activity each day. However, less than 25% of children and adolescents meet this guideline. The proportion of girls who participate in daily physical activity is lower than the proportion of boys. Multilevel determinants are likely to influence whether girls participate in physical activity. Because mothers are a potential source of interpersonal influence on their daughters' behaviors, studies have examined the effects of mother-daughter physical activity interventions on girls' physical activity levels. Applying the socioecological model to evaluate mother-daughter physical activity interventions can help identify the multilevel determinants influencing whether girls meet physical activity guidelines.

Objective: The objective of this systematic review is to identify the determinants of daughters' participation in interpersonal mother-daughter physical activity interventions.

Methods: A systematic review following Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines was performed. Data abstraction was performed in Excel to characterize studies and interventions and to analyze daughters' pre- and post-intervention physical activity. Deductive, in vivo coding was performed in MAXQDA to identify the social cognitive theory concepts and socioecological model levels addressed by each intervention. In vivo coding followed by inductive thematic grouping of codes was performed in

MAXQDA using the creative coding function to identify barriers and facilitators of daughters' participation in mother-daughter physical activity interventions.

Results: Eight studies met eligibility criteria. Study, intervention, and population demographic characteristics, as well as the measure of daughters' physical activity varied across studies. Four studies performed statistical analysis of daughters' pre- and post-intervention physical activity change. Three of the four studies showed statistically significant improvement in daughters' post-intervention physical activity. Interventions varied in the use of social cognitive theory concepts and in the levels of the socioecological model that were targeted. Among those that showed significant improvement, two used all six social cognitive theory concepts, and one primarily used observational learning and behavioral capability. All three targeted the individual and interpersonal levels of the socioecological model, and two targeted the institutional level. Among all eight studies, the most common barriers to daughters' participation were competing obligations, physical limitations due to health, weather, or transport, and the time commitment required for intervention activities. A lack of interest and cultural factors were also identified as barriers. Facilitators of daughters' participation in mother-daughter interventions were being with their mother and gaining a sense of community and social support.

Conclusions: Identifying multilevel determinants of physical activity participation among girls is critical for improving physical activity behaviors and promoting long-term health benefits. Future mother-daughter physical activity interventions should apply standardized methods to assess physical activity, allowing for systematic meta-analysis and comparison of effects. Future interventions should also consider the social ecology in which mothers and daughters live. Targeting the multilevel determinants influencing daughters' participation in mother-daughter interventions can help increase the proportion of girls who participate in daily physical activity.

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Acknowledgments

I would like to express my deep appreciation to my thesis committee – Chair, Dr. Felipe Lobelo, Field Advisor, Dr. Eric Nehl, and Advisor, Dr. Juan Leon – for sharing their time and expertise. Your mentorship, guidance, and support, and the commitment you have for teaching and public health exemplify the power of role models and learning by example.

I would like to thank Hannah Rogers at Woodruff Health Sciences Center Libraries for our consultation on developing a search strategy for this systematic review. Thank you for de-mystifying this process and teaching me how to develop a systematic search strategy.

I am fortunate to be a member of the EMPH community and offer my deep gratitude to my Prevention Science cohort, colleagues, faculty, mentors, and staff. I learn so much from each of you, whether in person at on-campus weekends, virtually, or on the Canvas discussion boards. Thank you for sharing your experiences, perspectives, and knowledge and for modeling humility, empathy, and persistence. Your commitment to public health inspires me each day.

My deepest gratitude and love go to my family for their unconditional love and support. Thank you for your unwavering patience, humor, and encouragement as I move through my thesis and EMPH experiences. I recognize that being surrounded by kindness, openness, peace, and deep connection, in an environment where I have always felt safe to be myself, is a gift. I love you and thank you so very much.

Table of Contents

Chapter 1. Introduction

Introduction and rationale

Engaging in moderate to vigorous physical activity (MVPA) promotes long-term health and prevents chronic diseases (CDC, 2022a; Sothern et al., 1999). Current U.S. and global guidelines recommend that children and adolescents ages 6 to 17 years engage in at least 60 minutes of MVPA each day (U.S. Department of Health and Human Services [USDHHS], 2018; World Health Organization [WHO], 2020). Guidelines further state that most activities for children and adolescents 6 to 17 years of age should be aerobic, with vigorous, muscle-strengthening, and bone-strengthening activities included on at least three days of the week (USDHHS, 2018). Long-term benefits of MVPA include cardiovascular fitness, reduced risks of obesity, diabetes, and some forms of cancer, and improved mental health and academic performance in children and adolescents (CDC, 2022a; Coe et al., 2006; Erickson et al., 2018; Sothern et al., 1999; WHO, 2020; WHO, 2022; YTS, 2021).

Problem statement

The proportion of adolescents who meet physical activity guidelines has declined over the past 10 years, prompting a national Healthy People 2030 goal to "increase the proportion of adolescents who do enough aerobic and muscle-strengthening activity" (Merlo et al., 2020; Nader et al., 2008; Office of Disease Prevention and Health Promotion [ODPHP], 2020; USDHHS, n.d.). This Healthy People 2030 goal is currently rated as "getting worse." The proportion of US high school girls in grades 9-12 who meet physical activity guidelines is lower than the proportion of boys (8.8% vs 22.9%; **Table 1**) (Michael et al., 2023; Play, n. d.; Vella et al., 2014). The proportion of US high school boys and girls in grades 9-12 who are physically

active for at least an hour each day on all seven days has declined from 2011 to 2021, with a lower proportion of girls meeting this guideline each year (**Table 2**). The proportion of US high school boys and girls in grades 9-12 who engage in muscle strengthening activities at least three days a week has also declined from 2011 to 2021, with a lower proportion of girls meeting this guideline each year (**Table 3**). The same downward trend in meeting the guideline of at least an hour of physical activity each day, seven days a week, was found among middle school children in grades 6-8 from 2011 to 2019 (**Table 4**). Similar to high school students, the proportion of middle school girls meeting the guideline each year is lower than the proportion of boys. Physical activity habits during early childhood are predictive of future physical activity habits during adolescence (Hearst et al., 2012). Thus, efforts to improve girls' participation should begin early and continue along the life course. The primary **problem** studied in this thesis is that **most girls in childhood and adolescence do not meet physical activity guidelines**.

Social ecological model (SEM)

Multilevel determinants are likely to influence whether girls meet physical activity guidelines, including socioeconomic disparities and interpersonal parental support (National Survey of Children's Health, n. d.; Tandon et al., 2021; Antoine, 2020; Berthold, 2012). Thus, understanding the context in which girls live and grow must be considered when promoting behavioral change. The SEM, or social ecology perspective, adopts a multilevel approach to understanding behavioral determinants. A five-level SEM commonly applied in health promotion research and practice includes the individual/intrapersonal, interpersonal, institutional/organizational, community, and policy levels (Rimer & Glanz, 2005). An SEM used by CDC condenses these levels into four primary levels – individual, relationship, community,

and societal (CDC, 2015; CDC, 2022c). The individual level encompasses the characteristics of an individual that influence health, such as biological, genetic, and pathophysiological processes, as well as beliefs, attitudes, and knowledge. Interpersonal or relationship influences include social networks and support systems, as well as other environmental influences. Institutional, community, and policy factors are sometimes referred to collectively as the community level (Rimer & Glanz, 2005). Institutional factors are those that operate within a specific organization, such as a school, to impede or facilitate health behaviors. Community factors may include the built environment or social norms in a local context. The policy level includes regulations that influence an individual's ability to access resources and opportunities.

Applying the SEM to evaluate interventions might help identify the multilevel determinants influencing whether girls meet physical activity guidelines. Accurate identification of determinants requires understanding the perspectives of the target audience. Community-based participatory research (CBPR) and culturally responsive evaluation (CRE) have been used to include community members as equal partners in intervention research (Israel et al., 2005; CDC, n. d. a, Hood et al., 2015). Benefits of CBPR and CRE include empowering the target audience toward the desired behavioral change and elevating voices that might typically be excluded, such as children. Parent-child interventions have previously integrated CBPR and CRE principles as part of a multilevel SEM approach by partnering with schools and faith-based organizations, co-developing communications materials with children, parents, and community members, and including parents on program advisory boards (Israel et al., 2005).

Social cognitive theory (SCT)

Social cognitive theory posits that human behavior is influenced by interpersonal interactions with the surrounding environment (Glanz & Bishop, 2010). SCT can be applied to target the interpersonal level of the SEM and consists of six primary concepts for promoting behavioral change (Rimer & Glanz, 2005).

(1) Reciprocal determinism refers to interactions that occur between the individual (internal experiences, knowledge, beliefs, and attitudes), the environment (external societal context), and the behavior (responses to interventions, stimuli, and effects on the desired behavior goal).
(2) Behavioral capability refers to the knowledge and skills required to carry out the target behavior.
(3) Expectations refer to the results that an individual believes will happen if they engage in the target behavior.
(4) Self-efficacy is the feeling that one can successfully achieve the target behavior.
(5) Observational learning refers to learning by watching others, often referred to as role modeling.
(6) Reinforcements are positive or negative responses to the target behavior that increase or decrease, respectively, the likelihood that the behavior will be repeated.

Purpose statement

The **purpose** of this systematic review is to identify the determinants of girls' participation in interpersonal mother-daughter physical activity interventions.

Research questions

Do mother-daughter physical activity interventions increase physical activity of girls ages 5 to 17 years?

What are the determinants of whether girls ages 5 to 17 years participate in mother-daughter physical activity interventions?

Significance

Meeting physical activity guidelines reduces the risk of multiple chronic diseases. However, most girls do not meet physical activity guidelines during childhood or adolescence. Mothers are a potential source of interpersonal influence on girls' behaviors; thus, studies have examined mother-daughter physical activity interventions. A systematic review of these studies is needed to understand if interpersonal mother-daughter interventions improve girls' participation in physical activity and to identify the determinants of girls' participation in these interventions. This knowledge can be used to develop more effective, context-specific physical activity interventions to increase the proportion of girls who meet physical activity guidelines.

