

ABSTRACT

Changes in Activation of Mexican-Heritage Children and Father Physical Activity Social Networks in Response to a Father-Focused Family-Centered Health Program

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Physical activity (PA) and active play are beneficial for physical, mental, and emotional health; however, very few families meet PA guidelines to attain health benefits. Unfortunately, Latinx children report lower PA levels and are at elevated risk for developing obesity. PA is also significantly associated with PA behaviors of friends and family through support, influence, and co-participation. Past studies have focused on mother's influence on and perception of child PA, especially within Mexican-heritage families; however, recently scholars have called for a renewed focus on fathers to promote the health of their children. This dissertation examined if participation in a father-focused family-centered health program changes the social connections within Mexican-heritage children's and fathers' PA networks. Participating families consisting of child (aged 9-11), mother, and father were recruited from *colonias* by *promotoras* for participation in a six-week father-focused family-centered health program focused on family dynamics relative to healthy eating and active living. Children reported up to five people (alters) they actively played with the most in the previous month before and after

the program. Likewise, fathers reported up to five people they with whom they were physically active. Children and fathers then reported each alters' sex, their relationship to the alter, and frequency with which they played with the alter, if they thought the alter was active regularly, and if they alter helped them to be active as well as what they did most often with that person. Multilevel regression models examined the change in alter level variables. Children and fathers were more likely to report more frequent PA with their alters after the program when compared to before the program. Additionally, girls were more likely to report more frequent active play with alters when compared to boys; however, a significant interaction term indicated boys were more likely to increase this frequency as compared to girls. Supporting families to activate their social network ties to be more active, which is theoretically supported through family systems theory and Social Ecological Model, could result in more PA for children and families. Results indicate these connections or activations are possible through a family-centered father-focused health program.

Changes in Activation of Mexican-heritage Children and Father Physical Activity Social Networks
in Response to a Father-focused Family-centered Health Program

by

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TABLE OF CONTENTS

LIST OF FIGURES	vii
LIST OF TABLES.....	viii
ACKNOWLEDGMENTS	ix
DEDICATION	x
CHAPTER ONE	11
Introduction.....	11
Purpose and Significance.....	11
Research Questions.....	19
Study Overview	21
Limitations	21
Public Health Benefit.....	22
CHAPTER TWO	24
Literature Review	24
Chronic Disease Impact	24
PA Benefits	25
PA Guidelines	27
Prevalence of PA.....	28
Racial and Ethnic Disparity	29
Urbanicity	30
Socioeconomic Status	32
Colonias	34
Culturally tailored programs	35
Theoretical Foundations Related to PA	36
Social Cognitive Theory	39
Family Systems Theory	45
Family-Centered PA Programs	47
Theory of Social Networks	49

Social Networks and PA	50
Theoretical Framework.....	55
Identified Gaps.....	55
CHAPTER THREE	57
Methods	57
Purpose Statement.....	57
Hypotheses.....	57
Setting	59
Sample.....	60
Promotora Research Model.....	61
Program Curriculum Development.....	61
Intervention Components.....	62
Methods of Social Network Analysis	63
Evaluation Measures	66
Quantitative Data Analysis	69
Qualitative Data Analysis	73
CHAPTER FOUR.....	76
Will you play with me? Changes in active play social network activation for Mexican-heritage children participating in a father-focused health program	76
Abstract	76
Introduction.....	77
Methods.....	81
Results.....	87
Discussion	101
CHAPTER FIVE	107
¿Qué está haciendo papá? Changes in activation of Mexican-heritage father physical activity social networks in response to a father-focused family-centered health program	107
Abstract	107
Introduction.....	108
Methods.....	111
Results.....	116
Discussion	128

CHAPTER SIX.....	133
Conclusions.....	133
Synthesis of Study Findings.....	133
Limitations	138
Impact to Field of SNA and PA.....	139
Next Steps	140
Public Health Impact and Implications.....	141
Conclusion	142
BIBLIOGRAPHY	143

LIST OF FIGURES

Figure 2.1. Visual representation of the social cognitive theory Constructs	40
Figure 2.2. Visual depiction of family systems theory influence on individual level behavior.....	45
Figure 3.1. Visual representation of the three possible levels of analysis	71

LIST OF TABLES

Table 3.1: Coding framework for physical activity types.....	75
Table 3.2: Coding framework for types of support.....	75
Table 4.1: Descriptive statistics for child social networks	88
Table 4.2: Multilevel ordinal regression model results for child frequency of active play with alters.....	91
Table 4.3: Multilevel logistic regression model results for child perception of activity ...	94
Table 4.4: Multilevel logistic regression model results for child perception of help	96
Table 4.5: Boys self-reported physical activities with network members stratified by timepoint and alter relationship	100
Table 4.6: Girls self-reported physical activities with network members stratified by timepoint and alter relationship	101
Table 5.1: Descriptive statistics for father social networks	117
Table 5.2: Multilevel ordinal regression model results for father frequency of active play with alters.....	119
Table 5.3: Multilevel logistic regression model results for father perception of activity	122
Table 5.4: Multilevel logistic regression model results for father perception of help	124
Table 5.5: Fathers reported activities with network members	127

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DEDICATION

To my mom and dad who have supported me every step of my journey, I could not have done it without you. We are onto the next chapter.

CHAPTER ONE

Introduction

Purpose and Significance

Chronic diseases, such as cardiovascular disease, diabetes, and cancer, accounted for nearly two-thirds of deaths in the United States in 2016 (National Center for Health, 2017). These conditions create an economic burden on the American people as treatments cost the United States an estimated \$1.1 trillion in direct costs and an additional \$2.6 trillion in lost economic productivity in 2016 (Waters & Graf, 2018). It is no surprise that the United States spends more on health care than any other country and is expected to increase national health expenditures at an average rate of 5.5% annually over the next 7 years (Sisko et al., 2019). Despite this increase in spending, life expectancy is declining in recent estimates while deaths due to preventable causes are on the rise (Ho & Hendi, 2018). Behavioral risk factors, including low fruit and vegetable intake, physical inactivity, and tobacco use, are among the leading causes of chronic disease (Dietz et al., 2016; Gonzalez et al., 2017; Schulze et al., 2018). Specifically, inadequate physical activity (PA) was associated with \$117 billion in annual health care costs and roughly 10% of premature mortality in the United States (Carlson et al., 2018; Carlson et al., 2015). PA is sometimes considered the “pill not taken” in the fight to prevent chronic disease (McKenzie & Lounsbery, 2014).

PA has long been considered beneficial for health (Powell et al., 2018; United States Public Health Service Office of the Surgeon General, 1996). Specifically, regular

PA reduces the risk of several types of cancer including bladder, breast, colon, endometrium, kidney, stomach, and lung cancers (Powell et al., 2018). For children and adults, regular PA improves weight status, reduces the risk for Type 2 diabetes, and lowers risk for heart disease (Powell et al., 2018). PA is also associated with improvements in mental health including: improved quality of life, reduced feelings of anxiety and depression, and improved cognitive function (Powell et al., 2018). Despite the numerous health benefits stemming from regular PA, only 26.1% of adolescents reported they had engaged in PA for 60 minutes on each of the last seven days (Kann et al., 2018). Unfortunately, data show a marked decline in PA levels throughout childhood and adolescence (Cooper et al., 2015). Additionally, the rate of adults meeting these recommendations are declining in the United States and Latin America (Guthold et al., 2018). Many researchers credit sedentary lifestyles and other life obligations as potential reasons for this decline (Lindsay et al., 2018).

Further, disparities are noted in PA participation among racial and ethnic groups as well as urbanicity and socioeconomic status. Children of color (specifically Black and Latinx children) are significantly less likely to meet PA recommendations when compared to non-Latinx White children (Guerrero et al., 2016; Moore et al., 2013; Powell et al., 2006). This is more concerning as these populations also have the highest prevalence of obesity (Davis et al., 2011; Kenney et al., 2014). Specifically, Latinx children are 60% less likely to meet PA recommendations when compared to non-Latinx white children (Fakhouri et al., 2013a) and are also more likely to be obese or overweight (Centers For Disease Control and Prevention, 2019a; Yusuf et al., 2020). Aside from race and ethnicity, individuals in rural communities also experience disparities in chronic

disease related to physical inactivity when compared to those living in urban areas. Specifically, rural children have a greater prevalence of obesity than urban children (Davis et al., 2011; Kenney et al., 2014). Research findings are mixed regarding differences in PA levels between rural and urban children; some studies have concluded no significant differences (Davis et al., 2011; Euler et al., 2019), while some have reported children in rural communities are significantly less active (Moore et al., 2013). Still other researchers have reported adults in rural communities are also less likely to achieve the recommended levels of PA (Jackson et al., 2005; Yousefian et al., 2009). Rural residents face unique obstacles to engaging in PA including walkability and scarcely available PA resources (e.g., parks, sports/recreation facilities, playgrounds; (Hansen et al., 2015; Umstattd Meyer et al., 2016). Additionally, children from low-income neighborhoods are less active than those from more affluent areas (Burgi et al., 2016; Sallis et al., 2018). Children in these neighborhoods report more barriers and fewer supports of PA (Peralta et al., 2019). This increased prevalence of barriers and reduction in supports may be due, in part, to a lack of quality PA resources and programing (Powell et al., 2006; Sallis et al., 2018).

A region which encompasses all three of the above-described disparities (i.e., rurality, low-resource, racial/ethnic disparities) is the *colonias* along the U.S.-Mexico border. *Colonias* are defined as economically distressed communities consisting of persistently low or very-low income households based on the Federal poverty index located at or near the U.S.-Mexico border area with an outer range stretching from 50–150 miles into the U.S. (Donelson & Esparza, 2010). These communities are characterized by low or very-low-income households originally set up to address a deficit

of low-income housing within proximity to the U.S.-Mexico border area and are described as functionally rural developing areas (Mier et al., 2008; Parcher & Humberson, 2009; Ward, 1999). According to the U.S. Department of Health and Human Services, the U.S.-Mexico border region is a medically underserved area with increased social and health barriers, increased rates of poverty, and disproportionate rates of disease (Anders et al., 2010; Office of Global Affairs, 2017).

While there are many theories which have been used to explain and understand PA behavior, this work employed three main theoretical foundations. First, the social cognitive theory was used as a basis for understanding how individuals might be encouraged to change their behavior specifically through constant interaction with their social and physical environment (Bandura, 2001). Second, family systems theory was used to explain the role family plays on behavior and behavior change (Broderick, 1993). Lastly, theory of social networks was examined as a theoretical basis of influence and change among individuals seen throughout the previous two theories but also as a methodological underpinning by which these influences can be quantified and examined (Borgatti et al., 2018).

The social cognitive theory postulates behavior changes or learning happens through dynamic and reciprocal interactions between the person and their social and physical environments (Bandura, 1989, 2001). Bandura theorizes that it is within this dynamic interaction individuals adopt new behaviors or maintain existing ones (Bandura, 2001). Further, the social cognitive theory is one way to explain how individuals regulate or control their behavior through reinforcement and expectations over time (Bandura, 2001). The social cognitive theory is used to better understand many health behaviors and

is specifically useful in understanding and promoting PA (Dzewaltowski et al., 1990; Plotnikoff et al., 2013). Self-efficacy mediates the relationship between the health behavior (e.g., PA) and behavioral capability, behavioral expectations, and self-regulation through constant feedback (reciprocal determinism) and observational learning (Bandura, 2001, 2004).

Building from the social cognitive theory, family systems theory places an increased focus on the social influences and norms related to the family (Broderick, 1993). family systems theory posits that a family functions as a system wherein people are expected to interact with and respond to one another in certain ways creating family norms and social influence on health behavior (Broderick, 1993). Family norms and interactions also differ depending on racial, ethnic, and cultural differences (Taylor et al., 2013). For example, Latinx families exhibit higher levels of familism and collectivism when compared to non-Latinx White families (Ramirez et al., 2004). Familism is an emphasis on family relationships or having loyalty and pride in one's family (Sabogal et al., 2016; Steidel & Contreras, 2016). Similarly, collectivism is defined as providing financial or social support to one's familial unit above all else (Fuligni et al., 1999). This greater focus and importance given to the family strengthens the justification for the use of family systems theory in these populations.

The family environment is strongly associated with the PA of children and can help reinforce good PA habits or present barriers to these habits (Kaushal & Rhodes, 2014; Maitland et al., 2013). Capitalizing on this influence and environment, family centered programs have demonstrated success in improving the PA of children (Brown et al., 2016; Kitzman-Ulrich et al., 2010). Specifically, family centered programs which

focus on self-regulation, goal setting, reinforcement, and family functioning appear to be the most effective in promoting child PA (Brown et al., 2016; Kitzman-Ulrich et al., 2010). Many of these programs focus solely on improving the PA of children instead of improving family PA as a whole (Shonkoff & Fisher, 2013). Considering reciprocal determination as a core element to behavior change in the social cognitive theory, as well as the importance of social norms seen in both the family systems theory and social cognitive theory, one would posit that programs which simultaneously aim to improve PA of parents and children would be most effective given the reinforcement of this behavior (Rhodes & Lim, 2018). Additionally, many family focused programs fail to significantly engage fathers (Freeman et al., 2012; Morgan et al., 2017). Researchers have called for an increased focus on fathers in health research especially within Latinx populations due to the significant influence fathers have on child health behaviors and development (Davison et al., 2016; Morgan et al., 2017; O'Connor et al., 2018; Patrick et al., 2013)

Continuing the focus on intrapersonal factors and social influence, the theory of social networks and social network analysis (SNA) offer a set of combined social theories and statistical methods to analyze the role of social structure in health behavior research. Many health behavior scholars over the years have called for a renewed focus on social context as researchers are being asked to look beyond the individual nature of traditional social survey contexts (Barton, 2016; Goodson, 2010, 2015). The theoretical use of networks to understand health behavior is supported through reciprocal determination in social cognitive theory (Bandura, 2001), family influences in family systems theory (Broderick, 1993), and intrapersonal influences in socioecological models, among other

established theoretical models (McLeroy et al., 1988; Sallis et al., 2006; Sallis et al., 2015).

Social network analysis is a set of theories and methods which aim to detail, analyze, and interpret social structure and the factors which influence it (Borgatti et al., 2018). SNA can be used to determine how social structure influences or impacts health behavior and vice versa (Valente, 2010). As documented in a recent systematic literature review, researchers have consistently found a connection between adolescent PA and social network concepts (Prochnow, Delgado, et al., 2020). Specifically, researchers have studied the associations between network characteristics and PA in cross-sectional studies, the differences between peer selection and influence in longitudinal studies, and the possible moderating effects of social networks in intervention studies (Prochnow, Delgado, et al., 2020).