Table 1. High school students meeting physical activity guidelines, 2021 YRBS

	Female, %	**Male, %**
Physically active ≥60 min/day, 7 days/wk	15.7	31.7
Muscle strengthening, ≥3 days/wk	32.3	56.6
Met both aerobic and muscle-strengthening physical activity guidelines	8.8	22.9

*Adapted from Michael et al. (2023); Abbreviations: min, minutes; wk, week, YRBS, Youth Risk Behavior Surveillance

Table 2. Trend in proportion of high school students physically active ≥60 min/day, 7 days/wk

	2011	2013	2015	2017	2019	2021
Total						
%	28.7	27.1	27.1	26.1	23.2	23.9
(95% CI)	(27.1-30.3)	(25.5–28.8)	(25.4–28.8)	(24.1–28.3)	(21.9–24.6)	(22.8-25.0)
Female						
%	18.5	17.7	17.7	17.5	15.4	15.7
(95% CI)	(16.8–20.3)	(16.1–19.5)	(16.2–19.2)	(15.5–19.6)	(14.2–16.6)	(14.1-17.4)
Male						
%	38.3	36.6	36.0	35.3	30.9	31.7
(95% CI)	(36.3–40.4)	(34.5–38.6)	(33.6–38.5)	(33.4–37.3)	(28.9–33.1)	(30.2-33.2)

Data were retrieved from CDC High School Youth Risk Behavior Surveillance Youth Online database (CDC, n. d. b); Abbreviations: CI, confidence interval; min, minutes; wk, week

Table 3. Trend in proportion of high school students engaging in muscle strengthening ≥3 days/wk

	2011	**2013**	**2015**	**2017**	**2019**	**2021**
Total						
%	55.6	51.7	53.4	51.1	49.5	44.9
(95% CI)	(53.6–57.5)	(49.5–53.9)	(51.1–55.6)	(47.5–54.7)	(47.6–51.3)	(42.5-47.2)
Female						
%	43.8	41.6	42.7	40.8	39.7	32.3
(95% CI)	(41.3–46.3)	(39.0–44.3)	(39.5–46.0)	(36.3–45.4)	(37.2–42.4)	(29.7-35.1)
Male						
%	66.7	61.8	63.7	62.1	59.0	56.6
(95% CI)	(64.8–68.5)	(59.5–64.1)	(61.2–66.1)	(59.2–64.8)	(56.8–61.0)	(54.4-58.8)

Data were retrieved from CDC High School Youth Risk Behavior Surveillance Youth Online database (CDC, n. d. b); Abbreviations: CI, confidence interval; min, minutes; wk, week

Table 4. Trend in proportion of middle school students physically active ≥60 min/day, 7 days/wk

	2011	**2013**	**2015**	**2017**	**2019**
Female, %	25.4	25.3	24.7	24.6	23.2
Male, %	39.3	39.4	38.6	38.0	34.0

Data were retrieved from CDC Middle School Youth Risk Behavior Surveillance Youth Online database (CDC, n. d. c); Abbreviations: min, minutes; wk, week

Chapter 2. Review of the Literature

Chronic disease burden in the US

Chronic diseases are generally defined as those that negatively impact quality of life or require clinical guidance and last one year or longer (CDC, 2022d). Approximately 60% of adults have at least one chronic disease, and 40% have ≥2 chronic diseases. Chronic diseases are the primary cause of death and disability among US adults (CDC, 2020). Chronic cardiovascular conditions include heart disease and stroke, which kill more than 800,000 people in the US each year (CDC, 2022e). Diabetic conditions increase the likelihood of serious cardiovascular problems, among other complications, and affect almost 40 million people in the US (CDC, 2022e). Prediabetes increases the risk of developing type 2 diabetes and affects another 96 million adults (CDC, 2022e). Cancer is another group of chronic conditions, with almost two million new diagnoses and more than 600,000 deaths estimated for 2023 in the US (Siegel et al., 2023). Approximately 90% of US healthcare expenditures are attributed to chronic diseases, including mental health conditions (CDC, 2022e).

A common chronic condition that increases the risk of other chronic conditions, including heart disease, type 2 diabetes, and some types of cancer, is obesity (Hales et al., 2020; NIH, 2018). Obesity is generally defined by a body mass index (BMI) of ≥30 kg/m^2, whereas being overweight is defined by a BMI of ≥25 kg/m^2 but less than 30 kg/m^2. Approximately 40% of children and adolescents ages 5 to 17 years were considered overweight or obese before the COVID-19 pandemic in 2019, with a steady increasing trend observed since 1999 (CDC, 2022e; Hales et al., 2020; Woolford, et al., 2021). During the COVID-19 pandemic, the percentage of obese or overweight children and adolescents ages 5 to 17 years increased (Woolford, et al., 2021). The percentage of children aged 5-11 years who were considered obese or overweight

increased from 36% to 46%; those ages 12-15 years increased from 39% to 43%; and those ages 16-17 years increased from 36% to 38% (Woolford, et al., 2021).

Lifestyle risk factors

Risk factors for developing chronic diseases include potentially modifiable behaviors related to lifestyle choices. Modifiable risk factors refer to those factors that one can control, as opposed to non-modifiable factors, such as age and genetics. Modifiable risk factors for chronic diseases include tobacco and alcohol consumption, poor sleep hygiene, unhealthy eating, physical inactivity, and being obese or overweight (CDC, 2020; CDC, 2022f; CDC, 2022g; CDC, 2022h; Omura et al., 2022). Although these factors are potentially modifiable, social and systemic barriers can impact the ability to access resources or opportunities for healthier choices. In addition, adverse childhood and adolescent experiences increase the risk of engaging in unhealthy lifestyle behaviors later in life (CDC, 2023). Thus, applying a multilevel SEM is essential for identifying the social and systemic determinants of behaviors.

Physical activity during childhood and adolescence

Although physical activity has been defined as any movement that burns calories, the "dose" of physical activity recommended for long-term health benefits in children and adolescents is defined by specific guidelines and metrics (Caspersen et al., 1985; USDHHS, 2018; WHO, 2020). Physical activity intensity is defined by units called metabolic equivalents (METs), where one reference MET represents the energy expended by sitting quietly (Ainsworth et al., 1993). Physical activities with moderate intensity expend three to six METs, and vigorous activities expend more than six METs (CDC, 1999). Thus, MVPA is defined as those activities

that expend three or more METs. Guidelines for children and adolescents 6 to 17 years of age recommend 60 minutes of MVPA daily, with at least three days of vigorous intensity activity, and most of the 60 minutes spent on aerobic activities, such as running, swimming, jumping rope, and dancing (USDHHS, 2018). Muscle-strengthening and bone-strengthening activities should be included on at least three days of the week as part of that 60 minutes.

Establishing healthy physical activity behaviors early in childhood was supported by a longitudinal study of children ages 3 to 8 years showing that those who engaged in regular MVPA at age 3 were more likely to engage in MVPA at age 8 compared with those who had low MVPA and higher sedentary behavior at age 3 (Martin et al., 2022). Further, children (average age, 7 years) who met MVPA guidelines were twice as likely to meet MVPA guidelines five years later as adolescents (average age, 12 years) compared with those who did not meet guidelines (Breau et al., 2023). The significant odds of sustaining MVPA behaviors during adolescence were present for both girls (OR=1.8, 95% CI, 1.0-3.2) and boys (OR=2.5, 95% CI, 1.5-4.1) who met MVPA guidelines during childhood.

Physical activity has been called a “wonder drug” and “miracle cure” due to its potential to prevent multiple chronic conditions and promote long-term health benefits (McNally, 2020; Macmillan Cancer Support, n. d.). Conversely, physical inactivity or sedentary behavior increases the risk of becoming overweight or obese during childhood (CDC, 2022a; CDC, 2022i; Hills et al., 2011). For example, children and adolescents followed longitudinally in eight European countries who met MVPA guidelines at baseline and at follow up had 50% lower odds of becoming overweight or obese at two years follow up and 60% lower odds at six years follow up compared with those who did not meet guidelines at baseline and follow up (Sprengeler et al., 2021). Further, in a study of children aged 8-10 years whose parents had a history of obesity,

children who engaged in MVPA showed improved insulin sensitivity at two years and seven years follow up, whereas those with higher sedentary behaviors showed lower insulin sensitivity compared with baseline (Harnois-Leblanc et al., 2023). MVPA is associated with better overall quality of life, in addition to physical health outcomes, among adolescents (Khan et al., 2021). Among more than 3,000 adolescents, 12-13 years old, in Australia, those who met both MVPA and screen time guidelines had higher quality of life and physical health. However, only 3% of adolescents met those guidelines, emphasizing the need to increase MVPA in children and adolescents.

Physical activity participation in girls

Multiple studies demonstrate declining MVPA behaviors in children as they enter adolescence, with greater declines observed among girls. Data from the cross-sectional National Health and Nutritional Examination Survey (NHANES) showed 42% of children 6 to 11 years meeting the MVPA guideline compared with 8% of adolescents 12 to 19 years (Troiano et al., 2008). Sex disparities were observed in children, with 35% of girls meeting the MVPA guideline compared with 48% of boys, and became worse during adolescence, with 3% of girls aged 12 to 15 years meeting the MVPA guideline compared with 12% of boys. A systematic review and meta-analysis of 52 longitudinal studies representing more than 22,000 children and adolescents ages 3 to 18 years showed declining MVPA participation in both boys and girls, with a greater decline among girls (Farooq et al., 2020). Both girls and boys showed the greatest declines at ages 9 and 13. Another longitudinal study showed declining MVPA in boys and girls aged 5 to 10 years during three years of follow up (Pereira et al., 2022). However, mean MVPA time for boys continued to meet guidelines, whereas girls spent less time in MVPA compared with boys

at three years follow up. Longitudinal analysis of approximately 800 children ages 8 to 12 years for five years in Australia similarly showed that girls spent less time in MVPA compared with boys (Telford et al., 2013). Among sixth graders, only 14% of girls met MVPA guidelines of ≥60 minutes/day compared with 30% of boys. Longitudinal analysis of more than 7,000 children ages 7 to 12 showed that fewer girls met MVPA guidelines at baseline (25% vs 47%) and five years follow up (17% vs 30%) compared with boys (Breau et al., 2022). Low MVPA among girls compared with boys has been observed across racial and ethnic groups (Belcher et al., 2010). However, girls in a higher poverty category were significantly less likely to meet MVPA guidelines. Promoting MVPA behaviors among girls will require a multilevel approach that considers the individual, interpersonal, and multilevel influences in the built environment, including home, school, and community contexts (Gustafson & Rhodes, 2012; McNally, 2020).