One particularly useful application of SNA is through a mixed method approach. Using mixed method approaches can help provide rich qualitative information to further assess the impact of one's network on health. Specifically, convergent designs employ both qualitative and quantitative methodologies simultaneously but separately with equal priority to each frame of thought. This design has also been conceptualized as a concurrent triangulation of qualitative and quantitative methodologies (Creswell, 2013). Mixed method designs have employed SNA to understand child PA behavior previously. In one group of studies, Garcia et al. examined youth obesogenic behaviors through the lens of social connection by using qualitative interviews to further explain and understand the social network results which were generated (Garcia et al., 2017; Garcia, Healy, et al., 2016; Garcia, Sirard, et al., 2016; Garcia et al., 2019).

The use of SNA to determine mediating influence on intervention effects have shown surprising results, but this use of SNA remains underdeveloped in the literature (Prochnow, Delgado, et al., 2020). In line with social cognitive theory and family systems theory, it would benefit researchers to understand the reinforcing and limiting impacts of social networks and social norms both from peers and family members to fully understand the impact of intervention programs. Further, understanding how a health program changes one's social network and subsequent activation of social ties would better explain these mediating effects. Additionally, there is a gap in understanding social network influences in Latinx populations (Prochnow, Delgado, et al., 2020). As noted previously, racial, ethnic, and cultural differences can impact the way individuals create and utilize connections particularly when it comes to family and peer influences (Pachucki & Breiger, 2010; Steidel & Contreras, 2016; Yamauchi, 1998). Further, using a mixed method approach to fill these gaps in the literature would provide a quantitative structure while simultaneously allowing the opportunity for richness in detail provided by qualitative analysis.

Building from these gaps in the literature, this dissertation aimed to use a convergent mixed method design with a SNA framework to analyze changes in the composition and activation of the social networks of Mexican-heritage fathers and children who participate in a father-focused, family-centered health program. Further, these changes were analyzed through quantitative social network measures as well as qualitative thematic analysis of activation of ties. In this manner, activation of ties was operationalized as increased frequency of PA, perception of PA, and help felt from the people in their networks. Implications of these changes are discussed in the context of

culturally tailored family-centered health programing using the social cognitive theory and family systems theory.

Research Questions

Research questions and specific hypotheses are divided into those related to children and those related to fathers in this study. Specifically, hypotheses build from the following research questions:

1. How does a father-focused family centered culturally tailored health program impact the PA networks of children enrolled in the program?
 - a. Are there differences in this change based on sex of the participant child?
2. How does a father-focused family centered culturally tailored health program impact the PA networks of fathers enrolled in the program?
 - a. Are there differences in how fathers report PA with children based on the sex of the child?

Child Hypotheses

- 1.1: Children will report active play more often within their relationships after the program.
- 1.2: Children will be significantly more likely to report relationships who are physically active regularly after the program.
- 1.3: Children will be significantly more likely to report relationships who help them to be physically active after the program.
- 1.4: Sex of the egos as well as sex of the alters will have no significant effect on the change in network measures.

1.5: Qualitatively, there will be no difference in the types of activities children report engaging in with social network members between pre- and post-program analysis.

1.6: Qualitatively, there will be no difference in the types of activities reported by children based on the sex of the child and the sex of the social network members reported.

1.7: Qualitatively, there will be no difference in the amount and types of parental support reported by children between pre- and post-program analysis.

Father Hypotheses

2.1: Fathers will report being physically active more often within their relationships after the program.

2.2: Fathers will be significantly more likely to report relationships who are physically active regularly after the program.

2.3: Fathers will be significantly more likely to report relationships who help them to be physically active after the program.

2.4: There will be no significant effect on the change in network measures based on the sex of children reported in their network.

2.5: Qualitatively, there will be no difference in the types of activities fathers report engaging in with social network members between pre- and post-program analysis.

2.6: Qualitatively, there will be no difference in the types of activities reported by fathers based on the sex of the child reported.

2.7: Qualitatively, there will be no difference in the amount and types of social support fathers report receiving from their children between pre- and post-program analysis.

Study Overview

This dissertation used a mixed method approach with a SNA framework to analyze changes in the composition and activation of the social networks of Mexican-heritage fathers and children who participate in a father-focused, family-centered health program. More specifically, this work details changes in how these individuals are physically active within their network. These changes were analyzed through quantitative social network analysis as well as qualitative thematic analysis of what these egos (central person; father or child) do with their connections most often. Additionally, comparisons based on sex are made to further understand how the sex of the children may impact these changes.

This study stemmed from a larger program to develop a father-focused, family-centered program to improve fruit and vegetable consumption, increase PA, and enhance family communication for Mexican-heritage family triads (fathers, mothers, and children) in *colonias*. The *Haz Espacio para Papi!* (Make Room for Daddy!; HEPP) program was developed as part of this larger research and outreach effort. This specific study focused on the social networks of the fathers and children who participated in this program.

Limitations

The specific focus on Mexican-heritage families residing in *colonias* limits generalizability outside this geographic area but adds vital specificity which is lacking in PA social network and family focused programming research (Prochnow, Delgado, et al.,

2020). Participants in this study were also only allowed to report five individuals with whom they were physically active which should be considered a limitation. It is possible that this left out important connections; however, limits have been used in past studies in order to limit respondent burden and in an attempt to only elicit the most important connections (adams, 2019). Studies may also wish to use more exhaustive qualitative procedures to investigate these changes in greater detail.

Public Health Benefit

This research takes a critical step towards understanding how family focused programing, such as the one investigated here, can impact the social networks of children and fathers and subsequent activation of social network ties. Often lost in the investigations of outcomes are the reinforcing or limiting behaviors exhibited in the networks of the individuals participating. Family focused programs have an implicit need to impact these behaviors and norms. Using SNA to investigate the reported change in these networks related to PA behaviors provides further information on how similar programs impact these networks. Understanding the change in networks is a vital first step towards engaging that change as a moderator or mediator of larger behavioral change (i.e., change in PA). Further, understanding the change will help to inform further changes in these programs. For example, family interaction and active co-participation in PA are goals of this program, which can be investigated using SNA. Additionally, community health programs often impact more than just the participants as the participants share their experiences and socially influence others in the community to make health changes as well (Drummond et al., 2009; Olfert et al., 2019). The use of a mixed method approach with SNA framework to investigate this broader impact may

show that program participants are influencing others in their social network potentially permeating the benefits of the program far beyond just the participants.

CHAPTER TWO

Literature Review

Chronic Disease Impact

In 2016, nearly two-thirds of deaths in the United States were attributed to chronic diseases such as cardiovascular disease, diabetes, and cancer (National Center for Health, 2017). In the same year, it was estimated that these conditions cost the United States an estimated \$1.1 trillion in direct treatment costs and an additional \$2.6 trillion in lost economic productivity (Waters & Graf, 2018). These costs mean the United States spends more on health care than any other country and is expected to increase national health expenditures at an average rate of 5.5% annually over the next 7 years according to one estimate (Sisko et al., 2019). However, despite this increase in spending, life expectancy is declining among Americans due in large part to an increase in deaths by preventable chronic disease (Ho & Hendi, 2018).

Behavioral risk factors, including low fruit and vegetable intake, physical inactivity, and tobacco use, are among the leading causes of chronic disease (Dietz et al., 2016; Gonzalez et al., 2017; Schulze et al., 2018). Specifically, inadequate PA was associated with \$117 billion in annual health care costs and roughly 10% of premature mortality in the United States (Carlson et al., 2018; Carlson et al., 2015). PA is sometimes considered the “pill not taken” in the fight prevent chronic disease (McKenzie & Lounsbery, 2014).

PA Benefits

The promotion of PA has been a significant public health focus for over 30 years (United States Public Health Service Office of the Surgeon General, 1996). Current literature reviews and guidelines note the wide range of health benefits relative to PA, which have expanded in recent years (Powell et al., 2018).

Specifically, regular PA reduced the risk of several types of cancer (Powell et al., 2018). It is estimated that regular PA reduced the risk for bladder, breast, colon, endometrial, esophageal adenocarcinoma, renal, and gastric cancers by between 10% to 20% (McTiernan et al., 2019). Further, greater amounts of PA were associated with relative risk reductions of up to 50% in all-cause and cancer-specific mortality in individuals with breast, colorectal, or prostate cancer (McTiernan et al., 2019). Additionally, patients diagnosed with cancer who maintain or increase PA throughout postdiagnosis report significantly less severe fatigue when compared to patients who reduce PA or remain inactive (Matias et al., 2019). Similarly, women diagnosed with breast cancer who increased PA or maintained sufficient PA had a significantly lower rate of overall mortality, breast cancer mortality, and cancer reoccurrence (Jung et al., 2019).

Regular PA also improves weight status and reduces the risk for Type 2 diabetes and cardiovascular disease for adults and children (Powell et al., 2018). More specifically, PA improves blood glucose control, reduces related cardiovascular risk factors, and can prevent or delay the onset of Type 2 diabetes while providing substantial health benefits to those currently living with Type 1 and Type 2 diabetes (Chen et al., 2015; Colberg et al., 2016; Yardley et al., 2014). It is estimated that physical inactivity

may be responsible for 6% to 10% of the global Type 2 diabetes prevalence (Lee et al., 2012). PA has also been associated with a decreased risk of developing cardiovascular diseases including a reduced risk of mortality due to cardiovascular disease (Kraus et al., 2019). In a cohort study on 5,861 women, light PA was associated with a 42% reduced risk of myocardial infarction and 22% reduced risk of cardiovascular disease (LaCroix et al., 2019). In children, regular PA is associated with improved cardiovascular fitness, blood pressure, and overall heart health (Proudfoot et al., 2019; Söğüt et al., 2019).

It is important to note benefits are not limited to physical health, as PA is also associated with improvements in mental health including: improved quality of life, reduced feelings of anxiety and depression, and improved cognitive function (Powell et al., 2018). This benefit is seen across the lifespan, as regular PA is related to cognitive development and learning in children (Tandon et al., 2016), and maintenance of cognitive function in older adults (Etnier et al., 2019). In children specifically, regular PA is significantly associated with lower levels of depressive symptoms and anxiety as well as increased self-image, self-esteem, and life satisfaction (Rodriguez-Ayllon et al., 2019). Further, PA is also significantly associated with improved academic performance and cognition scores for school-aged children (Singh et al., 2019). Specifically, in a 20-week classroom-based PA program, integrating PA breaks within the classroom produced significantly improved academic and cognitive performance when compared to sedentary instruction (Egger et al., 2019).

A dose-response relationship between the benefits of PA and the duration of PA has also been noted (Powell et al., 2018). It is suggested that there is no beginning threshold where benefits begin; meaning even the least active individuals would benefit

from adding even small amounts of PA (Powell et al., 2018; Warburton & Bredin, 2017). Meanwhile, reduction in risk for all-cause mortality and cardiovascular disease continue to decrease with additional PA; however, there are diminishing returns above what is recommended in the current 2018 PA guidelines (Powell et al., 2018; Warburton & Bredin, 2017).

PA Guidelines

In 2018, a revised 2nd edition of the PA Guidelines for Americans was published following a systematic process of literature and expert review (King et al., 2019; Physical Activity Guidelines Advisory Committee, 2018; Piercy et al., 2018; Powell et al., 2018; U.S. Department of Health and Human Services, 2018). Currently, children (6-17 years old) are recommended to participate in at least 60 minutes of PA each day including bone and muscle strengthening activities on at least 3 days per week (U.S. Department of Health and Human Services, 2018). Adults are encouraged to participate in at least 150-minutes of moderate-to-vigorous intensity PA (MVPA) each week for health benefits; however, additional benefits could be experienced above a 300 minutes per week threshold (U.S. Department of Health and Human Services, 2018). The adult guidelines also recommend muscle-strengthening activities on two or more days per week (U.S. Department of Health and Human Services, 2018).

Many of these guidelines have remained constant from past editions; however, the 2018 edition includes an emphasis on decreasing sedentary and sitting time. This addition is in response to the increased rates of sedentary activity (Du et al., 2019). This revision also removed the recommendation stating that PA bouts should be at least 10 minutes in duration, as recent evidence suggests benefits to PA bouts less than 10 minutes in total

duration (Piercy et al., 2018). This emphasis focuses on encouraging Americans to be active more often even if it is for short durations as it breaks up periods of sedentary behavior. The 2018 report also added recommendations for children under 6 years of age (Piercy et al., 2018; U.S. Department of Health and Human Services, 2018). Care givers for children under the age of 6 years old are recommended to encourage a variety of active play options to promote healthy growth and development (U.S. Department of Health and Human Services, 2018). While no specific amount of PA is defined, experts think 3 hours a day of active play is a reasonable target for children under 6 years of age (U.S. Department of Health and Human Services, 2018).

Prevalence of PA

Despite the numerous health benefits related with regular PA, only 26.1% of adolescents engaged in PA for 60 minutes on each of the last seven days (Kann et al., 2018). Unfortunately, data show a marked decline in PA levels throughout childhood and adolescence as they get older (Cooper et al., 2015). Currently, it is estimated that 65.2% of American adults meet the basic PA Guidelines (Du et al., 2019). However, the rate of adults meeting these recommendations are declining in the United States and Latin America (Guthold et al., 2018). Sedentary lifestyles, current hobbies, and competing life obligations may be potential reasons for this decline (Lindsay et al., 2018). Time spent by adults on sedentary behavior has significantly increased over the last ten years (Du et al., 2019).

Data also show a significant sex disparity as female children are less active than their male counterparts (Cooper et al., 2015; Lenhart et al., 2012). A scoping review reported social gender norms and social influences as a possible barrier or deterrent for

girls' activity (Spencer et al., 2015). For example, girls tend to be more active when a close friend is active, and when they perceive their entire network to be active as compared to boys (Garcia, Sirard, et al., 2016). Both direct social influence (via close friends) and indirect social influence (via perception of networks) is associated with child females' PA (Garcia, Sirard, et al., 2016). Further, girls are often expected to engage in less physically rigorous hobbies than boys, such as socializing, and might be taught to think sports are "less cool" for girls (Spencer et al., 2015). Lenhart et al. (2012) found girls who participated in regular physical education were more likely to be physically active, while the association between physical education and PA was not significant among boys. While specific programming has been developed for girls (Bean et al., 2014), further understanding differences in PA between girls and boys can lessen this disparities. Further, disparities are noted in PA attainment among racial and ethnic groups as well as across factors such as urbanicity and socioeconomic status.

Racial and Ethnic Disparity

Children of color (specifically Black and Latinx children) are significantly less likely to meet PA recommendations when compared to non-Latinx White children. Specifically, 27.1% of White children, 24.5% of Black children, and 25.8% of Latinx children reported meeting PA guidelines (Kann et al., 2018). In an analysis on parental reported National Health and Nutrition Examination Survey (NHANES) data, only 65.7% of Latinx children met recommendations as compared to 73.4% for White children and 72.5% for Black children (Fakhouri et al., 2013b). Specifically, when controlling for other variables such as age, gender, and family level socioeconomic status, Latinx children were 60% less likely to meet PA recommendations when compared to non-

Latinx White children (Fakhouri et al., 2013b). Further, minority neighborhoods (i.e., Latinx and Black neighborhoods) often have fewer PA resources and lower quality resources (e.g., parks, community resource centers, gyms) which can exacerbate these disparities (Estabrooks et al., 2003; Moore et al., 2008). This is more concerning as these populations also have the highest prevalence of and risk for obesity (Davis et al., 2011; Kenney et al., 2014). Latinx children aged 10-17 years old are also 1.5 times more likely to be obese or overweight (22.5%) as compared to White children (20.6%) (Yusuf et al., 2020). Latinx adults have an obesity prevalence rate of 33.8% nationally which is significantly higher than rates among White adults (29.9%) however lower than the prevalence among Black adults (39.8%) (Centers For Disease Control and Prevention, 2019a).

Urbanicity

Aside from race and ethnicity, individuals in rural communities also experience disparities in chronic disease related to physical inactivity when compared to those living in urban areas. Rural children have a greater prevalence of obesity (Contreras et al., 2020; Kenney et al., 2014) and were 26% more likely to be overweight or obese than urban children (Davis et al., 2011; Kenney et al., 2014). Specifically, obesity among US youth aged 10 to 17 years in rural areas was 38% compared with 30% among urban youth (US Department of Health and Human Services, 2015).

Research findings are mixed regarding differences in PA levels between rural and urban children. According to a study using NHANES data, authors reported no significant difference in the percentage of children (aged 2-18 years) who met PA recommendations between rural (65.0%) and urban (66.5%) children (Davis et al., 2011).

However, in a study which separated the age groups, authors reported that among children aged 2-11 years old, rural children (20.3%) were significantly less likely to report being active less than five days per week when compared to children in urban communities (Liu et al., 2012). The same authors reported no significant difference in the percentage of children aged 12-19 years old whom are physically active for more than 60 minutes or more per day between rural (37.4%) and urban (34.6%) children (Liu et al., 2012). Still yet, some authors have reported a significant difference as one study found children in rural communities (15.9 minutes of MVPA per day) are significantly less active than children residing in urban/suburban communities (19.2 minutes of MVPA per day) (Moore et al., 2013). Authors have also reported that rural residents attained significantly less minutes of MVPA (42.5 ± 6.2 minutes per week) when compared to urban residents (55.9 ± 2.8 minutes per week) as measured by an accelerometer (Fan et al., 2014). A more recent analysis of trends in adult PA meeting PA guidelines by urbanicity reported that rates of PA are increasing more rapidly among rural adults (13.3% in 2008 to 19.6% in 2017 corresponding to a 47.4% increase) when compared to adults in urban areas (19.4% in 2008 to 25.3% in 2017 corresponding to a 30.4% increase)(Whitfield et al., 2019). It is important to note that despite this increase rural adults are still significantly less likely to meet PA guidelines when compared to urban adults (Whitfield et al., 2019).

These disparities may be due to a difference in barriers to PA experienced in these communities. Specifically, rural residents face unique obstacles to engaging in PA including walkability and scarcely available PA resources (e.g., parks, sports/recreation facilities, playgrounds) (Hansen et al., 2015; Umstattd Meyer et al., 2016). In a

qualitative focus group study, youth in rural areas mentioned a lack of PA resources and PA opportunities as barriers to engaging in PA in their community (Kumar et al., 2016).

Socioeconomic Status

Children from low-income neighborhoods are less active than those from more affluent areas (Burgi et al., 2016; Sallis et al., 2018). Specifically, Sallis et al. investigated the associations between child PA and neighborhood socioeconomic status as well as its interaction with neighborhood walkability scores (Sallis et al., 2018). Authors reported a significant main effect ($p=.01$) for income stating for average minutes of MVPA per day between children in low-income areas (low walkability – 27.6 ± 4.2 ; high walkability – 32.5 ± 4.2) and children in high income areas (low walkability – 30.9 ± 4.1 ; high walkability – 35.8 ± 4.1) (Sallis et al., 2018). In an international study using spatially tracked monitoring, Burgi et al. reported that children from high socioeconomic neighborhoods recorded significantly more accelerometer measured minutes of MVPA per day in streets (median=102.8 min), parks (median=18.2 min), sport facilities (median=6.7 min), and outside their home (median=5.5 min) when compared to children from low socioeconomic status neighborhoods (median=69.3 min; 3.3 min; 1.1 min; 0.1 min respectively) (Burgi et al., 2016). There were no significant differences based on socioeconomic status reported in this study for MVPA at home and school (Burgi et al., 2016)

Children in these neighborhoods also face more barriers and less enablers to PA (Peralta et al., 2019). Specifically, when assessing barriers and enablers to PA at the school level, students in low socioeconomic schools faced more overall barriers (3.1 vs 1.7; $p < .001$), curriculum and teaching barriers (2.0 vs .6; $p < .001$), intrinsic factor

barriers (1.1 vs 1.0, respectively; $p < .001$), and barriers related to school policy and environment (.24 vs .16; $p < .001$) (Peralta et al., 2019). This same study reported that students in low socioeconomic schools were also less likely to be encouraged to walk or bike to school, be active outside of school, use equipment or PA facilities, and less likely to have PA be included as a main focus of health and physical education classes (Peralta et al., 2019).

This increased prevalence of barriers and reduction in enablers may also be due to a lack of quality PA resources and programming in low-income areas (Powell et al., 2006; Sallis et al., 2018). Based on analysis conducted by Powell et al. moving from a community with a median household income level of \$25,000 to one with a median income level of \$75,000 would increase the likelihood of the presence of physical fitness facilities by over 17% (Powell et al., 2006). Low-income neighborhoods were 4.5 times more likely to not have PA facilities or parks than high-income areas (Moore et al., 2008). This is of vital importance as one study reported that while adult women who live in lower socioeconomic neighborhoods reported significantly less moderate and vigorous activity when compared to women in moderate and high-socioeconomic status neighborhoods, there was a significant interaction between PA resource availability and socioeconomic status suggesting that those who live in lower-socioeconomic status neighborhoods may differentially benefit from greater PA resource availability (Lee et al., 2007). Children from low socioeconomic status families also are significantly less likely to report participating in organized sports (Johnston et al., 2007; Sallis et al., 2018). A survey of recreation center directors reported that low-income youth were the most difficult to reach with the current programming offered (Moody et al., 2004).

Colonias

Several of the previously mentioned disparities are present in neighborhood communities known as *colonias* along the U.S.-Mexico border. These communities were originally founded in response to a rapidly growing population and need for low-income housing near the U.S.-Mexico border area (Mier et al., 2008). *Colonias* are typically defined as economically distressed communities of low income Mexican-heritage households located at or near the U.S.-Mexico border area (Donelson & Esparza, 2010). Many *colonias* lack infrastructure and are described as functionally rural developing areas (Parcher & Humberson, 2009; Ward, 1999). Approximately 500,000 people live in *colonias* located along the Texas-Mexico border (Barton et al., 2015). According to the U.S. Department of Health and Human Services, this region is a medically underserved area with increased social and health barriers, increased rates of poverty, and disproportionate rates of disease (Anders et al., 2010; Office of Global Affairs, 2017).

Specifically, residents of *colonias* along the Texas-Mexico border are classified as a systematically underserved population due to their rural geographic location, rates of poverty, and disproportionate obesity rates often due to decreased PA, increased sedentary behavior and dietary habits (Anders et al., 2010; Waisel, 2013). Many residents in this area live near (19%) or below (42%) the poverty line which is substantially higher than the Texas (10.9% and 17.0%) and United States (9.2% and 14.3%) averages (U.S. Census Bureau, 2011). In a study in *colonias* in Cameron County (Fisher-Hoch et al., 2012), the weighted prevalence of diabetes was 30.7% which is substantially higher than the reported national rates of 10.5% (Centers for Disease Control and Prevention, 2019b). Other recent studies examining the health of individuals in *colonias* have found high rates

of obesity (41.3%-55.5%), diabetes (32.5%) hypertension (23.6%-39%), hypercholesterolemia (20.4%), and depression (19%-29%) (Manusov et al., 2019; Marquez-Velarde et al., 2015; Millard et al., 2017; Olvera et al., 2015; Watt et al., 2016). This area also has alarming rates of low or very low food security among children (reported at 64%) which is also associated with poor diet (Sharkey et al., 2012). Previous research has reported unleashed dogs in the street, heat, bad weather, traffic, no streetlights, and no place like a park to exercise as the most frequent barriers to PA for children in these areas (Tyler Prochnow et al., 2019; Umstattd Meyer et al., 2013). Further, few *colonias* have PA resources like parks and other public spaces for residents to be active (Federal Reserve Bank of Dallas, 2015).

Culturally Tailored Programs

Given these disparities and unique health challenges, it is important to take into account the specific community and culture within which a health program is to be implemented to culturally tailor the program to fit the individual needs of the community (Israel et al., 2019; Satcher, 2005). The goal of community-based participatory research is to develop a more focused program by fostering greater buy in from the community to ultimately create greater fidelity and specification in programing due to the consistent feedback from the community and participation in the research process (Israel et al., 2019). While this approach leads to more focused programing, it also makes generalization and dissemination difficult at times. Programs may not be as effective in every community or culture. In this manner it is vital for researchers and practitioners to engage the community in the planning and development of such programming.

When conducting community-based participatory research, it is vital for academic researchers to partner with members of the community to provide cultural and contextual grounding (Israel et al., 2019; Satcher, 2005). These members may be known by different names including community health advisors, community health workers, and lay educators (Scott et al., 2018). Often, community health workers in Latinx communities are known as *promotoras de salud* (female promoters of health), or simply *promotoras* (Cassandra M Johnson et al., 2013; St. John et al., 2013). *Promotoras* are trusted by community residents and serve as cultural bridges. They also provide a better view of the community context and are typically chosen based on their ability to develop partnerships within the community, two key dimensions of community based participatory research (Israel et al., 2019; Matthew et al., 2020). Programs which employ a *promotora* model are effective in decreasing health disparities present in Latinx communities such as access to health care and chronic disease prevention and management (Ayala et al., 2010; Matthew et al., 2020). Specifically, *promotoras* were successful at increasing PA through a faith-based PA program in San Diego, California which offered free PA classes taught by *promotoras* (Arredondo et al., 2017). Similarly, a group of *promotoras* in South Texas were able to significantly increase participants MVPA through leading weekly PA educational sessions and guided PA at community resource centers (Salinas & Parra-Medina, 2019).

Theoretical Foundations Related to PA

Health behavior theories are often used to better understand health behavior change and future health behavior (US Department of Health & Human Services, 2005). The use of health behavior theories provides a systematic way for researchers to

understand the underlying factors related to the behavior and successful behavior change (US Department of Health & Human Services, 2005). A theory is defined as a set of concepts, constructs, or variables which systematically model a behavior, belief, or change in behavior (US Department of Health & Human Services, 2005). These models provide health researchers and practitioners a blueprint to understand and promote healthy behaviors. Theories may be at the intrapersonal, interpersonal, or community levels or across multiple levels (US Department of Health & Human Services, 2005). These levels are also based in the Social Ecological Model which examines influences of health across multiple levels (McLeroy et al., 1988). Recently there has been a call for theoretical approaches at multiple levels (Walsh et al., 2017) as well as a renewed focus on how the theory may interact within the context of behavior change specific to health interventions (Moore & Evans, 2017). Further, Moore & Evans (Moore & Evans, 2017) state that a broader interdisciplinary conceptualization of theory may be vital to enhancing the use of theory within health intervention research.

Starting with the intrapersonal level, theories such as the Health Belief Model (Rosenstock et al., 1988), Transtheoretical Model (Marcus & Simkin, 1994; Prochaska & DiClemente, 2005), and Theory of Planned Behavior (Ajzen, 1991) have all been used to examine PA (King et al., 2002; Ng et al., 2018). In a study which employed a two month educational program directed at the constructs of perceived severity, perceived susceptibility, perceived benefits, perceived barriers within the Health Belief Model, researchers reported a significant increases in PA among a sample of women (Hoseini et al., 2014). In a study on college students framed within the Health Belief Model, authors reported significant correlations between the number of perceived benefits, barriers, cues

to action, and vigorous PA (King et al., 2013). Additionally, PA levels were significantly influenced by perceived barriers in a sample of primary school children; however, cues to action and perceived benefits were not significantly associated with PA levels (Ar-Yuwat et al., 2013). The Transtheoretical Model may be helpful in determining the stage of change in behavior; however, literature reviews on PA studies using this model have been inconsistent and have not applied the theory accurately across the studies (Hutchison et al., 2008). In a study on rural low-income women framed in the Transtheoretical Model, individuals in the intervention group were significantly more likely to move from the contemplation stage to the action/maintenance stage (56% compared to 31% in control; Ries et al., 2014). Further, children who progressed through the stages of change in the Transtheoretical Model were significantly more physically active than children who remained in the same stage or regressed stages (Zachary et al., 2015). The Theory of Planned Behavior was used to understand the determinants of PA among a sample of Mexican-American children explaining roughly 9% of variance in MVPA reported (Jeffrey et al., 2007). Among the constructs in the Theory of Planned Behavior, attitude, subjective norm, and perceived behavioral control accounted for 45% of the variance explained in the study (Jeffrey et al., 2007).

At the community level, some authors have used theories such as the Diffusion of Innovations Theory (Rogers, 2010) to explain the spread of PA and PA related policy (Ng et al., 2018). Mainly this theory has described policy dissemination and implementation largely regarding evidence-based PA and physical education practices (Stephenson et al., 2018). Studies employing this model have reported the need for

engaged stakeholders, and dissemination avenues that are trusted (Egan et al., 2019; Tremblay et al., 2016).