Social determinants of health

Behavioral change strategies require understanding girls' underlying social determinants of health. Social determinants of health are non-medical factors related to an individual's lived experiences that impact their quality of life and health outcomes. These factors are generally categorized as "economic stability, education access and quality, healthcare access and quality, neighborhood and built environment, and social and community context" (Healthy People 2030, n. d.). Examples of social determinants of adolescent physical activity behaviors are neighborhood characteristics, such as safe areas to play, family support, and access to activities (Kris-Etherton, P. M. et al., 2021). Clinical guidelines recommend assessing social determinants, including family and environmental context, when counseling children and adolescents about physical activity (Kris-Etherton, P. M. et al., 2021). Guidelines also recommend including family

members in goal-setting conversations and encouraging them to serve as role models for healthy physical activity behaviors.

Socioeconomic status is one social determinant that can heavily influence other social determinants, such as access to education, healthcare, place of residence, and surrounding community, which are often dependent on economic capital (Kelly-Irving & Vineis, 2019). Low socioeconomic status has been associated with worse health outcomes (Phelan et al., 2010; Kelly-Irving & Vineis, 2019). The life-course perspective highlights the dynamic circumstances of children as they age into adolescence and transition into new contexts (Elder, et al., 2003; van Sluijs et al., 2021). “Poor socioeconomic circumstances during childhood are particularly important in determining… higher risk…” (Kelly-Irving & Vineis, 2019). Jin & Jones-Smith (2015) explored the potential association of family socioeconomic status with the fitness level of children and adolescents based on the premise that low income would impose a barrier to accessing physical activity opportunities. Using free or reduced-cost access to the National School Lunch Program as a proxy of low family income, physical fitness was found to be significantly higher in children and adolescents from high-income versus low-income families among 1.6 million children in California when adjusting for race, sex, and age. Gustafson & Rhodes (2012) similarly showed that family socioeconomic status was generally associated with greater access to physical activity opportunities in a systematic review of 24 studies examining parental correlates of physical activity behaviors in children.

Other studies have shown conflicting associations between socioeconomic status and physical fitness of adolescents (Freitas et al., 2007; Sandercock et al., 2017). These studies suggested that larger physical stature of adolescents from higher income families could confound associations between socioeconomic status and physical fitness. Sandercock et al. (2017)

suggested that the socioeconomics of the school environment rather than family income might play a role in physical fitness, with private education offering more sports opportunities and the potential to achieve higher fitness levels. Thus, multi-level social determinants, including neighborhood, school, or community context and socioeconomic status, influence physical activity behaviors.

Parental influence on physical activity behaviors of children and adolescents

One key interpersonal influence on a child or adolescent is their parent (Su et al., 2022). Parental support, positive reinforcement, and co-participation have been associated with physical activity participation among children and adolescents in multiple studies (Gustafson & Rhodes, 2012; Loprinzi & Trost, 2011; Martin-Matillas et al., 2012; Moore et al., 1991; Robbins et al., 2018; Su et al., 2022; Tuominen et al., 2020). Young children aged 4 to 7 years were 2-3 times more likely to be active if their parents were active compared with children whose parents were inactive (Moore et al., 1991). Adolescents showed a similar positive association between their physical activity behaviors and those of their parents (Martin-Matillas et al., 2012).

Evidence supports a role for parents as motivators and models of healthy physical activity behaviors in children and adolescents. However, results from studies examining differences between maternal and paternal support are mixed. Moore et al. (1991) showed that children aged 4 to 7 years were twice as likely to be physically active if mothers were active and 3.5 times as likely to be active if fathers were active. Martin-Matillas et al. (2012) similarly showed a potentially higher benefit from paternal involvement. Adolescents who were encouraged to engage in physical activity by their fathers were more likely to engage in a range of activities, including those related to cardiovascular, muscular, and speed. Although adolescents' physical

activity behaviors were also positively associated with maternal encouragement, this association was only found for muscular activities.

By contrast, An et al. (2021) showed that maternal, but not paternal, support was significantly associated with meeting the MVPA daily guideline throughout the week in children and adolescents aged 7 to 15 years. The physical activity behaviors of children aged 5 to 9 years resembled those of their mother in 73% of families and of their father in 67% of families (Freedson & Evenson, 1991). Gustafson & Rhodes (2012) reviewed 11 studies that examined maternal correlates with physical activity behaviors of children and adolescents. Six of eleven studies showed a correlation between maternal and daughter physical activity. In addition, girls aged 10 to 14 years identified their mother as the primary source of social support for physical activity (Robbins et al., 2018). Forms of maternal support that were associated with MVPA included planning and access, such as transport to activities and paying for resources, co-participation, taking time to watch activities, and positive reinforcements, such as praise.

Summary of current problem and study relevance

Understanding determinants of physical activity participation among girls is critical for improving physical activity behaviors to meet guidelines and promote long-term health benefits. Although literature sources support a potential role for mothers as interpersonal influences on girls' behaviors, barriers and facilitators of the effectiveness of mother-daughter physical activity interventions on girls' physical activity participation remain to be identified. Two previous systematic reviews of mother-daughter physical activity interventions have been performed (Barnes et al., 2018; Brennan et al., 2021). Barnes et al. (2018) had expanded eligibility criteria compared to this thesis and included girls 3-19 years of age and interventions that "targeted

physical activity, fitness, nutrition, and adiposity." Among the 14 studies they identified, Barnes et al. (2018) found that the evidence supporting the effectiveness of mother-daughter interventions was inconclusive due to differences in methods and the variables that were assessed across studies. Brennan et al. (2021) focused on the behavioral change techniques present in mother-daughter dyad physical activity interventions. Techniques that appeared promising across studies included "information on the health consequences of the behavior and the self-regulatory techniques of goal setting, self-monitoring and problem-solving" (Brennan et al., 2021).

The previous two systematic reviews (Barnes et al., 2018; Brennan et al., 2021) did not assess the multilevel determinants influencing whether girls meet physical activity guidelines. Understanding the multilevel determinants is critical for informing the development of future interventions. The current systematic review adds to the existing literature by analyzing the (1) pre- and post-intervention changes in girls' participation in physical activity and (2) the multilevel determinants of girls' participation in mother-daughter physical activity interventions.

Chapter 3. Methodology

The systematic review process followed Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines (Emory University, n.d.).

Search strategy

A search strategy, including selection of databases, medical subject heading (MESH) terms, text words, and eligibility criteria, was developed in consultation with Hannah Rogers, Head of Information Services for the Woodruff Health Sciences Center Library, Emory University. The search was conducted in November 2022 using the PubMed, APA PsycInfo, and Sports Medicine & Education Index databases and included terms and concepts following the population-intervention-comparison-outcomes (PICO) framework (**Table 5**).

Eligibility criteria

The following inclusion and exclusion criteria were applied to each study retrieved through the search process.

Inclusion criteria:

(1) The intervention exclusively targeted healthy mothers and their daughters.

(2) Daughters were 5-17 years of age.

(3) Study measures included pre- and post-intervention physical activity data for daughters.

(4) Articles were peer-reviewed research published in English.

(5) There were no geographical or publication date constraints; studies could be conducted anywhere in the world and published in any year.

Exclusion criteria:

(1) The primary focus of the study was a disease state, obesity, cognitive or physical disability, mental health, pregnancy, or prenatal care.
(2) The population targeted by the intervention included fathers, sons, or teachers.
(3) Daughters were younger than 5 years or older than 17 years.
(4) No pre- or post-intervention physical activity measures were provided for daughters.
(5) Articles were not published in English.
(6) Articles were not peer-reviewed primary research articles.
(7) Articles were duplicates or an earlier report of an intervention.

Selection process

One author (R.N.) screened full manuscripts of studies retrieved through the search process to determine eligibility according to the inclusion and exclusion criteria.

Data abstraction

Data about study characteristics, including population demographics, study design, daughters' physical activity measures, other measures performed on girls pre- and post-intervention, and methods of assessment, were extracted into an Excel document. Data about intervention characteristics included frequency, duration, education content, and physical activities. The primary physical activity measure (in most studies, reported as mean ± SD) for daughters was abstracted from each study. Studies were reviewed to determine if statistical analysis was performed on the primary pre- and post-intervention physical activity measure for daughters or between groups. For studies that reported statistics, the statistic was abstracted.

Thematic analysis

PDFs of manuscripts were uploaded to MAXQDA software (VERBI GmbH, Berlin, Germany). Deductive, in vivo color coding of the methods and results sections of each study was performed to identify the SCT concepts and SEM levels (**Table 6**) in each intervention. In vivo color coding of the results sections of each study, followed by inductive thematic grouping of codes, was performed to identify determinants of girls' participation in mother-daughter physical activity interventions. The "creative coding" function was then used to develop a visual hierarchical tree structure for thematic groupings.

Table 5. Search terms and concepts

Population	**Intervention**	**Comparison**	**Outcome**
Female	Exercise	Cluster	Participation
Child	Sport(s)	Experiment	Engagement
Teen	Physical Activity	Program	Motivation
Adolescent	Physical Fitness	Trial	Encouragement
Daughter	Sedentary Behavior	Intervention	Health Promotion
Mother			Physical Activity Level
Mother-Daughter			
Mother-Teen			
Mother-Adolescent			
Mother-Child Relations			

Table 6. SCT concepts and SEM levels

SCT concepts	**SEM levels**
Reciprocal determinism	Individual / Intrapersonal
Self-efficacy	Interpersonal
Observational learning	Institutional
Behavioral capability	Community
Expectations	Policy
Reinforcements	

Abbreviations: SCT, social cognitive theory; SEM, socioecological model

Chapter 4. Results

Study selection

The search strategy identified 186 records (**Figure 1**). After removing 23 duplicate records and one record that was not a primary peer-reviewed research article, a dissertation, the full texts of the remaining articles were reviewed for eligibility. Another 73 articles were removed, because the interventions included sons, fathers, teachers, daughters younger than 5 years, or focused on a disease state, obesity, cognitive or physical disability, mental health, pregnancy, or prenatal care. Seventy-eight articles that lacked pre- and post-intervention physical activity data for daughters were removed. Three articles were earlier reports of mother-daughter physical activity interventions and were excluded. Eight articles meeting the inclusion and exclusion criteria were eligible for the systematic review.