While there are many theories which have been used to explain and understand PA behavior, this work will employ three main theoretical foundations. First, social cognitive theory was used as a basis for understanding how individuals might be encouraged to change their behavior (Bandura, 2001). Second, family systems theory was used to explain the role family influences play on behavior and behavior change (Broderick, 1993). Lastly, the theory of social networks was examined as a theoretical basis of influence and change between individuals seen throughout the previous two theories but also as a methodological underpinning by which these influences can be quantified and brought to light (Borgatti et al., 2018). These three theories have been used to investigate PA at the interpersonal level and given the proposed projects foci are ideal theories to study PA and change in PA (Ng et al., 2018).

Social Cognitive Theory

Social cognitive theory postulates behavior change or learning happens in dynamic and reciprocal interactions between the person and their social and physical environment (Bandura, 1989, 2001). Bandura theorizes that it is within this dynamic interaction individuals adopt new behaviors or maintain existing ones (Bandura, 2001). Further, social cognitive theory is one way to explain how individuals regulate or control their behavior through reinforcement and expectations over time (Bandura, 2001). Social cognitive theory is used to better understand many health behaviors and is specifically useful in understanding and promoting PA (Dzewaltowski et al., 1990; Plotnikoff et al., 2013). Social cognitive theory includes reciprocal determinism, self-efficacy, behavioral

capability, outcome expectations, self-regulation, and observational learning as constructs (Bandura, 2004). Self-efficacy mediates the relationship between the health behavior (e.g., PA) and behavioral capability, behavioral expectations, and self-regulation through constant feedback (reciprocal determinism) and observational learning (Bandura, 2001, 2004). Figure 2.1 displays the constructs of the social cognitive theory.

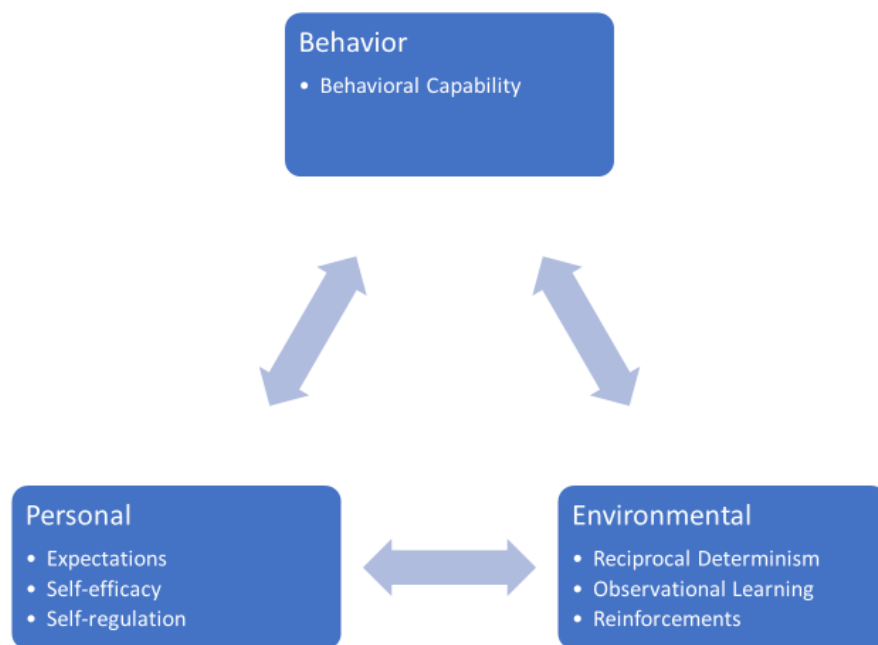


Figure 2.1: Visual representation of the social cognitive theory constructs

Self-efficacy is one of the most cited individual level correlates of PA in adults and children and is a main construct of social cognitive theory (Choi et al., 2017; Sterdt et al., 2013). Self-efficacy is the belief in one's ability to perform an action (Bandura, 1989, 2001; Bandura et al., 1999). Individuals who feel more confident in their ability to perform a given behavior are more likely to follow through with the behavior (Bandura, 2004). Self-efficacy is associated with increased PA and is both as a covariate of PA and

a mechanism to increase PA over time (Annesi, 2006; Hamilton et al., 2017; Verloigne et al., 2016). More specifically, in an analysis of adolescent PA behaviors, self-efficacy was significantly associated with intention to engage in PA ($r=.80$) and showed a moderate association with vigorous PA, but the effect was moderated by intention (Hamilton et al., 2017). Similarly, self-efficacy mediated the relationship between social support and PA among a sample of adolescent girls (Verloigne et al., 2016). This mediating effect is modeled within the social cognitive theory. In a sample of middle school students, self-efficacy was significantly correlated with average steps per day ($r=.27$) and aerobic fitness ($r=.24$) while being negatively associated with BMI ($r=-.24$) (Manley et al., 2014). In adults, a meta-analysis reported a significant pooled effect for self-efficacy on PA ($d=.37$) (French et al., 2014). Self-efficacy was also significantly associated ($\beta=.28, p<.001$) with self-reported PA in college students (Joseph et al., 2014). Within a study of middle aged adults self-efficacy was significantly associated with self-reported PA ($r=.50$) (Ayotte et al., 2010).

Similarly, behavioral capacity refers to one's own ability to perform the behavior with the knowledge or direct skills to do so (Bandura, 2001). This is shown through health and physical literacy as well as physical skill competence. Health literacy refers to the knowledge or understanding of healthy behaviors particularly in the understanding of health and clinical decisions, options, or resources (Nutbeam, 2008). Those with lower health literacy are less likely to meet guidelines for PA (Geboers et al., 2014). Additionally, authors in this study found associations between health literacy and PA are significantly mediated by self-efficacy (Geboers et al., 2014). Further, physical literacy is the motivation, knowledge, competence, and understanding of physical activities and

movements (Edwards et al., 2017; Whitehead, 2013). Physical literacy in children is significantly associated with overall health and greater PA as well as improved academic performance (Edwards et al., 2017). Similarly, physical skill competency is significantly associated with increased child PA (Inchley et al., 2011) and improved health and wellbeing (Powell et al., 2018).

Outcome expectations refer to the anticipated benefits or consequences of one's behavior (Bandura, 2001). These expectations, as with the other constructs of social cognitive theory, are consistently influenced by social context as well as mediated by self-efficacy. Individuals who believe there to be a large benefit to the behavior will be more motivated to adopt and continue the behavior (Rosenstock et al., 1988). In this way, the social cognitive theory is similar to the health belief model which centers around this hypothesis (Rosenstock et al., 1988). Specifically, individuals who perceive more benefits to being physically active are more likely to be active on a regular basis (King et al., 2013). Outcome expectations were significantly associated ($r=.26$) to self-reported PA in a sample of adults (Ayotte et al., 2010). Similarly, researchers have reported a significant association ($r=.42$) between outcome expectations and self-reported PA in adolescent girls (Taymoori et al., 2010).

Self-regulation is one's perception of control over behaviors or emotions in correspondence with desired intentions (Hall & Fong, 2007). For example, one's ability to habitually choose active options instead of sedentary activities. Self-regulation is also positively associated with PA (Anderson et al., 2006; Padin et al., 2017). Adults who reported a higher ability to self-regulate were active longer and at greater intensities as compared to those with lower self-regulation (Anderson et al., 2006; Padin et al., 2017).

Self-regulation strategies are strategies to reinforce personal regulation of a behavior typically in the form of goal setting, behavior preparation, overcoming barriers, and self-monitoring (Bandura, 2005). These strategies have consistently been found to be positively associated with PA as well as associated with the promotion of PA in a variety of samples. Self-regulation showed a large significant association with MVPA ($r=.52$) in a sample of older adults (Umstattd et al., 2008). A brief intervention directed at increasing self-regulation behavior among adults with type 2 diabetes resulted in significant increases in PA ($d=.76$, $p<.01$; Olson & McAuley, 2015). Similarly, authors reported that self-regulation contributed the most to variance explained (11.2% out of 42.4%) in a multivariate assessment of social cognitive theory constructs and PA in adults with type 2 diabetes (Heiss & Petosa, 2016). Goal setting, one form of self-regulation, was significantly associated ($r=.13$) with average steps per day in a sample of elementary school children (Ramirez et al., 2012).

Reciprocal determinism refers to the interaction between the person and their surrounding environment (Bandura, 2001). In other words, the individual, with their own set of skills and learned experiences, is constantly interacting with the external social and physical environment which provides feedback regarding the individual's beliefs and behaviors. This interaction can be thought of as positive feedback from reinforcement of the behavior through social support from one's network or even negative feedback from unintended or negative consequences of one's actions (Bandura, 1989). Both types of influence are heavily related to the social context or social norms present. Social norms are unwritten rules or influences on how to behave dictated by the social context or networks in which an individual resides (Reid et al., 2010). Social norms of PA are

effective in promoting further PA in children and adults (Kim et al., 2017). Social support was significantly associated ($r=.35$) with self-reported PA in a sample of middle-aged adults (Ayotte et al., 2010). Similarly, social support from parents and peers is significantly related to child PA (Beets et al., 2010; Prochaska et al., 2002). Parental support was significantly associated ($r=.38$) with child PA in a combined meta-analysis of effect (Yao & Rhodes, 2015). In a study using accelerometers, children with parents who provided above average levels of support participated in more minutes of MVPA (114.2 vs. 98.3, $p=.03$; Hennessy et al., 2010). In terms of peer support, Haidar et al. reported that for every 1-point increase in peer support, adolescents had 1.17 higher odds of engaging in MVPA five or more days per week ($p<.001$; Haidar et al., 2019).

Social cognitive theory also places a high value on observational learning (Bandura, 2001). Observational learning is a key first step in building self-efficacy and, in turn, promoting the behavior in question. For example, parental modeling of PA is associated with higher PA among children (Beets et al., 2010). Further, while this modeling is important for child development, research suggests a greater focus should be placed on the quality and amount of this support in the form of co-participation in active play opportunities (Wright et al., 2008). Parental modeling was significantly associated ($r=.16$) with child PA according to a recent meta-analysis combination of random effect models (Yao & Rhodes, 2015). Self-reported child PA and parental PA were significantly associated ($r=.44$) in a longitudinal dyadic study (Brandon et al., 2010). Further, parental modeling behavior was significantly associated ($r=.12$) with accelerometer measured child PA (Østbye et al., 2013).

Family Systems Theory

Building from the social cognitive theory, family systems theory places an increased focus on the social influences and norms related to the family (Broderick, 1993). Family systems theory posits that a family functions as a system wherein people are expected to interact with and respond to one another creating social influence on health behavior (Broderick, 1993). In this sense, the family acts as a complex and dynamic combination of family members who influence and are influenced by each other in a circular or reciprocal way (Broderick, 1993). It is theorized that to better understand the health behaviors of one family member it is critical to understand the familial social influences and social norms present (Broderick, 1993). Figure 2.2 displays a theoretical circle of influence and how family systems impact individual level behavior. This depicts how family social norms generate social influence which impact individual level behavior which in turn generates feedback from the system that may or may not impact the family social norm.

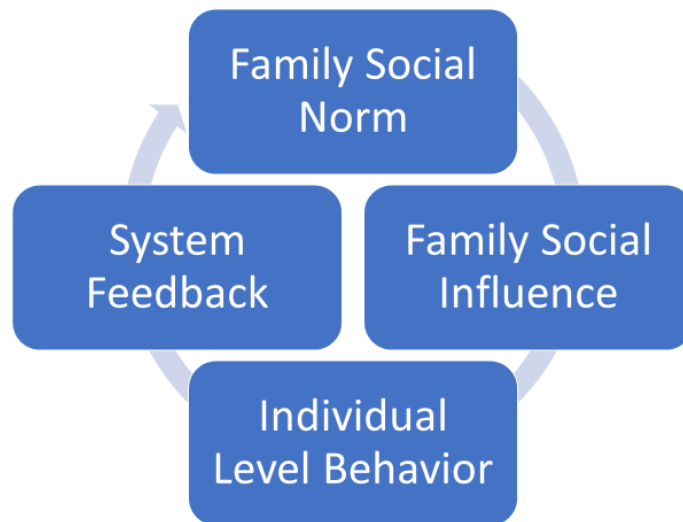


Figure 2.2: Visual depiction of family systems theory influence on individual level behavior.

The family environment is strongly associated with the PA of children and can help reinforce good PA habits or present barriers to these habits (Draper et al., 2015; Kaushal & Rhodes, 2014; Maitland et al., 2013). In this sense, the family social norm is the generally accepted way of acting or belief regarding a behavior which has been developed by the family unit and is impacted by outside social forces as well as familial behavior (Broderick, 1993). These higher order norms typically defined as subjective social norms (norms that have been enforced by others perceived as important) can also contribute to levels of family cohesion and family functioning if the perceived norms are in fact followed (Broderick, 1993; Ravis & Sheeran, 2003). Higher family functioning is associated with higher levels of PA ($\beta=.03$, $p=.03$) and lower risk of obesity ($\beta=-.05$, $p=.01$) for children (Berge et al., 2013).

Further, the familial social norms significantly influence individual level behaviors in the form of family behavioral influence or behavior similarity and familial social support (Beets et al., 2010; Pedersen et al., 2015). For example, family influence ($r=.14$, $p<.01$) was more significantly associated with child eating behavior than peer influence ($r=.02$) (Pedersen et al., 2015). Further, authors in this study suggested parental actions ($r=.40$) were more important than what they said ($r=.32$) relating to eating behaviors of their children (Pedersen et al., 2015). Similarly, parental PA has been significantly associated ($r=.21$) with child PA in a study of 8-11 year old children (Jacobi et al., 2011). In a family study, when both parents reported being active, boys had nearly two times higher odds of being active and girls had nearly three times higher odds of being active (Martin-Matillas et al., 2011). Reciprocated encouragement to engage in PA in Mexican-American parent child dyads was significantly associated with co-

participation in PA (de la Haye et al., 2014). Encouragement and co-participation are both significant factors in parental social support (Beets et al., 2010). Specifically, perceptions of paternal tangible support were significantly associated with MVPA behavior ($\beta=.28$, $p=.003$) in a sample of children (Brunet et al., 2014). Tangible social support is either providing equipment or transportation for PA or co-participating in PA (Beets et al., 2010). Intangible social support on the other hand is motivational or informational in nature (Beets et al., 2010).

Family-Centered PA Programs

Capitalizing on this influence and environment, family-centered programs are successful in improving the PA of children (Brown et al., 2016; Kitzman-Ulrich et al., 2010). Specifically, family-centered programs which focus on self-regulation, goal setting, reinforcement, and family functioning appear to be the most effective in promoting child PA (Brown et al., 2016; Kitzman-Ulrich et al., 2010). Many of these programs focus solely on improving the PA of children instead of improving family PA as a whole (Shonkoff & Fisher, 2013). Considering the reciprocal determination noted by the social cognitive theory as well as the importance of social norms seen in both the family systems theory and social cognitive theory, one would posit that programs which simultaneously aim to improve PA of parents and children would be most effective given the reinforcement of this behavior (Rhodes & Lim, 2018). Additionally, many family focused programs fail to significantly engage fathers (Freeman et al., 2012; Morgan et al., 2017). Researchers have called for an increased focus on fathers in health research especially within Latinx populations due to the significant influence fathers have on child

health behaviors and development (Davison et al., 2016; Morgan et al., 2017; O'Connor et al., 2018; Patrick et al., 2013).

One notable exception to this gap is the ‘Healthy Dads, Healthy Kids’ program (Morgan et al., 2014; Morgan, Lubans, Callister, et al., 2011; Morgan, Lubans, Plotnikoff, et al., 2011). This program aimed to engage fathers to be active participants in the healthy life choices of their children (Morgan, Lubans, Callister, et al., 2011; Morgan, Lubans, Plotnikoff, et al., 2011). ‘Healthy Dads, Healthy Kids’ involved informational and PA based sessions which promoted engagement between the father and their children in hopes to improve the health and wellbeing of both (Morgan et al., 2014). This dual focus program is effective in promoting PA in both fathers and children as well as encourage healthy weight status (Morgan et al., 2014). However, while the “Healthy Dads, Healthy Kids” program may be effective in certain populations, it may not be applicable to all communities and cultures.

Family norms and interactions differ depending on racial, ethnic, and cultural differences (Taylor et al., 2013). For example, Latinx families exhibit higher levels of familism and collectivism when compared to non-Latinx White families (Ramirez et al., 2004). Familism is an emphasis on family relationships or having loyalty and pride in one’s family (Sabogal et al., 2016; Steidel & Contreras, 2016). Similarly, collectivism is defined as providing financial or social support to one’s familial unit above all else (Fuligni et al., 1999). Hence, a program like ‘Healthy Dads, Healthy Kids’ would need to be tailored to fit the cultural context as related above.

Theory of Social Networks

Continuing the focus on intrapersonal factors and social influence, theory of social networks and social network analysis (SNA) offers a set of combined social theories and statistical methods to analyze social structure in health behavior research. More specifically, SNA aims to detail, analyze, and interpret social structure and the factors which influence how people connect and what those connections mean for health behavior (Borgatti et al., 2018). In this manner, researchers are placing a higher importance on understanding the connections between individuals instead of only the attributes of the individuals (Borgatti et al., 2018). SNA can be used to determine how social structure and influences impact health behavior and vice versa (Valente, 2010). SNA as a method is used in many health fields including adolescent obesity behaviors (Fletcher et al., 2011; Prochnow, Delgado, et al., 2020), teen smoking (Seo & Huang, 2012), mental health (Albert et al., 1998), college health (Patterson & Goodson, 2019), and health care provider networks (Bae et al., 2015).

Some main underlying concepts and theories which make up the theory of social networks includes homophily, network position, and social capital (Borgatti et al., 2018). Homophily is also known as the phenomena in which individuals are more likely to connect to those with whom they share something in common (McPherson et al., 2001). This preferential connection may be due to demographic similarities such as race or gender (Laniado et al., 2016) or behavior such as smoking, eating, or PA (Berry et al., 2018). The concept of network position confers that a person's position within a network influences their behaviors or beliefs (Valente, 2010). For example, in a study investigating social connections and body dissatisfaction among a sample of college

sorority women, women who were on the periphery of the network reported significantly more body dissatisfaction (Prochnow et al., 2019). Similarly, social capital is the amount of support, information, or resources an individual has access to through their social network connections (Dubos, 2017). Many times, social capital is split into bonding social capital and bridging social capital (Dubos, 2017). Bonding social capital is formed with close social connections and tends to provide the person with more social support (Dubos, 2017). Bridging social capital on the other hand constitutes loose social connections on the periphery of their network which may provide information or a differing viewpoint (Dubos, 2017). Bridging social capital provides less social support but can be particularly useful due to its ability to supply information from outside the insulated close network (Dubos, 2017). Specifically when assessing social capital among mothers, greater diversity of network contacts based on the occupation of network members (OR=1.11, 95% CI=1.03, 1.20, $p=.02$) and a higher percentage of physically active network members (OR=1.97, 95% CI=1.02, 3.82, $p=.04$) were associated with higher odds of meeting PA guidelines (Child et al., 2017). Among less educated adults, having more bridging social capital reduced the likelihood of obesity (OR 0.58, 95% CI 0.38–0.88), compared to those reporting more bonding social capital (Kamphuis et al., 2019).

Social Networks and PA

Researchers have consistently found a connection between adolescent PA and social network concepts (Prochnow, Delgado, et al., 2020). Specifically, researchers have studied the associations between network characteristics and PA in cross-sectional studies, the differences between peer selection and influence in longitudinal studies, and

the possible moderating effects of social networks in intervention studies (Prochnow, Delgado, et al., 2020).

Network characteristics such as homophily and network composition have been significantly associated with PA in several cross-sectional studies. Homophily is a similarity in demographic or behavioral characteristics; this similarity is noted to increase the odds of connection between the individuals (McPherson et al., 2001). For example, there is a significant association between an adolescent girl's PA and the PA of her nominated best friend ($r=.45$) (Schofield et al., 2007). Further, MVPA and sedentary time for children were significantly associated with that of their friends in a sample of 8 and 9-year-old children (Salway et al., 2018). The relative association between the child's measure and measure of their friends (also termed network autocorrelation) was greater for boys' MVPA ($I=0.21$) and sedentary time ($I=0.14$) than girls' MVPA ($I=0.13$) and sedentary time ($I=0.11$), yet both were statistically significant (Salway et al., 2018). Children also exhibit significant similarity to their social connections in reported barriers to PA (Prochnow, van Woudenberg, et al., 2020), team sport participation (Prochnow, Patterson Megan, et al., 2021), and perceived skill competency (Prochnow, Patterson, Bridges Hamilton, et al., 2020). Similar effects have been exhibited in adults as preference and tolerance for high-intensity exercise exhibited the same network autocorrelation among a sample of adults at CrossFit gyms (Patterson et al., 2020). Adults who did not report regular PA were significantly more likely ($p<.001$) to report fewer network members who were physically active when compared to those who were active regularly (Mötteli & Dohle, 2020).

Network composition, or the overall collection of attributes or behaviors in one's network, is commonly reported in various ways associating network measures to PA. Greater levels of friends' MVPA was associated with greater levels of MVPA in both males ($p < .001$) and females ($p < .001$) in a sample of children (Garcia, Sirard, et al., 2016). A higher number of friends ($OR = 1.38$) and greater proportion of same sex friends ($OR = 4.43$) were associated with boys engaging in more MVPA outside of school hours (Marks et al., 2015). For adults, those who reported more friends overall and greater social integration predicted higher odds ($OR = 1.24$) of meeting PA guidelines (Larsen et al., 2014). Further, among a sample of Latinx adults, network size, familial ties, contact frequency were associated with increased MVPA (Marquez et al., 2018). Additionally, having more regular exercisers in an adult's network was associated with higher PA levels ($\beta = 1.18, p < .001$; Mötteli & Dohle, 2020).

Several longitudinal studies have investigated the differences between peer selection (the formation of friendships based on an attribute or behavior) and peer influence (the process of becoming more like friends). Both selection and influence effects are reported in the literature which may suggest both are happening simultaneously within social networks (Prochnow, Delgado, et al., 2020). In a longitudinal analysis data from the National Longitudinal Survey of Adolescent Health (Add Health), researchers reported that a 10% increase in the proportion of friends who exercise was associated with a 0.79% ($p = 0.025$) greater likelihood that the individual exercises (Ali et al., 2011). In a study on Australian children, both selection and influence effects were significant; however, influence descriptively explained more variance in the model (47%-29%) compared to selection (23%-11%) across time points and groups (de la

Haye et al., 2011). Further, in a similar study children who had a higher proportion of total friends who were perceived as being very active at baseline was predictive of more MVPA and less sedentary time at follow-up (Marks et al., 2018). In a sample of children in an after-school program, children were significantly more likely (OR=6.89) to become more like their friends in PA over time (Gesell et al., 2012). However, when this effect was tested on multiple after school programs, the effect of PA was not significant across all models (Henry et al., 2016). For adults, a latent growth curve analysis determined that changes in social integration over time significantly predict changes in PA ($\beta = 0.12$, $P < .05$; (Lightner et al., 2018). Further, a longitudinal study on walking partners found an increase in stability of connections (8%-11% to 36%-45% stability measured by Jaccard index) suggesting walking partners, once established, remained stable across the study (Hunter et al., 2015). Additionally, those engaged in PA with others maintained higher activity levels of PA throughout the follow-up time (Hunter et al., 2015).

Further, SNA can be used to determine change agents and understand mediating factors in intervention studies related to PA. In this manner, SNA can determine if the presence or absence of a particular type of connection impacts the effectiveness of interventions. Researchers used empirically measured social networks to develop simulation models to test the diffusion of PA across a network of children in an after-school program (Zhang et al., 2015). Researchers concluded that targeting opinion leaders (children who were nominated as friends most often) within the program would be the most effective in increasing the average level of PA across the entire network; however, a program which would target the most sedentary children would be best at increasing the total amount of children who meet recommendations (Zhang et al., 2015).

Another simulation in a school setting determined closeness centrality (a measure of how many paths or connections between people an individual would have to “travel” to get to others in the network) to be the most effective way to increase PA across a school network (van Woudenberg et al., 2019). Children with higher closeness scores were also perceived to be significantly more physically active among a sample of children in an after-school setting ($\beta=.33$, $p<.01$) (Prochnow, Patterson, & Umstattd Meyer, 2020). Researchers then tested this hypothesis by completing a SNA prior to an intervention to determine change agents or thought leaders within a network using closeness centrality (van Woudenberg et al., 2018). These adolescents with the most influential closeness centrality scores were trained to be peer health promoters through vlogs (video blogs). While this intervention showed no significant difference between intervention effect and control group ($b=.04$, $SE=.10$, $p=.66$), the method opens the door to future studies using centrality measures as identification of intervention points (Valente & Pumpuang, 2007; van Woudenberg et al., 2018; van Woudenberg et al., 2019). In another study, intervention effectiveness was moderated ($b=-.16$, $p<.05$) by the presence of sedentary behavior within the adolescent’s network (Shin et al., 2014). In other words, the intervention program mitigated the detrimental influence of peer sedentary behavior if it was present (Shin et al., 2014).

There is less published literature on network interventions among adult populations (Shelton et al., 2019). As part of a community based healthy lifestyles program, researchers reported that being a person who connected clusters of intervention participants at any point during the intervention predicted an average reduction of 31.3 min/day of sedentary behavior (Gesell et al., 2020). In another notable intervention study,

researchers used a controlled experimental study to understand the spread of a health innovation through fixed social networks in which the level of homophily was independently varied across groups to determine if differing levels of sameness in PA would impact adherence and increase PA (Centola, 2011). The success of this intervention was judged on the number of “adopters” or individuals that joined the program and maintained activity on the online site. By week four of the seven-week program adoption levels were significantly higher among groups with higher levels of homophily ($p < 0.01$) (Centola, 2011). While this showed an increase in engagement it did not report increases in PA behaviors in these groups (Centola, 2011).

Theoretical Framework

This study was built on each of these theories to add the current base of literature. Further, the study examined reciprocal determinism, observational learning, and social reinforcements from the social cognitive theory. These three constructs are framed in the family systems theory as these influences and mechanisms of change are further investigated with a decided focus on the family and PA with family members specifically between the father and child. Expanding from this focus, the theory of social networks informed the investigation of social influence and change in social influence from both peers and family.

Identified Gaps

From this framework, this study aimed to fill several gaps in the literature. Specifically, the use of SNA as part of an intervention research design is still a gap in the PA literature which warrants further investigation, specifically outside of the school

context (Prochnow, Delgado, et al., 2020). Further, the use of a mixed method approach is particularly beneficial in understanding these changes in networks. The use of SNA to determine mediating influence on intervention effects have shown surprising results; however, to this point there are limited results using mixed method approaches in SNA and hence remains a gap in the literature (Prochnow, Delgado, et al., 2020). In line with social cognitive theory and family systems theory, it would benefit researchers to understand the reinforcing and limiting impacts of social networks and social norms both from peers and family members to more fully understand the impact of health programs. Further, understanding if a health program changes one's social network and subsequent activation of social ties could help better explain these mediating effects. Additionally, there is a gap in understanding social network influences in Latinx populations and specifically those residing in *colonias* (Prochnow, Delgado, et al., 2020). As noted previously, racial, ethnic, and cultural differences can impact the way individuals create and utilize connections particularly when it comes to family and peer influences (Pachucki & Breiger, 2010; Steidel & Contreras, 2016; Yamauchi, 1998). Using a mixed method approach to fill these gaps in the literature would provide a quantitative structure while simultaneously allowing the opportunity for richness in detail provided by qualitative analysis.

CHAPTER THREE

Methods

Purpose Statement

This dissertation aimed to use a SNA framework to examine changes in the composition and activation of the social networks of Mexican-heritage fathers and children who participated in a father-focused, family-centered health program. More specifically, this work detailed changes in how these individuals are physically active with their network. Additionally, comparisons based on sex were made to further understand how the sex of the children may impact these changes.

This study stemmed from a much larger project which aimed to develop and implement a father-focused, family-centered program to improve fruit and vegetable consumption, increase PA, and enhance family communication for Mexican-heritage family triads (fathers, mothers, and children) in *colonias*. The *Haz Espacio para Papi!* (Make Room for Daddy!; HEPP) program was developed as part of this larger research and outreach effort. While the program outcomes (e.g., nutrition and PA) focused on fathers and children, mothers were engaged in the program, as mothers are family gatekeepers in this cultural context and primarily responsible for caregiving and health (Altenburger et al., 2018; Galanti, 2003).

Hypotheses

Hypotheses were divided into those related to the child and those related to the father.