Study characteristics

Three studies used a two-arm, parallel, randomized, controlled design (**Table 7**) (Olvera et al., 2010; Schwinn et al., 2014; Barnes et al., 2015), and one used a three-arm, parallel, randomized, controlled design (Alhassan et al., 2018). One study used a two-arm, parallel, randomized design comparing home-based and community-based groups (Ransdell et al., 2004). Kargarfard et al. (2012) used a two-arm, parallel, controlled design without randomization. Two studies were single-arm intervention trials (Arredondo et al., 2014; Corr et al., 2020).

Five studies were conducted in the US, and the remaining were conducted in Iran, Australia, or Ireland. Study duration ranged from 3 to 12 weeks, with a mode of 12 weeks. The age range of girls across the eight studies was 6-17 years, and the age range of mothers was 28-60 years. Population demographics varied across studies. Four studies were conducted in low-

income populations, where most mothers lacked full-time employment and had fewer than four years of college education (Olvera et al., 2010; Schwinn et al., 2014; Arredondo et al., 2014; Alhassan et al., 2018). Two studies were conducted primarily in mothers and daughters of Mexican or Latina origin (Olvera et al., 2010; Arredondo et al., 2014), and one (Alhassan et al., 2018) was exclusively in mothers and daughters who identified as African American.

Seven of eight studies reported physical activity measures that allowed assessment of whether daughters met physical activity guidelines pre- and post-intervention (Ransdell et al., 2004; Olvera et al., 2010; Schwinn et al., 2014; Arredondo et al., 2014; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020). One study provided the number of days per week that daughters engaged in physical activity (Ransdell et al., 2004), and one reported the number of hours per week (Arredondo et al., 2014) based on self-reporting through surveys. Two studies reported percent time spent in MVPA (Barnes et al., 2015; Alhassan et al., 2018), and one provided the number of minutes spent in MVPA (Olvera et al., 2010) as indicated by accelerometer. Two studies reported the physical activity level of daughters according to a survey (Schwinn et al., 2014; Corr et al., 2020), and one reported the fitness level of daughters based on the number of minutes required to complete a one-mile walk (Kargarfard et al., 2012).

Three studies provided additional pre- and post-intervention physical activity measures for daughters related to strength, flexibility, or endurance (Ransdell et al., 2004; Olvera et al., 2010; Kargarfard et al., 2012). Three studies reported pre- and post-intervention sedentary time for daughters (Arredondo et al., 2014; Barnes et al., 2015; Alhassan et al., 2018). Two studies reported measures of dietary intake pre- and post-intervention Olvera et al., 2010; Schwinn et al., 2014). Five studies examined psychosocial measures, including mother-daughter communication

and attitudes or perceptions of daughters (Ransdell et al., 2004; Schwinn et al., 2014; Arredondo et al., 2014; Alhassan et al., 2018; Corr et al., 2020).

Intervention characteristics

The frequency of intervention varied among studies from once a week to three times a week, with the duration per session ranging from 25 minutes to three hours (**Table 8**). Group physical activity interventions incorporated aerobic activities in seven studies. Aerobic activities included walking (Corr et al., 2020), dance (Alhassan et al., 2018), or a mix of activities, such as running, jumping rope, and playing tag (Ransdell et al., 2004; Olvera et al., 2010; Kargarfard et al., 2012; Arredondo et al., 2014; Barnes et al., 2015). Two interventions incorporated sports (Ransdell et al., 2004; Olvera et al., 2010). One intervention incorporated weight training (Ransdell et al., 2004), and one incorporated resistance training (Olvera et al., 2010). Three interventions included stretching, yoga, or abdominal exercises (Ransdell et al., 2004; Kargarfard et al., 2012; Barnes et al., 2015). Physical activities were led by professionally trained coaches or instructors in seven studies. One study exclusively used web-based health education modules at home without group or instructor-led activities (Schwinn et al., 2014).

Seven interventions included education content targeting physical activity knowledge, beliefs, attitudes, and skills in daughters (Ransdell et al., 2004; Olvera et al., 2010; Arredondo et al., 2014; Schwinn et al., 2014; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020). Five interventions included tips and strategies for daughters to overcome barriers to physical activity and reducing screen time (Ransdell et al., 2004; Schwinn et al., 2014; Arredondo et al., 2014; Barnes et al., 2015; Corr et al., 2020). Three interventions included education about nutrition and diet for both mothers and daughters (Olvera et al., 2010; Arredondo et al., 2014; Schwinn et al.,

2014). Four interventions included education for mothers about communication and modeling healthy behaviors (Schwinn et al., 2014; Arredondo et al., 2014; Barnes et al., 2015; Corr et al., 2020). One intervention included education about types of physical activity by level of intensity, how to identify and use community resources, and how to modify the home environment to increase physical activity for both mothers and daughters (Arredondo et al., 2014).

Culturally responsive approaches

Six interventions included culturally responsive components (Ransdell et al., 2004; Olvera et al., 2010; Arredondo et al., 2014; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020). Three (Ransdell et al., 2004; Arredondo et al., 2014; Alhassan et al., 2018) conducted focus groups with mother-daughter dyads to inform the development of the intervention, such as intervention components, frequency, and scheduling, before the study was initiated. Three (Arredondo et al., 2014; Barnes et al., 2015; Corr et al., 2020) used process evaluations to adapt interventions based on participant responses after initiating the study. Process evaluation measures included feasibility, acceptability, satisfaction, and recommendations for improvement. One intervention (Olvera et al., 2010) was informed by a formative pilot in Latina mother-daughter dyads and an advisory panel of Latina/Latino community members (Olvera et al., 2008). Another (Arredondo et al. 2014) was informed by a church leader and the church community and included a readability assessment of surveys to ensure a third-grade reading level or lower given that English was not the primary language of most participants. Alhassan et al. (2018) included historical information, role models, and physical activities culturally relevant to and informed by the participants, all of whom identified as African American.

Post-intervention physical activity improvement among girls

Four studies (Olvera et al., 2010; Schwinn et al., 2014; Alhassan et al., 2018; Arredondo et al., 2018) did not provide statistical analysis comparing the post- and pre-intervention primary physical activity metric for daughters (**Table 9**). Three of the other four studies showed a statistically significant improvement in post- versus pre-intervention physical activity in girls (Ransdell et al., 2004; Kargarfard et al., 2012; Corr et al., 2020). Significant improvements in girls' physical activity were found in all arms of the three studies (Ransdell et al., 2004; Kargarfard et al., 2012; Corr et al., 2020). Two studies (Kargarfard et al., 2012; Alhassan et al., 2018) reported significant between-group improvements in daughters' physical activity in the mother-daughter group versus daughter group, and one (Olvera et al., 2010) reported significant between-group improvements in daughters' physical activity in the intervention versus control group. The primary measure of girls' physical activity differed among the three studies, preventing a combined quantitative analysis of the improvement in physical activity.

SCT concepts used in interventions

Six of eight articles explicitly stated that the interventions were based on SCT (Ransdell et al., 2004; Olvera et al., 2010; Arredondo et al., 2014; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020), and the other two (Kargarfard et al., 2012; Schwinn et al., 2014) applied a subset of SCT concepts without explicitly identifying the theory. Examples of in vivo codes identified in studies are provided (**Table 10**). Based on in vivo coding, one randomized, controlled, two-arm trial integrated all six SCT concepts into both the control and experimental arms (**Table 11**) (Olvera et al., 2010). Two additional two-arm trials included all SCT concepts in the intervention arm but not the parallel arm (Ransdell et al., 2004; Barnes et al., 2015). Both

single-arm intervention trials included all SCT concepts (Arredondo et al., 2014; Corr et al., 2020). Schwinn et al. (2014) integrated five concepts- observational learning, behavioral capability, self-efficacy, expectations, and reinforcements- into the intervention arm. Kargarfard et al. (2012) used observational learning and behavioral capability in both the intervention and control arms. The one three-arm trial (Alhassan et al., 2018) integrated SCT concepts except reinforcements into the mother-daughter arm.

The most common SCT concepts across intervention groups were observational learning and behavioral capability, which were applied in all eight interventions. Promoting girls' self-efficacy was the next most common and was applied in six of eight interventions. The three studies that reported statistically significant post-intervention improvements in girls' physical activity varied in the SCT concepts that they integrated (Ransdell et al., 2004; Kargarfard et al., 2012; Corr et al., 2020). Ransdell et al. (2004) applied all six SCT concepts in the community-based arm, and Corr et al. (2020) integrated all six SCT concepts in the single intervention arm, both of which showed significant improvements in girls' physical activity. By contrast, Ransdell et al. (2004) applied self-efficacy and behavioral capability in the home-based arm, which also showed significant improvements in girls' physical activity. Kargarfard et al. (2012) applied observational learning and behavioral capability in the control and intervention arms, both of which also showed significant improvements in girls' physical activity.

SEM levels targeted by interventions

Examples of in vivo codes representing how SEM levels were targeted are provided (**Table 12**). All interventions targeted girls at the individual and interpersonal levels (**Table 13**). Four interventions targeted institutions, specifically schools (Ransdell et al., 2004; Olvera et al.,

2010; Kargarfard et al., 2012) and church (Arredondo et al., 2014). Three interventions targeted the community (Olvera et al., 2010; Arredondo et al., 2014; Alhassan et al., 2018).

Among those mother-daughter interventions that showed a significant improvement in daughters' physical activity (Ransdell et al., 2004; Kargarfard et al., 2012; Corr et al., 2020), the individual and interpersonal levels were consistently targeted. Two interventions that showed significant improvement in daughters' physical activity (Ransdell et al., 2004; Kargarfard et al., 2012) also targeted the institutional level.

Inductive thematic analysis of determinants of daughters' participation in mother-daughter physical activity interventions

Examples of in vivo codes related to determinants of girls participating in mother-daughter interventions are provided in **Table 14**. The most common barriers to girls' participation in mother-daughter interventions were competing obligations, physical limitations, and the time commitment required to engage in the intervention activities (**Figure 2**) (Ransdell et al., 2004; Olvera et al., 2010; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020). Existing obligations that competed with the ability to participate in the intervention were primarily school commitments, such as homework, or work commitments, including restrictive schedules of mothers. Physical limitations included unexpected illness, inclement weather, and lack of transportation. The time commitment required to engage in the activities, including tracking physical activity, was also viewed as a barrier to participation in interventions. Additional barriers included a lack of interest and cultural factors, such as language barriers (Olvera et al., 2010; Corr et al., 2020).