Child Hypotheses

1.1: Children will report active play more often within their relationships after the program.

1.2: Children will be significantly more likely to report relationships with people who are physically active regularly after the program.

1.3: Children will be significantly more likely to report relationships with people who help them to be physically active after the program.

1.4: Sex of the egos as well as sex of the alters will have no significant effect on changes in network measures.

1.5: Qualitatively, there will be no difference in the types of activities children report engaging in with social network members between pre- and post-program analysis.

1.6: Qualitatively, there will be no difference in the types of activities reported by children based on the sex of the child and the sex of the social network members reported.

1.7: Qualitatively, there will be no difference in the amount and types of parental support reported by children between pre- and post-program analysis.

Father Hypotheses

2.1: Fathers will report being physically active more often within their relationships after the program.

2.2: Fathers will be significantly more likely to report relationships with people who are physically active regularly after the program.

2.3: Fathers will be significantly more likely to report relationships with people who help them to be physically active after the program.

2.4: There will be no significant effect on changes in network measures based on the sex of children reported in their network.

2.5: Qualitatively, there will be no difference in the types of activities fathers report engaging in with social network members between pre- and post-program analysis.

2.6: Qualitatively, there will be no difference in the types of activities reported by fathers based on the sex of the child reported.

2.7: Qualitatively, there will be no difference in the amount and types of social support fathers report receiving from their children between pre- and post-program analysis.

Setting

This study occurred in *colonias* surrounding the unincorporated San Carlos, Texas area. As previously mentioned, the *colonias* along the U.S.-Mexico border are considered medically underserved and impacted by health barriers, increased rates of poverty, and disproportionate rates of disease (Anders et al., 2010; Office of Global Affairs, 2017). Further, many *colonias* are described as functionally rural developing areas which may be disproportionately impacted by barriers to health (Parcher & Humberson, 2009; Ward, 1999). Approximately 500,000 people are estimated to live in *colonias* located along the Texas-Mexico border (Barton et al., 2015).

Sample

Families were recruited from the study areas for participation in this program. *Promotora*-researchers identified potential program participants by completing door-to-door screening and re-contacting participants from previous studies who had provided consent for re-contact. In total, 308 families were screened, and 59 families were recruited into the program, who were split into five groups of roughly 12 families. To be eligible to participate in the program, each participating family member needed to meet the following recruitment criteria: 1) have no food allergies, 2) have no PA restrictions, 3) both parents being at least 21 years of age, 4) have at least one member of the nuclear family, or one directly related family member (i.e., grandparents or great-grandparents to child participant), born in Mexico (to establish Mexican-heritage), 5) have a child 9-11 years old living in the household, 6) both parents preferring to speak, write, and read in Spanish, and 7) both parents actively living in the same household. A participating family consisted of the father (biological/non-biological), mother, and child (boy or girl, 9-11 years old).

In total, 49 families participated in the 6-session program. Families were divided into 5 family groups, each consisting of roughly 10 families and each family participated in the program during different times of the year. A modified stepped-wedge cluster randomized trial design was used to maximize benefit to participating families and reduce the amount of resources needed to provide the program (Hussey & Hughes, 2007). Group 1 families participated in the program from July 2019 – August 2019. Group 2 families participated in the program from August 2019 – September 2019. Group 3 families participated in the program from October 2019 – November 2019. Group 4 families

participated in the program from November 2019 – January 2020 (to adjust to holidays). Due to COVID-19 pandemic and changes to face-face interactions, Group 5 families were only able to participate in 2 out of the 6 sessions and hence not included in this analysis. Each family group was divided into subgroups of 4-6 families for the weekly weekend sessions. Two separate sessions were conducted on Saturday (morning and afternoon) to allow families to choose the option that best worked for their Saturday schedule.

Promotora Research Model

The study heavily relied on the expertise of *promotoras*. Specifically, *promotoras* in this study were specially trained community health workers who promote health within their own communities (Cassandra M Johnson et al., 2013; St. John et al., 2013). These community health workers were native Spanish-speakers and lived in the similar *colonias* as program participants. *Promotoras* were trained in research methodologies and ethics and serve as a cultural bridge between community members and academic researchers (Cassandra M Johnson et al., 2013; St. John et al., 2013). *Promotoras* in this program were vital to creating a culturally appropriate curriculum specialized for the community being served. In addition to their role in engagement, recruitment, and delivery of the HEPP program, *promotoras* were essential partners in curriculum development.

Program Curriculum Development

A research team consisting of *promotoras* and academic researchers worked together to create and refine the curriculum through an iterative process of creation, modification, and testing. Curriculum development is explained in detail elsewhere

(Prochnow, Umstattd Meyer, et al., 2021). In short, researchers conducted a literature review to prepare a first draft of the curriculum which *promotoras* reviewed and provided feedback. Researchers piloted lesson plans with *promotoras* as participants which allowed *promotoras* a chance to develop skills while also providing feedback on curriculum components. Finally, *promotoras* pilot tested the program with volunteer families from the community. This curriculum was simultaneously developed in English and Spanish, with support from the *promotoras* and the project team for data management and linguistics.

Intervention Components

The HEPP PA curriculum included lesson plans, in-session activities, and take-home challenges. *Promotoras* delivered weekly lessons during in-person group sessions. The program curriculum including full lesson plans can be found elsewhere (Prochnow, Umstattd Meyer, et al., 2021). In short, the overall curricular theme was embracing existing traditions while creating new traditions. For example, several lessons added active variations to traditional games played among Mexican-heritage families. Leader's guides were given to the *promotoras* which provided semi-scripted program segments as well as cueing guides, equipment/materials checklists, and overall lesson goals. Weekly lessons aimed to progressively build skills and basic movement competencies and encourage creative, active play for the whole family. Curricular activities engaged father, mother, and child, but primarily focused on father-child co-participation in light-to-moderate PA.

Take-home challenges provided continuity between in-person sessions and the family context at home. Take-home challenges were short and fun activities for the entire

family. Each week the families were given two challenges to complete between sessions. The “kid’s challenge” challenged children to initiate a PA-related activity independently or with their families. The families were also given an “everyone play” challenge which involved an activity for the whole family. The take-home challenges can be found elsewhere (Prochnow, Umstattd Meyer, et al., 2021).

Methods of Social Network Analysis

To further understand the framework of this study, a review of SNA methodology and data collection is needed. SNA is generally split into two analytic approaches: egocentric (person centered) analysis and sociocentric (whole network) analysis (Borgatti et al., 2018). While both approaches investigate the connections between and among individuals, these approaches differ in how the research is conducted, analyzed, and interpreted (Borgatti et al., 2018; Perry et al., 2018).

Egocentric Network Analysis

Egocentric network studies are developed from the perspective of a focal individual (ego) who is surveyed. In this sense, egocentric studies aim to understand how the people in an individual’s personal network are associated with or effect the ego’s behavioral outcomes. Specifically, it is the ego’s perception of these people which is being measured. Egocentric network studies sample individuals and ask them to report the people in their own networks. This means an egocentric network can contain people from various social groups, if they are connected to the ego. For example, a child might report their teacher, parent, sibling, friend, classmate, or other relative, who all operate

within different social groups in the child's life but are important to the child in unique but often overlapping ways.

Egocentric surveys are typically broken up into three parts: name generators, name interpreters, and inter-relator questions. First, a name generator is used to elicit a list of names of individuals who are meaningful to the ego. For example, a name generator is, "Tell me the names of up to five people you speak to about important life matters." Name generators are typically generated based on the relationship in question or the theoretical relationship posed by the research question (adams, 2019; Borgatti et al., 2018; Perry et al., 2018). The ego can answer or nominate anyone in their life whom they think fits the name generator. These people which are nominated are referred to as "alters" (Perry et al., 2018). Next, name interpreters are used to obtain information about each nominated alter. Name interpreters can be demographics of the alters (e.g., gender, race, age) or the ego's perceptions of alters' behaviors, attitudes, and beliefs. Alters in egocentric studies are often not surveyed themselves so all information regarding the ego's network is reported by the ego and solely from their perspective.

Sociocentric Network Analysis

In sociocentric or whole network studies, the researcher specifies a group with a defined boundary and surveys individuals within the group with the goal of uncovering all connections between the individuals within that group (Borgatti et al., 2018). Sociocentric surveys collect individual-level information from each person in the network (e.g., age, sex, behavioral characteristics). Researchers then ask each participant network-generating questions similar to egocentric studies like, "please tell me the names of people you hang around with, talk to, and do things with the most in this after-school

program.” In sociocentric studies, participants can only nominate other members within the specified group, rather than anyone they know in their life. Using these nominations, researchers map the entire social structure of the group. Thus, the aggregated data includes the perceptions of all network members, instead of one person’s perception of their own network exhibited in egocentric studies (Borgatti et al., 2018). Additionally, sociocentric data collection and analysis allows the investigation of individual, group, and network level measures which might not be possible in egocentric studies (Borgatti et al., 2018).

Mixed Methods and SNA

One particularly useful application of SNA is through a mixed method approach. Using a mixed method approach can help provide rich qualitative information to further assess the impact of one’s network on health behaviors and outcomes. Specifically, convergent designs, employ both qualitative and quantitative methodologies simultaneously but separately with equal priority to each frame of thought. This design has also been conceptualized as a concurrent triangulation of qualitative and quantitative methodologies (Creswell, 2013). In this design, both frames are analyzed separately and combined during interpretation of results for a better understanding of the problem question.

Researchers have used SNA within a mixed method design to understand child PA behavior previously. In one group of studies, Garcia et al. examined youth obesogenic behaviors through the lens of social connection by using qualitative interviews to further explain and understand the social network results generated (Garcia et al., 2017; Garcia, Healy, et al., 2016; Garcia, Sirard, et al., 2016; Garcia et al., 2019). Through focus group

data analysis, researchers concluded that PA with friends provided additional enjoyment over PA alone (Garcia, Sirard, et al., 2016). Authors also posited that programs which include interaction with others would be more effective in increasing PA among children (Garcia, Sirard, et al., 2016). Authors noted a theme of social influences on PA behaviors through co-participation from peers and parents as well as modeling from older siblings and parents (Garcia et al., 2017); however, male and female children are impacted differently through these mechanisms which require additional research (Garcia et al., 2017). Males preferred to be active in larger groups, while females were more active with close friends and displayed a significant propensity for socializing and encouragement from others to do more sedentary activities (Garcia et al., 2017; Garcia, Sirard, et al., 2016). Further focus group analysis revealed friends influenced the choice of activities and overweight children were more influenced by their friends' sedentary behaviors (Garcia et al., 2019). This is important to note as the presence of unhealthy behaviors (e.g., sedentary behavior) in a child's network influences the effectiveness of health programing, which was brought to light by using SNA in an intervention research design (Shin et al., 2014). To this point, there is a dearth of information regarding changes in social networks using mixed methods approaches.

Evaluation Measures

Promotora-researchers noticed that while most child participants were able to speak, write, and read in Spanish, most of them preferred and were more comfortable thinking and responding in English. While recruitment criteria limited both parents to prefer to speak, write, and read in Spanish to be eligible for the intervention program, this criterion did not apply to child participants to adapt to their current language trends and

preferences. Thus, surveys were researcher administered in English or Spanish, based on child's preference, in the child's household. For fathers, surveys were administered by researchers in Spanish primarily in the father's household. In several cases, and to provide the necessary schedule flexibility, surveys were also administered at the participant's job site, church, or at the home of another family member. Children reported their age and sex as demographic information. Fathers reported their age and education level as demographic information. Surveys were then translated using a forward-translation, back-translation method to ensure accuracy of translation prior to further analysis (Brislin, 1970).

Social Network Data - Child

For this study, based on the concepts of peer influence and selection, data were collected on social connections with whom the child was physically active (Prochnow, Delgado, et al., 2020). From this theoretical grounding, a network generator was crafted to elicit such a network. Children reported up to five individuals (alters) with whom they had "actively played with most often" in the previous month. The term alter is used extensively in egocentric network analysis studies referring to individuals in a person's network (Perry et al., 2018). This is similar to other studies and in line with social network data collection processes (adams, 2019; Henry et al., 2016; Prochnow, Delgado, et al., 2020). This name generator developed a list of five names or pseudonyms to protect participant confidentiality. This list was limited to five pseudonyms to attempt to capture the most salient connections and reduce respondent burden (adams, 2019; Merluzzi & Burt, 2013). Children were then asked name interpreters regarding each person they listed. Children reported sex, relationship (sibling, mother, father, friend,

grandparent, aunt/uncle, cousin, other), frequency with which they played with that person (“once in a while”, “sometimes”, “often”), whether the person helped them to be physically active (“yes” or “no”), and if they thought the person was active regularly (“yes”, “no”, or “I don’t know”) for each alter. Name interpreters were created based on past studies as well as feedback from *promotoras* (Voorhees et al., 2005).

Social Network Data – Father

In a similar manner, fathers were asked to report the initials or pseudonym of up to five individuals (alters) with whom they were “physically active with most often or actively played with most often” in the previous month. This network generator was chosen to closely mirror the question asked for the children in the study. Fathers were limited to five alters as well. Fathers were then asked similar name interpreters to better understand the people in their networks. Fathers reported the sex of each alter, his relationship (spouse, program child, friend, other child, or other) to each alter, how often they were physically active with each alter (“once in a while”, “sometimes”, or “often”), whether the alter was physically active regularly (“yes”, “no”, or “I don’t know”), and if he thought the alter helped him to be physically active (“yes” or “no”).

As this study aimed to better understand the social interactions between the family members involved in the study, and specifically between the father and child, participants were asked name interpreter questions regarding these members of their family even if they were not mentioned originally in the name generator. For example, if a child did not mention their father when asked who they played with most often, *promotoras* were instructed to also ask the child the frequency with which they played with their father (“once in a while”, “sometimes”, “often”), and if they thought he was active regularly

(“yes”, “no”, or “I don’t know”). Similarly, if the father did not mention the child involved in the program during the name generator, *promotoras* asked him similar questions regarding the child.

Qualitative Social Network Items

Several open-ended response items were also used to further understand the social influences and PA behaviors present within these networks. Children and fathers were both asked what activities they did most often with each person in their network. Children and fathers responded to this question for each alter separately. Additionally, children were asked separate questions regarding whether their parents helped them to be physically active to determine the types of parental social support present. Initially, children were asked whether their father helped them to be physically active (“yes” or “no”) as well as an identical question for their mother. If the child responded “yes”, they were then asked how that person helped them to be physically active. Similarly, fathers were asked if the child involved in the program helped them to be physically active and if so how.