Facilitators of girls' participation in mother-daughter interventions were being with their mother and gaining a sense of community (**Figure 3**) (Arredondo et al., 2014; Schwinn et al., 2014; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020). The main facilitator related to being with their mother was developing a close relationship. Being with their mother also allowed shared experiences and role modeling. The main facilitator related to a sense of community was having fun with a group, which was expressed as enjoyable, motivating, and reducing psychosocial stress. Social support and team activities were also facilitators contributing to a sense of community.

Thematic analysis shows multiple levels of influence on girls' participation in physical activity. These results support the need to consider the SEM to improve girls' physical activity participation and their ability to meet physical activity guidelines (**Figure 4**).

Figure 1. PRISMA study selection flow diagram

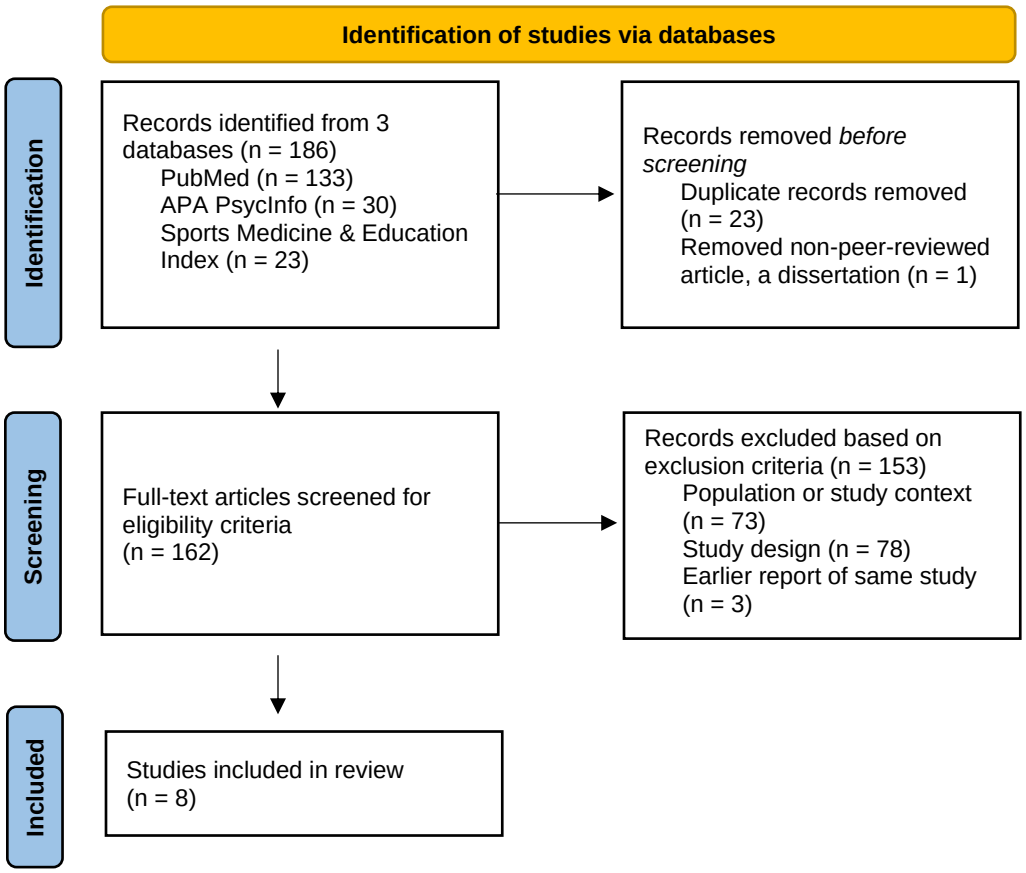


Table 7. Study characteristics

Author (year)	**Population**	**Design**	**Primary physical activity metric for daughters, method of assessment**	**Additional physical activity metrics for daughters**
Ransdell (2004)	*Daughters (n=20)* Age range, 14-17 years *Mothers (n=20)* Age range, 31-60 years College degrees, 47% In a committed relationship, 82% *Dyads* Caucasian, 93% Household incomes > $50,000, 82% Self-rated overall health as good or excellent, 63% *Location* Salt Lake City, Utah, USA	*DAMET* Two-arm parallel, randomized trial Home-based group (n=20) vs community-based group (n=20) 12 weeks	Number days per week engaged in aerobic activity Survey daughter	Number of modified push-ups and sit-ups VO_2 max Flexibility Body weight Self-perceived sports competence and body attractiveness Proportion of classes or exercise sessions attended
Olvera (2010)	*Daughters (n=46)* Age range, 7-13 years Born in US, 82% Self-reported low acculturation, 85% Overweight, 66% *Mothers (n=46)* Age range, 28-49 years Born in Mexico or Central America, all <8 years education, 68% Unemployed, 75% Spanish primary, 62% Overweight, 88% *Dyads* Latino, all	*BOUNCE* Two-arm parallel, cluster randomized, controlled trial Intervention (n=52) vs no intervention control (n=40) 12 weeks	Minutes MVPA per day Accelerometer	Number of laps, 20-meter endurance shuttle run test Daily activity counts per minute BMI Intake of high-fat foods and sweet beverages Intake of vegetables and fruits

	Location Houston, TX, USA			
Kargarfard (2012)	*Daughters (n=266)* Age range, 14-17 years *Mothers (n=204)* Age range, not provided *Location* Iran	*CASPIAN* Two-arm, parallel, non-randomized, controlled trial Mother-daughter (n=410) vs daughter only (n=60) group 12 weeks	Minutes to complete 1-mile walk, Fitnessgram	BMI VO_2 max Resting heart rate Flexibility Upper body muscular strength and endurance (repetitions) Abdominal muscular strength and endurance (repetitions)
Schwinn (2014)	*Daughters (n=67)* Age range, 10-12 years White, 40% Black, 45% Latina, 12% Asian, 3% Eligible for free or reduced-price lunch, 94% *Mothers (n=67)* Age range, 30-42 years Fewer than 4 years college, 72% Full-time employment, 45% *Dyads* Lived in public housing, all *Location* 27 US states	Two-arm parallel, randomized, controlled trial Intervention (n=72) vs no intervention control (n=62) 3 weeks	Physical activity level (composite score) 5-point Likert scale survey for daughter	Fruit intake Vegetable intake Drug refusal skills 30-day substance use Perceived stress Parental monitoring Mother-daughter closeness Mother-daughter communication
Arredondo (2014)	*Daughters (n=11)* Age range, 8-11 years Born in Mexico or outside US, 11% 4th grade, 44%	Single-arm intervention 8 weeks	Number hours per week engaged in MVPA Survey mother	Number hours per week watch television Attitudes toward physical activity Attitudes toward television watching Perceived support for physical activity

	Mothers (n=11) Age range, 30-43 years Married, 55% Employed, 44% Completed high school, 67% Born in Mexico or outside US, 89% Income < $2000/month, 67% *Location* Chula Vista, San Diego County, California			
Barnes (2015)	*Daughters (n=48)* Age range, 6-11 years Overweight or obese, 33% *Mothers (n=40)* Age range, 34-44 years Overweight or obese, 67% SES ≤6, 39% SES 7-8, 61% *Location* Australia	*MADE4Life* Two-arm, parallel, randomized, controlled trial Intervention (n=46) vs wait list control (n=42) 8 weeks	% time in MVPA accelerometer	BMI Waist circumference Blood pressure Resting heart rate Fat mass Mean counts per minute % MPA % VPA % LPA % SED Sitting time Screen time
Alhassan (2018)	*Daughters (n=76)* Age range, 7-10 years African American, all *Mothers (n=76)* Age range, 29-45 years African American, all Single, never married, 62% Married, 29% Fewer than 4 years college, 60% Income <$40k/year, 63% *Location* Springfield, MA, USA	*MAGNET* Three-arm, parallel, randomized, controlled trial Mother-daughter (n=28 dyads) vs daughter alone (n=25 dyads) vs control (n=23 dyads)	% time in MVPA accelerometer	BMI % LPA % SED % MVPA after school % LPA after school % SED after school Physical activity self-efficacy

		12 weeks		
Corr (2020)	*Daughters (n=31)* Age range, 12-15 years *Mothers (n=27)* Age range, 38-51 years Completed college, 55% Employed, 70% *Location* Ireland	*SOLE MATES* Single-arm feasibility trial 6 weeks	Physical activity level (composite score) PAQ-A survey for daughter	Steps per week, Pedometer Quality of life, KIDSCREEN-27 survey Communication with mothers, PACS scale Co-participation in physical activity with mothers, number days per week

Abbreviations: BMI, body mass index; LPA, light physical activity; MVPA, moderate to vigorous physical activity; PAQ-A, physical activity questionnaire for adolescents; SED, sedentary; VO2, maximum rate of oxygen consumption during physical activity

Table 8. Intervention characteristics

Author (year)	Frequency, duration per session	Education content	Physical activity	Reinforcements	Observational learning	Other components
Ransdell (2004)						
Home-based	N/A after classroom sessions	*Two classroom education sessions:* physical self-perception tactics, goal setting, positive self-talk, weight training skills *Self-education materials:* calendar of recommended activities, photos of various stretches, calisthenics, strength training activities, and tips for overcoming barriers	Self-driven	Required physical activity log emailed back every 2 weeks Incentives for the dyad with top adherence rate at midpoint and end of study – competition	N/A	
Community-based	Three times a week, 75 min	*Two classroom education sessions:* physical self-perception tactics, goal setting, positive self-talk,	*Twice a week:* Group fitness activities – 20 min warmup, 20 min aerobic, 20 min weight training, 10 min stretching and abdominal	Attendance recorded Weekly prizes	Taught by instructors, coaches Group fitness and sports sessions Mothers	At a fitness facility on a university campus

		weight training skills	*Once a week:* Group sports or recreation activities			
Olvera (2010)						
Control	Once a week, 1.5 hours	*Once a week:* Nutrition education – 45 min (1st part of session)	*Once a week:* Light intensity international aerobic (i.e., samba), resistance training, or sport sessions (i.e., basketball) – 45 min (2nd part of session)	Goal setting Rewards	Child psychologist and counselor, dietitian, fitness specialist Group physical activity Mothers	*Once a week:* Behavioral counseling session – 45 min (final part of session)
Intervention	Three times a week, 1.5 hours	*Twice a week:* Nutrition education – 45 min each session (1st part of session)	*Three times a week:* Structured group aerobic (e.g., Salsa), sport sessions (e.g., basketball), or free play recreational activities – 45 min (2nd part of session)	Goal setting Rewards	Child psychologist and counselor, dietitian, fitness specialist Structured group sports and physical activity sessions Mothers	*Once a week:* Behavioral counseling session – 45 min (final part of session)
Kargarfard (2012)						
Daughter only	Twice a week, 1.5 hours	N/A	*Twice a week:* Fitness activities – 10 min warmup, 30 min aerobic and stretching, 20 min free play, 10 min cool down	N/A	Female physical activity instructors	After school on campus