Quantitative Data Analysis

Network Descriptive Statistics

Network descriptive statistics were generated such as network size as well as frequencies of each network interpreter question. Networks are described at each timepoint separately. As a simplified way of showing change in the network size over time, a paired t-test are used to determine the presence of significant change. Similarly, changes in the amount of physically active network members and members who help the

ego be active were descriptively calculated as well. Paired t-tests, means, frequencies, and standard deviations for demographic variables were calculated in SPSS v.25 (IBM, 2018). Due to the nomination limit, it is vital to model the change in dyadic level (between each alter and the ego) characteristics through advanced multilevel models accounting for clustering within the ego's network and across time with repeated measures.

Multilevel Modeling

Variations of multilevel modeling techniques were used to test quantitative hypotheses presented in this study. Multilevel modeling provides proper statistical power and controls for the interdependent nature of clustered or nested variables (Luke, 2019). Multilevel modeling also provides the opportunity to model change at multiple levels while also modeling interactions between levels (Luke, 2019). Specifically, multilevel modeling is particularly useful for handling egocentric social network data as the alter level observations would be nested or clustered under the ego (Luke, 2019; Perry et al., 2018). In this manner, multilevel modeling was used to assess change in dyadic or alter level variables, such as how often the child is active with each individual alter (Luke, 2019). Measuring networks at this level provides more information than only measuring ego-level variables, and allows for testing of factors such as alter level covariates (Perry et al., 2018). In the present study three levels were created: 1) alter level, 2) time level, and 3) ego level. Figure 3.1 displays a visual representation of the three levels of analysis. At level 3, ego age and sex were used as fixed variables across time and alter levels. At level 2, aggregate measures of network size (total number of alters for each ego) at each time point were added. At level 1, alter sex and relationship were added as independent

covariates. Dependent variables in this study were assessed at the alter level. Random-coefficient models, which allow for each respondent to register a unique intercept and slope in the regression model, were used in order to include interaction effects between each level (Perry et al., 2018). Interaction effects were added for the interaction between time and the sex of the alters for fathers and children as well as between time and sex of the ego for children. Multilevel modeling was done using R studio and multilevel packages (RStudio Team, 2020).

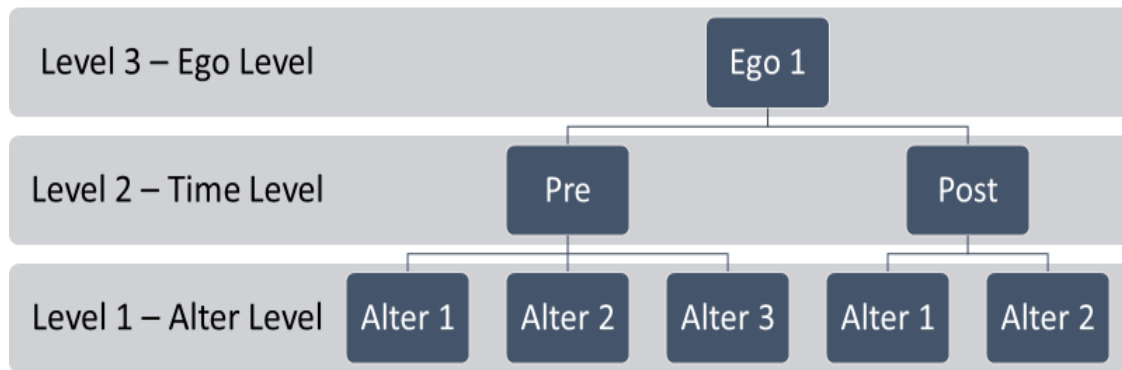


Figure 3.1: Visual representation of the three possible levels of analysis.

Frequency of PA. First, to test hypotheses 1.1 (Children will report active play more often with their relationships after the program) and 2.1 (Fathers will report being physically active more often with their relationships after the program) a three-level ordinal logistic longitudinal regression was calculated. Alter level dependent variable will be the Likert scale rating of each alter reported (“once in a while”, “sometimes”, “often”) at each time point (level 2) by each ego (level 3). This additional level of analysis allows for individual differences in the alter level to provide more information to the model (Luke, 2019; Perry et al., 2018). Multilevel ordinal logistic longitudinal regression is used in this case because it can model the mixed random effects within and between egos and

time points while also being robust for missing data and efficient with smaller data sets (Luke, 2019).

PA perception. Next, to test hypotheses 1.2 (Children will be significantly more likely to report relationships who are physically active regularly after the program) and 2.2 (Fathers will be significantly more likely to report relationships who are physically active regularly after the program) a multilevel binary logistic longitudinal regression model was used to determine the odds that egos perceive their alters to be active regularly after the program as compared to before. Like the above model, this model was also analyzed at three levels to provide each alter with a data point. This was assessed as a binary (yes or no) variable and will determine if the likelihood of an ego reporting an alter as active.

Help from alters. In a similar manner, multilevel binary logistic longitudinal regression model was used to determine whether participation in the program increased the likelihood that an ego would report that their alters help them to be active. Specifically, this tested hypotheses 1.3 (Children will be significantly more likely to report relationships who help them to be physically active after the program) and 2.3 (Fathers will be significantly more likely to report relationships who help them to be physically active after the program). Here, just as in the PA norms, the model was tested at three levels using the alter level as the dependent binary outcome of interest: yes, they do help or no, they do not.

Sex differences. For children, sex was introduced as an ego and alter level variables to determine significant effects of sex on the change seen through the program. Specifically, this will test hypothesis 1.4 (Sex of the egos as well as sex of the alters will

have no significant effect on the change in network measures). This variable was tested across all models to determine significant differences between sexes for each network composition. An interaction term was also used between these levels to test any interaction between ego level sex or alter level sex and time. Additionally, hypothesis 2.4 (There will be no significant effect on the change in network measures based on the sex of children reported in their network) by assessing the significance of alter level sex terms in each of the above models.

Qualitative Data Analysis

The qualitative portion of this study primarily consisted of a case-study regarding the change reported within networks (Creswell & Poth, 2016). More specifically, the study investigated if a father-focused family-centered program can alter the activities the fathers and children report doing with their networks as well as the types of support felt. Both inductive and deductive approaches were taken by the primary investigator to develop coding frameworks used in this study. Frameworks are supplied below accompanied by the corresponding hypotheses. Using these frameworks, coding was then performed by two coders: the primary investigator and a research assistant who was also involved in back-translation (O'Connor & Joffe, 2020). Intercoder reliability was assessed using a kappa score to take into account agreement by chance (O'Connor & Joffe, 2020). Qualitative coding will be facilitated by NVivo v.12 (QSR International Pty Ltd., 2020).

Types of Physical Activities

In regard to physical activities, an initial coding framework was developed through an inductive coding process by the primary investigator (Elo & Kyngäs, 2008). To do so the investigator read the responses and created a framework of the commonly occurring activities. Using this coding framework, frequencies of responses were generated. To fulfill Hypotheses 1.6 (Qualitatively, there will be no difference in the types of activities children report engaging in with social network members between pre- and post-program analysis) and 2.5 (Qualitatively, there will be no difference in the types of activities fathers report engaging in with social network members between pre- and post-program analysis) these frequencies were compared between pre- and post-program analysis. Additionally, in the child data set, these frequencies were classified by the sex of the child and sex of the alter for each activity reported. These crosstab style frequencies were compared to test hypothesis 1.7 (Qualitatively, there will be no difference in the types of activities reported by children based on the sex of the child and the sex of the social network members reported). Similarly, fathers' activities with children in their network were isolated and classified based on the sex of the child reported to test hypothesis 2.6 (Qualitatively, there will be no difference in the types of activities reported by fathers based on the sex of the child reported). Table 3.1 provides the coding framework for this section.

Table 3.1 Coding framework for physical activity types

Code	Description
Sedentary Activity	Used when response indicates a sedentary activity.
Food related	Used when response indicates food activities (e.g., cooking and eating)
Chore	Used when response indicates chores or household activities.
Sport related	Used when response indicates sport specific activities.
General active play	Used when response indicates active play without specifics.
Run	Used when response indicates running.
Walk	Used when response indicates walking.
Work	Used when response indicates occupational related activity.

Support for PA

In regard to support for PA, deductive coding was used based on prior research in types of social support (Elo & Kyngäs, 2008). In this manner, the coding framework was drawn from a systematic literature review on social support for PA (Beets et al., 2010). Frequencies for each type of social support were compared between pre- and post-program analysis to test hypotheses 1.8 (Qualitatively, there will be no difference in the amount and types of parental support reported by children between pre- and post-program analysis) and 2.7 (Qualitatively, there will be no difference in the amount and types of social support fathers report receiving from their children between pre- and post-program analysis). Table 3.2 supplies the coding framework for related to support for PA.

Table 3.2 Coding framework for types of support

Code	Description
Instrumental	Used for tangible support such as purchasing equipment or transportation
Conditional	Used for responses indicating doing activity with or watching and supervision.
Motivational	Used for responses indicating encouragement or praise.
Informational	Used for responses indicating teaching or discussing the benefits of PA.

CHAPTER FOUR

Will You Play with Me? Changes in Active Play Social Network Activation for Mexican-Heritage Children Participating in a Father-Focused Health Program

Abstract

Child physical activity (PA) and active play are beneficial for physical, mental, and emotional health; however, very few children meet PA guidelines to attain health benefits. Unfortunately, Latinx children report lower PA levels and are at elevated risk for developing obesity. Child PA is also significantly associated with PA behaviors of friends and family through support, influence, and co-participation. Past studies have focused on mothers' influence on and perceptions of child PA, especially within Mexican-heritage families; however, recently scholars have called for a renewed focus on fathers to promote the health of their children. This manuscript will examine if participation in a father-focused family-centered health program changes the activation of Mexican-heritage children active play networks. Participating families consisting of child (aged 9-11), mother, and father were recruited from *colonias* by *promotoras* for participation in a six-week father-focused family-centered health program focused on family dynamics relative to healthy eating and active living. Children reported up to five people (alters) they actively played with the most in the previous month before and after the program. Children also reported each alter's sex, their relationship to the alter, and frequency with which they played with the alter, if they thought the alter was active regularly, if the alter helped them to be active, and what they did most often with that person. Multilevel regression models examined the change in alter level variables.

Children ($n=42$, M age = 9.79, $SD=1.01$; 54.8% girls) reported a mean of 3.79 alters ($SD=1.32$) and 4.24 alters ($SD=1.13$) after the program. Children were more likely to report more frequent active play with their alters after the program when compared to before the program. Additionally, girls were more likely to report more frequent active play with alters when compared to boys; however, a significant interaction term indicated boys were more likely to increase their frequency of active play. Children activating their social network ties to be more active, theoretically supported through Family Systems Theory and Social Ecological Model, could result in more PA for children and families. Results indicate these connections or activations are possible through a family-centered father-focused health program.

Introduction

Child physical activity (PA) is associated with tremendous health benefits including obesity and diabetes prevention as well as improved cognitive, social, and physical development (Aue et al., 2016; Guinhouya, 2012). Despite these health benefits, many children do not achieve recommendations for daily PA (Kann et al., 2018). Specifically, United States and International health guidelines suggest that children be active for at least 60 minutes at a moderate-to-vigorous intensity each day and include muscle strengthening exercises on at least three days each week (Bull et al., 2020; Kann et al., 2018; Piercy et al., 2018). Children living in rural, low socioeconomic status, or minority communities are significantly less likely to meet PA guidelines (Guerrero et al., 2016; Johnson & Johnson, 2015; Moore et al., 2013). Specifically, Latinx children are 60% less likely to meet PA recommendations when compared to non-Latinx white children (Fakhouri et al., 2013a). Further, Mexican-heritage children residing in *colonias*,

functionally rural Mexican-heritage communities on the border of U.S. and Mexico characterized by low or very-low-income households (Donelson & Esparza, 2010; Mier et al., 2008), may be particularly at-risk for achieving less PA.

Data also show a significant sex disparity as girls are less active than male children (Cooper et al., 2015; Lenhart et al., 2012). A scoping review reported social gender norms and social influences as a possible barrier or deterrent for girls' activity (Spencer et al., 2015). For example, girls are often expected to engage in less physically rigorous hobbies than boys, such as socializing, and might be taught to think sports are "less cool" for girls (Spencer et al., 2015). Both direct social influence (via close friends) and indirect social influence (via perception of networks) are associated with girls' PA (Garcia, Sirard, et al., 2016). Further, girls, as compared to boys, tend to be more active when a close friend is active and when they perceive their entire network to be active (Garcia, Sirard, et al., 2016). While specific programming has been developed for girls (Bean et al., 2014), further understanding differences in PA between girls and boys could lessen these disparities.

The social environment or network in which a child resides can also be influential in shaping and influencing PA behaviors (Prochnow, Delgado, et al., 2020). Children who feel greater social support from their peers and parents are more likely to be physically active (Maturo & Cunningham, 2013; Mendonca et al., 2014). Children also tend to be more physically active when they engage in PA with another person, also referred to as co-participation or concurrent activity (Cleland et al., 2011; Prochnow, Umstattd Meyer, & Pollack Porter, 2020). Children can be influenced by social norms, Garcia and colleagues (Garcia, Sirard, et al., 2016) found children were more physically

active if their peers were more active, suggesting a social norm of PA within children's networks. Similarly, children who perceive their friends as being physically active are more physically active themselves (Marks et al., 2015; Martin-Matillas et al., 2011). In preliminary work, Mexican-heritage children who reported more frequent active play with friends attained significantly more PA and were sedentary for fewer minutes per day (Prochnow, Meyer, et al., 2021). While these studies demonstrate social influence, few have documented the changes in these networks for children participating in community health programs (Prochnow, Delgado, et al., 2020).

Researchers can use social network analysis (SNA), a set of theories and methods designed to measure the social structure and influences affecting a person and their health behaviors, to further understand social influence on child PA (Borgatti et al., 2018). In this way, SNA considers the connections between people and how those connections might impact beliefs and behaviors. SNA has been used to study multiple health behaviors, including bullying, drug use, disease transmission, PA, and sedentary behavior (Coronges et al., 2011; Huitsing & Monks, 2018; Patterson & Goodson, 2019; Shin et al., 2014). Egocentric, or personal network analysis, studies sample individuals and ask them about their most salient connections or relationships (these people are called alters). The term alter is used extensively in research on personal networks referring to those individuals reported within an individual's network (Perry et al., 2018). Through egocentric network analysis, researchers can develop an understanding of a child's perspective of their social network and potential impacts this network may have on their behaviors (Perry et al., 2018).