Mother-daughter dyad	Twice a week, 1.5 hours	N/A	Fitness activities – 10 min warmup, 30 min aerobic and stretching, 20 min free play, 10 min cool down	N/A	Female physical activity instructors Mothers	After school on campus
Schwinn (2014)						
Control	N/A	N/A	N/A	Monetary incentives for baseline, post-test, and 5-month follow up	N/A	
Intervention	Once per week, 25 min	*One session each:* Active listening, communication, family meals, drugs, how to establish rules (mothers only), healthy and economic grocery decision-making skills, making healthy dinners, coping skills	N/A	Monetary incentives for baseline, post-test, and 5-month follow up	Mothers	Web-based health promotion modules at home
Arredondo (2014)						
Intervention	Once a week, 2.5 hours	*Mothers and daughters (in separate groups):* Physical activity benefits, myths, guidelines; types of physical activity by intensity; family communication;	*Daughters group only:* Moderate to vigorous physical activity (jumping rope, tag, running) – 20 min (2nd part of session)	Dyads received certificate of completion from priest and intervention leaders	Group discussions Interactive games and activities Weekly session led by PI and health advisor from church (mothers group) or a youth	Implemented at a church on Saturday mornings Sessions integrated faith components

		using and finding community resources; modifying home environment; nutrition *Daughters only:* Physical activity safety; benefits of games; identifying individual motivations and environmental barriers; role of adults in physical activity support *Mothers only:* Discuss motivations and barriers of daughters' physical activity; pre-adolescent development; parenting and relationships (1st part of session)			leader (daughters group) Physical activity led by Latina graduate student trained in exercise physiology (daughters group)	Sessions began with community prayer before mothers and daughters were separated into groups Daughters ended intervention with a photovoice activity to document environmental factors hindering or facilitating physical activity and discussed solutions as a group
Barnes (2015)						
Control	N/A	N/A	N/A	N/A	N/A	
Intervention, 1.5 hours	Once a week, 75 min	Separate education sessions for mothers and	Aerobics, active games, yoga, Zumba, pilates,	Stickers (daughters)	Female physical education instructors	Afterschool

		daughters – 25 min (1st part of session) *Daughters:* Developing an active lifestyle, physical activity benefits, reducing screen time *Mothers:* Evidence for physical activity benefits, behavioral change, parenting and modeling strategies	movement, tumbling – 60 min (final part of session)	$10 local grocery store voucher upon completion of assessments (mothers)	Mothers	
Alhassan (2018)						
Control	Three times a week, 2 hours	Homework and healthy snack – 2 hours	N/A	Attendance recorded	N/A	Afterschool at one centrally located elementary school
Daughter only	Three times a week, 3 hours	Homework and healthy snack – 2 hours (final part of session) History of the dance and impact on African-American culture – 15 minutes Weekly health newsletter in topics relevant to	Dance – 1 hour – 2 min warmup, 8 min moderate to vigorous dance, 1 min cooldown per routine (1st part of 3-hour session)	Attendance recorded	Research staff African-American female dance instructors	Afterschool at one centrally located elementary school

		local African-American community tailored for mothers or daughters; daughters' newsletter also included activities and historical African-American females				
Mother-daughter	Three times a week, 3 hours	Homework and healthy snack – 2 hours (1st part of session) History of the dance and impact on African-American culture – 15 min Weekly health newsletter in topics relevant to local African-American community tailored for mothers or daughters; daughters' newsletter also included activities and historical	Dance – 1 hour - 2 min warmup, 8 min moderate to vigorous dance, 1 min cooldown per routine (Final part of session)	Attendance recorded	Research staff African-American female dance instructors Mothers	Afterschool at one centrally located elementary school

		African-American females				
Corr (2020)						
Intervention	Once a week, 1.5 hours	Separate education sessions for mothers and daughters *Mothers and daughters (in separate groups):* Physical activity benefits; communication *Daughters only:* Time management; stereotypes; screen time; empowerment *Mothers only:* Barriers to physical activity; female role models; being a physically active parent	Group walking	Twice a week cues and reminders, text messages (*mothers*) Private social media group (*mothers*) Goal setting (*daughters and mothers*) Feedback (*daughters*)	Female physical activity instructors Mothers	Community meeting at beginning of each session – 10 minutes

Abbreviations: N/A, not applicable

Table 9. Summary of pre- to post-intervention physical activity changes for daughters

Author (year)	Pre-intervention	Post-intervention	Statistic	Between Groups
Ransdell (2004)	Mean days/week ± SD		P value	None provided
Home-based	2.00 ± 1.83	2.71 ± 1.89	**≤ 0.001**	Text states not significant (value not provided)
Community-based	2.25 ± 1.62	4.30 ± 1.16	**≤ 0.001**	
Olvera (2010)	Mean min MVPA/day ± SD		None provided	P value
Control	35.4 ± 21.9	38.0 ± 13.1		**0.049**
Intervention	64.3 ± 23.9	70.7 ± 31.5		
Kargarfard (2012)	Mean min 1-mile walk ± SD		P value	P value
Daughter	15.3 ± 2.2	14.0 ± 1.8	**< 0.001**	**< 0.05**
Mother-daughter	15.6 ± 2.3	13.9 ± 1.6	**< 0.001**	
Schwinn (2014)	Mean PA level ± SD		None provided	P value
Control	2.29 ± 0.62	2.41 ± 0.70		> 0.05
Intervention	2.17 ± 0.65	2.19 ± 0.70		
Arredondo (2014)	Mean hours MVPA/week ± SD		None provided	NA
Intervention	6.25 ± 3.66	7.68 ± 3.76		
Barnes (2015)	Mean change from baseline in % time in MVPA (95% CI)		Mean difference between groups (95% CI)	Cohen's d between groups effect size
Control	0.96 (-0.03, 1.95)		-0.08 (-1.49, 1.33)	-0.03
Intervention	0.88 (-0.12, 1.88)			
Alhassan (2018)	Mean % time in MVPA ± SD		None provided	Rate of change between groups
Control	3.3 ± 2.1	3.5 ± 1.9		% time in MVPA, mother-daughter vs daughter, **p=0.007**
Daughter	2.5 ± 2.0	3.1 ± 1.6		
Mother-daughter	2.9 ± 2.0	2.8 ± 1.3		
Corr (2020)	Mean PA level ± SD		P value	NA
Intervention	2.2 ± 0.5	2.4 ± 0.4	**0.01**	

Abbreviations: CI, confidence interval; Min, minutes; MVPA, moderate to vigorous physical activity; NA, not applicable; PA, physical activity; SD, standard deviation

Table 10. Examples of in vivo codes representing SCT constructs used in interventions

SCT construct	
Reciprocal determinism	"…lifestyle-oriented physical activity during the week (e.g., taking the stairs instead of the elevator, parking farther away and walking) (Ransdell et al., 2004)
	"…the concept of family reciprocal determinism was developed with a focus on the complexities existing between the individual and the family unit and how the 2 influence each other when determining behavior change… last session of the series involved preadolescents taking pictures of environmental factors that facilitated and inhibited their PA" (Arredondo et al., 2014)
	"…interplay of personal (interest in the dance program, self-efficacy); behavioral (knowledge and skills needed to participate in dance); and environmental (inclusion of the mother, safe environment) factors (Bandura, 1986; Bandura, 1997). The intervention also incorporated the African-American culture by emphasizing both surface (e.g., selected dance style and music, utilizing an African-American dance instructor) and deep (e.g., social and historical influences, the importance of the maternal figure) structure cultural influences" (Alhassan et al., 2018)
Self-efficacy	"…taught sports such as racquetball, basketball, and softball to increase their perceived sports competence" (Ransdell et al., 2004)
	"The preadolescent daughters discussed learning to communicate more with their mothers as a result of the program, especially regarding PA" (Arredondo et al., 2014)
	"Girls' PA self-efficacy was assessed using the Child Self-Perception of Adequacy and Predilection for PA Scale" (Alhassan et al., 2018)
Observational learning	"All activities were led by qualified female instructors experienced in teaching PA" (Kargarfard et al., 2012)
	"We targeted observational learning by involving a credible Latina (exercise physiologist) to model PA and by engaging the preadolescents' mothers in PA" (Arredondo et al., 2014)
	"Sessions focused on the importance of mothers being a positive and active female role model" (Barnes et al., 2015)
Behavioral capability	"…tips for overcoming barriers…" (Ransdell et al., 2004)
	"…make healthy and economical decisions at the grocery store and how to make healthy dinners… 5-step problem solving process…" (Schwinn et al., 2014)
	"…behavioral capability were targeted through setting realistic, attainable goals to increase PA" (Arredondo et al., 2014)
Expectations	"…parental monitoring… mothers rated such parameters as "I know where my daughter is after school" and "I know my daughter's friends." (Schwinn et al., 2014)
	"In addition to being more active with their mothers and friends, the girls discussed the health benefits they had learned about PA. Besides weight control, participants acknowledged the effects of PA on circulation, cardiovascular function, muscular strength, and overall health" (Arredondo et al., 2014)
	"PA and Health – What are the benefits?" (Corr et al., 2020)

Reinforcements	"…twice weekly text messages sent to both mothers and daughters to reinforce walking behavior and a private Facebook group for mothers in which relevant content was shared… pedometer record book to record their daily steps… individualized, progressive weekly step goals" (Corr et al., 2020)
	"Daughters completed weekly 'pink slip' homework tasks that encouraged home PA with their mothers, e.g., creating home-based fitness circuits. Pink slips were reviewed weekly by facilitators and daughters were rewarded with a 'scratch n smell' sticker to attach to a sticker chart… To support retention rates of the primary outcome, families were sent two reminder text messages throughout their 7-day wear time… Families received a $10 voucher from a local supermarket chain on completing assessments" (Barnes et al., 2015)
	"We took into account reinforcement by addressing parenting skills and encouraging mothers to reward their daughters when attaining PA goals… The daughters' sessions involved some group discussions but also included interactive games and activities (eg, jeopardy-style games) to reinforce the health information… In the focus group with the daughters, participants also mentioned the benefit of faith and religion in the program. One participant stated that she participated in the program because "it taught us about God." (Arredondo et al., 2014)

Abbreviations: SCT, social cognitive theory

Table 11. SCT constructs used in each intervention

Author (year)	Reciprocal determinism	Self-efficacy	Observational learning	Behavioral capability	Expectations	Reinforcements
Ransdell (2004)						
Home-based		X		X	X	X
Community-based	X	X	X	X	X	X
Olvera (2010)						
Control	X	X	X	X	X	X
Intervention	X	X	X	X	X	X
Kargarfard (2012)						
Daughter only			X	X		
Mother-daughter			X	X		
Schwinn (2014)						
Control						X
Intervention		X	X	X	X	X
Arredondo (2014)						
Intervention	X	X	X	X	X	X
Barnes (2015)						
Control						
Intervention	X	X	X	X	X	X
Alhassan (2018)						
Control					X	
Daughter only	X	X		X	X	
Mother-daughter	X	X	X	X	X	
Corr (2020)						
Intervention	X	X	X	X	X	X

Abbreviations: SCT, social cognitive theory

Table 12. Examples of in vivo codes representing SEM levels targeted by interventions

SEM level	
Individual	"…positive self-talk to help them increase their overall physical self-worth" (Ransdell et al., 2004)
	"…received written educational materials on various nutrition and counseling topics" (Olvera et al., 2010)
	"…Daughters' education sessions focused on developing an active lifestyle, benefits of PA and ways to reduce screen time" (Barnes et al., 2015)
Interpersonal	"All activities were led by qualified female instructors experienced in teaching PA" (Kargarfard et al., 2012)
	"…impact of social support given by family and friends on decisions regarding diet and exercise… girls reported increases in parental support for PA" (Arredondo et al., 2014)
	"…focused on developing and maintaining girls' and mothers' healthy relationships" (Schwinn et al., 2014)
Institutional	"Participants in the UB group met three times per week… sports activities consisted of basketball, soccer, volleyball, etc." (Ransdell et al., 2004)
	"…in each center 24 sessions were held… at the school sites" (Kargarfard et al., 2012)
	"The 8-week intervention was implemented in a room adjacent to the participating church" (Arredondo et al., 2014)
Community	"Utilizing community resources, the BOUNCE intervention was delivered in community (i.e., community centers located in park, park playgrounds, and grocery stores) and school settings (e.g., classroom, gym, cafeteria, and playground)." (Olvera et al., 2010)
	"Participants also discussed being more motivated to get involved in their community as a result of their participation in the program." (Arredondo et al., 2014)
	"Afterschool dance classes were held at a centrally located elementary school in Springfield, MA." (Alhassan et al., 2018)
Policy	None identified

Abbreviations: SEM, socioecological model

Table 13. SEM levels targeted by each intervention

Author (year)	Individual	Interpersonal	Institutional	Community	Policy
Ransdell (2004)					
Home-based	X				
Community-based	X	X	X		
Olvera (2010)					
Control	X	X	X	X	
Intervention	X	X	X	X	
Kargarfard (2012)					
Daughter only	X		X		
Mother-daughter dyad	X	X	X		
Schwinn (2014)					
Control					
Intervention	X	X			
Arredondo (2014)					
Intervention	X	X	X	X	
Barnes (2015)					
Control					
Intervention	X	X			
Alhassan (2018)					
Control	X				
Daughter only	X			X	
Mother-daughter	X	X		X	
Corr (2020)					
Intervention	X	X			

Abbreviations: SEM, socioecological model

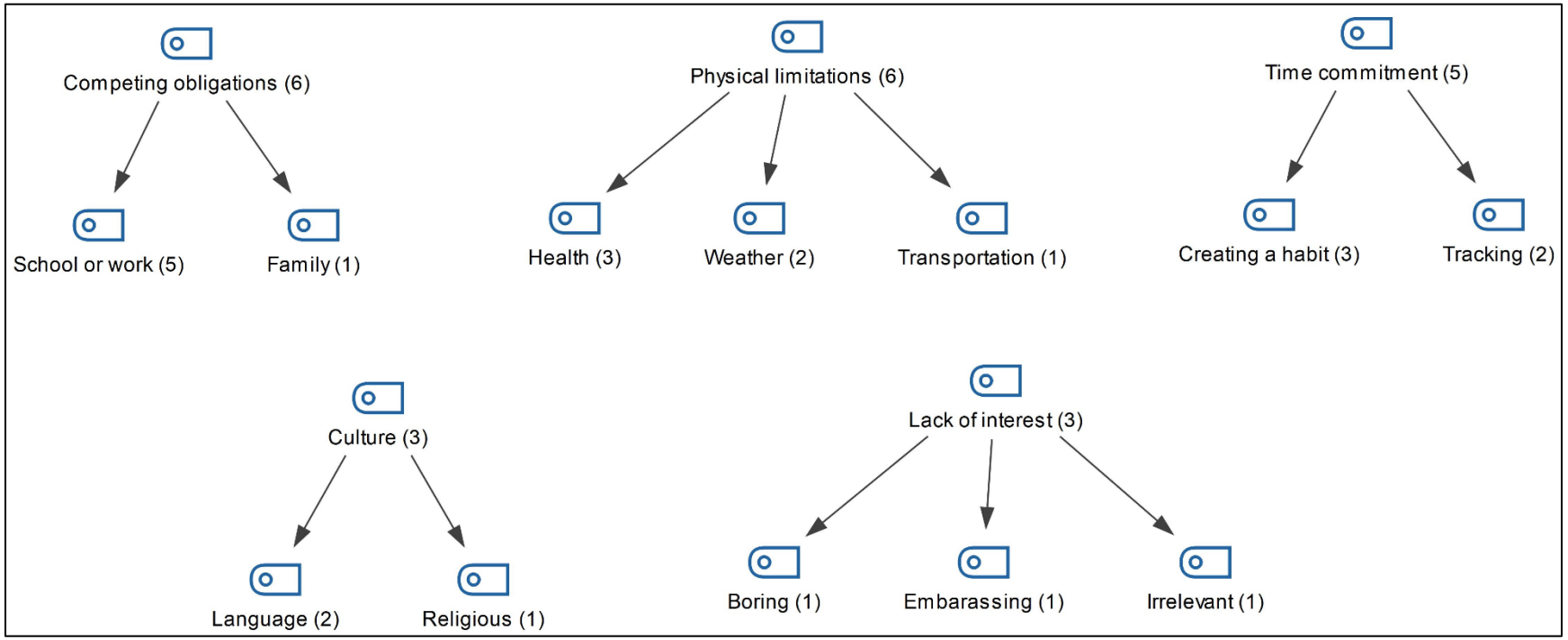
Table 14. Examples of in vivo codes representing determinants of girls' participation in interventions

Barriers	
Competing obligations	"…dropped out of the intervention due to… conflicts with job schedules" (Olvera et al., 2010)
	"Girls discussed struggling to reach step goals due to other commitments; "sometimes you have homework or study then it's a bit frustrating" (Corr et al., 2020)
Culture	"… dropped out of the intervention due to religious reasons…" (Olvera et al., 2010)
	"girls reported low levels of acculturation" (Olvera et al., 2010)
Lack of interest	"…didn't want to be seen walking around in this group" (Corr et al., 2020)
	"…the walks, they're grand like but they can get a bit boring" (Corr et al., 2020)
Physical limitations	"The most frequently reported barrier to the program was transportation…" (Alhassan et al., 2018)
	"…dropped out due to… illness (Ransdell et al., 2004)
Time commitment	"The most frequently reported barrier to the program was… time commitment" (Alhassan et al., 2018)
	"…didn't like that you had to track for the whole week" (Corr et al., 2020)

Facilitators	
Being with their mother	"…girls demonstrated greater mother–daughter communication, closeness" (Schwinn et al., 2014)
	"Besides doing PA together, the girls also liked doing activities with their mothers. Several participants also mentioned that they liked playing the jeopardy game with their mothers because it was fun and their mothers were helpful and knowledgeable." (Arredondo et al., 2014)
	"…daughters also commented that they enjoyed spending time with their mothers. One girl said; "I enjoyed having a reserved time of the week just to walk and spend time with her." (Corr et al., 2020)
Sense of community	"Some of the benefits they derived from the group setting included the ability to share similar experiences and obstacles with one another in a nonjudgmental atmosphere, and to put their experiences into perspective by listening to each other." (Arredondo et al., 2014)
	"…program highlights were spending quality time with their daughters in PA in a fun, supportive environment with other mothers and daughters." (Barnes et al., 2015)
	"Most of the daughters in the focus group agreed that they would encourage their friends to participate in a PA program and support one another to be more active. One said she would tell her friends "to come to the program because it is fun and it encourages you to do more PA." Participants also discussed being more motivated to get involved in their

	community as a result of their participation in the program. Many agreed that they enjoyed having the program in a group setting and that they prefer doing PA with other people, such as friends or their mothers (Arredondo et al., 2014)

Figure 2. Barriers to girls' participation in interventions

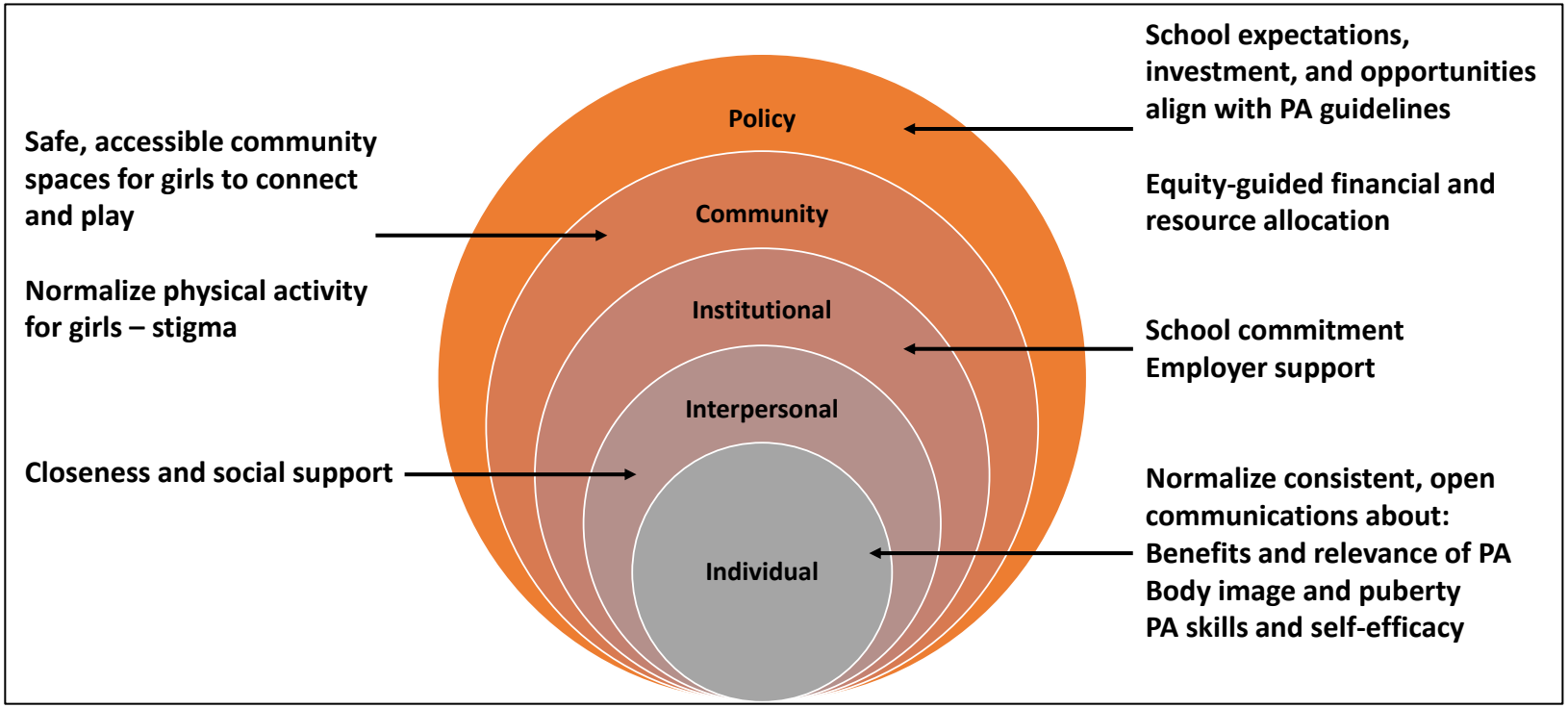


Numbers in parentheses represent number of instances that the distinct code or theme was identified across studies; some codes were identified multiple times by different participants in a study.

Figure 3. Facilitators of girls' participation in interventions

Numbers in parentheses represent number of instances that the distinct code or theme was identified across studies; some codes were identified multiple times by different participants in a study.

Figure 4. Recommendations based on thematic analysis of determinants of girls' participation in mother-daughter physical activity interventions through the SEM



Chapter 5. Discussion

Major findings

This systematic review provides insights into the determinants of girls' participation in interpersonal mother-daughter physical activity interventions. The two main barriers to girls' participation identified through thematic analysis of the eight studies were competing obligations and physical limitations. Girls had competing school commitments, primarily homework. Mothers had competing work commitments, including inflexible schedules, which prevented girls from participating in intervention activities. Temporary illnesses, inclement weather, and lack of transportation were physical limitations that prevented girls' participation.

The two facilitators to girls' participation were being with their mother and gaining a sense of community. Being with their mother provided closeness, which was described as "bonding time," "quality time," and improved communication (Schwinn et al., 2014; Barnes et al., 2015; Alhassan et al., 2018). Being with their mother also provided girls with role models who provided knowledge and monitoring, as well as the ability to share experiences as a mother-daughter team. A broader sense of community was gained through the group setting of interventions. Community provided girls with a sense of enjoyment, fun, and reduced stress, which motivated them to participate. Community also provided social support, where girls felt safe to "share similar experiences and obstacles" (Arredondo et al., 2014).

Three studies demonstrated a significant improvement in girls' physical activity after the intervention (Ransdell et al., 2004; Kargarfard et al., 2012; Corr et al., 2020). All six SCT constructs were addressed by two interventions, and the other addressed observational learning and behavioral capability. The SEM individual and interpersonal levels were targeted by all three interventions, and the institutional level was targeted by two of three interventions.

Findings in context

Consistent with the findings reported here, strong social support networks, including peers and family, parental role modeling, and a sense of fun and community have been reported to influence girls' participation in physical activity (Casey et al., 2009; Telford et al., 2016; Martínez-Andrés et al., 2020; Cowley et al., 2021; Woods et al., 2021; Soto-Lagos et al., 2022). Parental attitudes and their ability to support girls' involvement in physical activities influence girls' motivation to participate, as well as their ability to access opportunities (Van Royen et al., 2015; Taylor et al., 2018; Horodyska et al., 2019). Parental ability to support girls is related to numerous factors, including competing work commitments (Taylor et al., 2018), consistent with the findings of this thesis, and financial means (Van Royen et al., 201). A nonjudgmental environment has been reported to be an important part of social support (Cowley et al., 2021), consistent with the findings reported here. Fear of judgment as a barrier has been shown to follow the life-course perspective of changing circumstances, increasing as girls transition from childhood to adolescence (Cowley et al., 2021). Competing school obligations and physical limitations, such as weather, transportation, and poor facilities, have also been reported as a barrier to girls' participation in physical activity by others (Van Royen et al., 2015; Horodyska et al., 2019; Corr et al., 2019; Martínez-Andrés et al., 2020; Cowley et al., 2021). Additional determinants of girls' participation in physical activity reported in the literature include puberty-related changes, body image, single-sex activities, school commitment, safety of the surrounding community, financial means, and established policies related to physical activity (Casey et al., 2009; Van Royen et al., 2015; Martínez-Andrés et al., 2020; Cowley et al., 2021; Soto-Lagos et al., 2022).

The need to target multiple levels of the SEM to improve girls' participation in physical activity is supported by other studies (Casey et al., 2009; Van Royen et al., 2015; Telford et al., 2016; Taylor et al., 2018; Horodyska et al., 2019; Cowley et al., 2021; Woods et al., 2021; Soto-Lagos et al., 2022). The mother-daughter interventions included in this systematic review consistently considered the individual and interpersonal levels of the SEM. However, the influences of the institutional, community, and policy levels and strategies to target those levels of influence should be considered during intervention planning. The findings reported here and identified in the literature review support a need to educate girls at the individual level about the benefits and relevance of physical activity and to support a healthy body image and self-efficacy. Strategic communications should be tailored for the specific target audience of girls and be informed by or co-developed with the target audience. Communications should be provided consistently throughout childhood and adolescence and consider the life-course perspective of changing context as girls enter teenage years. Strategic communications frameworks that have been developed for public health practice can be applied to develop and disseminate information to girls. One example is *Communications Strategies for Social Justice*, which offers frameworks and worksheets to develop tailored communications, and was released by the American Public Health Association (APHA) (APHA, 2023). At the interpersonal level, behavioral capability, observational learning, self-efficacy, and the closeness of being with their mother and social support should be targeted. Institutions, such as schools, can be targeted to improve their commitment to girls' physical activities through time, infrastructure investment, and opportunities to participate. Employers can be targeted to provide flexibility to mothers to support mother-daughter interventions. Targeting the community level includes providing the resources, transport, and safe environments required for girls to participate in activities.

Providing this safe social infrastructure will allow girls to connect and play. *Social Connection – Current Priorities of the U. S. Surgeon General* discusses the needs and strategies related to designing and strengthening social infrastructure (USDHHS, 2023). Adults should normalize girls' physical activity and reduce stigma related to girls' participation in sports. Finally, policies must align with physical activity guidelines and consider the unique needs of each institution and community through an equity lens to improve girls' physical activity participation and ability to meet physical activity guidelines.

Limitations

Eight studies encompassing a diverse population of mothers and daughters, different measures of girls' physical activity, and varying formats for intervention frequency, duration, setting, and activities, were included in this systematic review. Demographic differences, such as race, ethnicity, or country of origin and socioeconomic background, among the populations included in the eight studies limits the ability to compare results between studies. The limited context and population included in each study restricts the ability to make inferences to the general population, as results are not necessarily representative of girls in contexts outside those that were directly studied. Seven of eight studies reported physical activity measures that would allow assessment of whether daughters met physical activity guidelines pre- and post-intervention (Ransdell et al., 2004; Olvera et al., 2010; Schwinn et al., 2014; Arredondo et al., 2014; Barnes et al., 2015; Alhassan et al., 2018; Corr et al., 2020). However, because the primary measure of girls' physical activity varied among studies, meta-analysis of girls' physical activity improvement from pre- to post-intervention was not possible. Other differences in study and intervention design, such as data collection methods and types of activities, limit the ability to

compare studies. The thematic analyses for this systematic review were performed by one author, limiting the perspective through which coding and themes were produced. In vivo coding reduces this bias; however, thematic grouping of codes introduces the viewpoint of the coder.

Future directions

Systematic analysis of mother-daughter physical activity interventions is critical for understanding which approaches and components of interventions are effective in improving girls' physical activity participation. However, the absence of uniformly applied study designs, measures of physical activity, and methods of assessment prevents comparison of studies. Developing a standardized set of primary physical activity measures and methods of assessment would allow meta-analysis of mother-daughter physical activity interventions. Meta-analysis would allow researchers to understand which interventions are effective and analyze those to identify shared characteristics that support physical activity among girls. Future mother-daughter physical activity interventions should also consider including muscle- and bone-strengthening activities, which were less commonly integrated into the interventions reviewed here, compared with aerobic activities. Girls encounter multiple barriers and facilitators that influence their participation in mother-daughter physical activity interventions. These determinants exist at all levels of the SEM. Future mother-daughter physical activity interventions should strategically assess the multilevel influences that exist within their specific community context and proactively target multiple levels to optimize the effectiveness of interventions.

Conclusion

Future mother-daughter physical activity interventions should apply standardized methods to assess girls' physical activity. Understanding the multilevel determinants of girls' participation in mother-daughter physical activity interventions can inform the development of future interventions. Targeting multiple levels of the SEM may more effectively support physical activity behaviors among girls, allowing them to meet current physical activity guidelines.

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