Culture appears to be related to how children form, maintain, and interact within their social networks (Taylor et al., 2013). For example, Latinx families exhibit higher levels of familism than non-Latinx white families (Ramirez et al., 2004). Familism is an emphasis on family relationships and having loyalty and pride in one's family (Sabogal et al., 2016; Steidel & Contreras, 2016). This value would also implicate the Family Systems Theory. Family Systems Theory posits that a family functions as a system wherein people are expected to interact with and respond to one another creating social influence on health behavior (Broderick, 1993). It is theorized that to better understand the health behaviors of one family member it is critical to understand the familial social influences and social norms present (Broderick, 1993). Capitalizing on this influence and environment, family-centered programs are successful in improving the PA of children (Brown et al., 2016; Kitzman-Ulrich et al., 2010). However, many family focused programs fail to significantly engage fathers (Freeman et al., 2012; Morgan et al., 2017). Researchers have called for an increased focus on fathers in health research especially within Latinx populations due to the significant influence fathers have on child health behaviors and development (Davison et al., 2016; Morgan et al., 2017; O'Connor et al., 2018; Patrick et al., 2013).

Further, familial social norms significantly influence individual level behaviors in the form of family behavioral influence or behavior similarity and familial social support (Beets et al., 2010; Pedersen et al., 2015). Specifically, reciprocated encouragement to engage in PA in Mexican-American parent child dyads was significantly associated with co-participation in PA (de la Haye et al., 2014). Encouragement and co-participation are both significant factors in parental social support (Beets et al., 2010). Specifically,

perceptions of paternal tangible support were significantly associated with MVPA behavior in a sample of children (Brunet et al., 2014). Tangible social support is either providing equipment or transportation for PA or co-participating in PA (Beets et al., 2010). Intangible social support on the other hand is motivational or informational in nature (Beets et al., 2010).

Specific Aims

While many articles have aimed to understand the social influences of child PA behavior using SNA, there has been a dearth of literature examining the changes in social network following health programs (Prochnow, Delgado, et al., 2020). This study uses SNA to examine changes in the composition and activation of social networks of Mexican-heritage children participating in a father-focused, family-centered health program. Further, a mixed methods approach is used to add context to the activities these children do with their social networks as well as the types of support they received from their parents.

Methods

Setting

As part of the larger *Salud Para Usted y Su Familia* (SPUSF) [Health for You and Your Family] parent project, this project utilized a *promotora*-researcher model to develop, implement, and evaluate a father-focused, family-centered program based on active living, healthy eating, and family communication available to Mexican-heritage families living in *colonia* areas along the south Texas border with Mexico. *Promotora*-researchers (or *promotoras*) are members of the community trained in health promotion

and research techniques to bridge the gap between academic researchers and the community (C. M. Johnson et al., 2013). *Promotoras* are particularly effective in creating culturally relevant research and cultivating rapport with traditionally hard to reach populations (St. John et al., 2013). As a result, The *Haz Espacio para Papi!* (Make Room for Daddy!; HEPP) program was developed. The program outcomes (e.g., nutrition and PA) focused on fathers and children; however, mothers were engaged in the program, as they are family gatekeepers in this cultural context and tend to be primarily responsible for child caregiving (Altenburger et al., 2018; Galanti, 2003).

Family participants of the program were recruited from four randomly identified geographic clusters located near unincorporated San Carlos, Texas. *Promotoras* identified potential participants by completing door-to-door canvassing, screening, and re-contacting participants from previous studies who had provided consent for re-contact for eligible future studies. In total, *promotoras* screened a total of 308 families and recruited 59 families (father, mother, and participant child), who were split into five groups of roughly 10-13 families (group five was not included in this analysis as it was disrupted by COVID-19). In this context, to be eligible to participate in the program, each participating family member needed to meet the following recruitment criteria: 1) have no food allergies, 2) have no PA restrictions, 3) both parents at least 21 years of age, 4) at least one parent, or one of their parents (grandparents to child participant), or one of their grandparents (great-grandparents to child participant) born in Mexico (to establish Mexican-heritage), 5) have a child of 9-11 years old living in their household, 6) both parents preferring to speak, write, and read in Spanish, and 7) both parents actively living in the same household.

A research team consisting of *promotoras* and academic researchers worked together to create and refine the curriculum through an iterative process of creation, modification, and testing. Curriculum development is explained in detail elsewhere (Prochnow, Umstattd Meyer, et al., 2021). In short, the overall curricular theme was embracing existing traditions while creating new traditions and included weekly lessons and take-home challenges. Weekly lessons aimed to progressively build skills and basic movement competencies and encourage creative, active play for the whole family. Take-home challenges were short, fun activities for the entire family. This curriculum was simultaneously developed in English and Spanish, with support from the *promotoras* and a project team for data management and linguistics.

A modified stepped-wedge cluster randomized trial design was used to maximize benefit to participating families and reduce the amount of resources needed to implement the program (Hussey & Hughes, 2007). Group 1 families participated in the program from July 2019 – August 2019. Group 2 families participated in the program from August 2019 – September 2019. Group 3 families participated in the program from October 2019 – November 2019. Group 4 families participated in the program from November 2019 – January 2020 (to adjust for holidays). Due to COVID-19 pandemic and changes to face-to-face interactions, Group 5 families were only able to participate in 2 out of the 6 sessions and hence not included in this analysis. Each family group was divided into subgroups of 4-6 families for the weekly weekend sessions. Two separate sessions were conducted on Saturday (morning and afternoon) to allow families to choose the option that best worked for their Saturday schedule.

Measures

Children were surveyed before and after participation in HEPP. While recruitment criteria limited both parents to prefer to speak, write, and read in Spanish to be eligible for participation in the program, this criterion did not apply to child participants in order to adapt to their current language trends and preferences. In other words, while *promotoras* noticed most children were all able to speak, write, and read in Spanish, most of them were more comfortable thinking and responding in English. Thus, surveys were researcher administered in the child's household in English or Spanish, based on child's preference. Children reported their age and sex as demographic information.

Social Network Data

Children reported up to five individuals with whom they had “actively played with most often” in the previous month—developing a list of five names or pseudonyms. This prompt (also termed name generator) was developed based on a literature review of SNA and child PA studies (Prochnow, Delgado, et al., 2020) and in collaboration with the *promotoras*. This list was limited to five pseudonyms to capture the most salient connections while reducing respondent burden (adams, 2019; Merluzzi & Burt, 2013). Children were then asked questions (termed name interpreters) regarding each person in their network (termed alter; Perry et al., 2018). Children reported sex, relationship (sibling, mother, father, friend, grandparent, aunt/uncle, cousin, other), what activities they did most often with each alter (open ended response), frequency with which they played with each alter (“once in a while”, “sometimes”, “often”), whether the alter helped them to be physically active (“yes” or “no”), and if they thought the alter was active regularly (“yes”, “no”, or “I don’t know”) for each alter they previously mentioned.

As this study aimed to better understand the social interactions between the family members involved in the study, children were asked name interpreters regarding their mother and father even if they were not mentioned originally in the name generator. For example, if a child did not mention their father when asked who they played with most often, *promotoras* were instructed to also ask the child how frequently they played with their father (“once in a while”, “sometimes”, “often”), what activities they did with him most often (open ended response), if they thought he was active regularly (“yes”, “no”, or “I don’t know”), and if they thought he helped them to be physically active (“yes” or “no”). If the child responded that the father did help them to be physically active, the *promotoras* also asked the child how the father helped them to be active (open ended response).

Qualitative Analysis

This study employed qualitative analysis consisting of a case-study regarding the change in activities and support reported (Creswell & Poth, 2016). More specifically, qualitative analysis was conducted to determine if a father-focused family-centered program changed the types of activities children report doing within their networks and the types of support felt. Both inductive and deductive approaches were used to develop coding frameworks in this study. An initial coding framework for the types of activities was developed through an inductive coding process by the primary investigator (Elo & Kyngäs, 2008). To do so the investigator read the responses and created a framework of the commonly occurring activities. Using this coding framework, frequencies of responses were generated and compared between pre- and post-program analysis. Additionally, these frequencies were classified by the sex of the child and sex of the alter

for each activity reported to detail sex differences. In regard to support for PA, deductive coding was used based on a systematic literature review on social support for PA (Beets et al., 2010). See Tables 3.1 and 3.2 for full coding framework. A second researcher independently coded all responses to strengthen the validity of the findings, acceptable inter-rater reliability was demonstrated, kappa=0.82 (Brennan & Hays, 1992; McHugh, 2012). Frequencies for each type of social support were compared between pre- and post-program analysis. Qualitative coding was facilitated by NVivo v.12 (QSR International Pty Ltd., 2020).

Data Analysis

Network descriptive statistics such as network size, average frequency of active play, percent of alters who help, and percent of alters who were perceived as active regularly were generated at each timepoint separately. As a simplified way of showing change in the network size over time, a paired t-test was used to determine the presence of significant change in these descriptive ego level measures. Paired t-tests, means, frequencies, and standard deviations for demographic variables were calculated using SPSS v.25 (IBM, 2018). Due to the nomination limit, it is vital to model the change in alter level (between each alter and the ego) characteristics through multilevel models accounting for clustering within the ego's network and across time with repeated measures (Perry et al., 2018).

Multilevel modeling provides proper statistical power and controls for the interdependent nature of clustered or nested variables (Luke, 2019). Specifically, multilevel modeling is particularly useful for handling egocentric social network data as the alter level observations would be nested or clustered under the ego (Luke, 2019; Perry

et al., 2018). In this manner, multilevel modeling was used to assess change in dyadic or alter level variables, such as how often the child is active with each individual alter (Luke, 2019). Measuring networks at this level provides more information than an aggregate ego-level variable (Perry et al., 2018). In the present study three levels were created: 1) alter level, 2) time level, and 3) ego level. At level 3, ego age and sex were used as fixed variables across time and alter levels. Level 2 was used to determine the changes across time points as well as include an aggregate measure of network size (total number of alters for each ego) at each time point. At level 1, alter sex and relationship were added as independent covariates. Random-coefficient models, which allow for each respondent to register a unique intercept and slope in the regression model, were used in order to include interaction effects between each level (Perry et al., 2018). A multilevel ordinal regression model was calculated to determine significant associations between the frequency egos reported playing with alters and alter level, time level, and ego level variables. Similarly, multilevel logistic regression models were calculated for perception of PA and help. Five models were calculated for each dependent variable: null model, alter model, time model, ego model, and fully specified model with interactions. Multilevel modeling was performed using R studio (RStudio Team, 2020).

Results

Sample

In total, 42 children (M age = 9.79, SD=1.01; 54.8% girls) completed both pre- and post-intervention evaluations. Children reported significantly more alters they had actively played with before the program (M= 4.38; SD=1.00) as compared to after the program (M=3.83; SD=1.32); $t(41)=2.60$, $p=.01$. Before the program, children reported

174 total alters: 90 male (51.7%) and 84 female (48.3%). However, when factoring in the sex of the child, 70.3% of the alters reported were of the same sex as the child. Friends were reported more often than any other relationship (37.1% of alters) with siblings being the next most frequent (24.6%). Similar frequencies were reported after the program. Children reported 160 total alters, 83 male (51.9%), 77 female (48.1%), and of those 76.3% were the same sex as the reporting child. Similarly, 40.0% of alters were friends (n=64) and 23.1% were siblings (n=37). See Table 4.1 for network descriptive statistics.

Table 4.1: Descriptive statistics for child social networks

Variable	Before Program		After Program	
	M (SD)	Frequency (%)	M (SD)	Frequency (%)
Network Size	4.38 (1.00)		3.83 (1.32)	
Play Frequency	1.18 (0.65)		1.29 (0.67)	
Active Regularly	3.58 (0.65)		3.25 (1.58)	
Helps	3.88 (1.36)		3.50 (1.61)	
Relationship				
Mother		11 (6.3%)		16 (10.1%)
Father		11 (6.3%)		15 (9.4%)
Sibling		43 (24.6%)		37 (23.3%)
Friend		65 (37.1%)		64 (40.3%)
Other		12 (6.9%)		6 (3.8%)
Aunt		6 (3.4%)		1 (0.6%)
Cousin		27 (15.4%)		4 (2.5%)

Note: Play Frequency – Average frequency of play with alters. Active Regularly – Number of alters in network who were reported to be active regularly. Helps – Number of alters in network who were reported to help the child. Relationship – Relationship between the child and the alter.

Further, there was no significant difference in the average frequency with which the children reported playing with their alters between before (M=1.18; SD=0.65) and after the program (M=1.29; SD=0.67); $t(41)=-0.98$, $p=.33$. Likewise, there was no significant difference in the number of alters they reported to be active between before (M=3.58; SD=1.43) and after the program (M=3.25; SD=1.58); $t(41)=1.25$, $p=.22$. Before the program children perceived 81.7% of alters (n=143) as physically active regularly

compared to 81.8% after the program (n=130). Similarly, there also was no significant difference in the number of alters they reported help them be active between before (M=3.88; SD=1.36) and after the program (M=3.50; SD=1.61); $t(41)=1.28$, $p=.21$. Before the program children perceived 88.6% of alters (n=155) as helping them to be active compared to 88.8% after the program (n=142). As these are aggregate measures of network composition scores and restricted by nomination limits, some interpretability and information are lost in this process. Hence, multilevel modeling was conducted to determine change among these networks.

Frequency of Activity

A multilevel ordinal logistic regression with proportional odds was run to determine the effect of alter level, time level, and ego level variables, on the frequency by which the child reported active play with the alter. Table 4.2 provides model parameters for all five models. Model 1 (null model) showed there were significant variation in the frequency of activity across children as displayed by the ICC. When specifying the model, according to the BIC, the fully specified model performed the best. After adjusting for other variables at the alter level, time level, and ego levels, girls were significantly more likely to report more frequent active play with their alters [OR = 6.51, 95 % CI 1.24–34.25] compared to boys. Additionally, controlling for covariates, children were significantly more likely to report more frequent active play after the program [OR = 7.82, 95 % CI 3.31–18.46] as compared to before the program. However, there was also a significant interaction term between sex of the child and program effect [OR = 0.05, 95 % CI 0.02–0.17] indicating boys disproportionately benefited from the program. More specifically, boys were significantly more likely to increase the frequency

of active play with their alters after the program as compared to girls. Further, children were significantly less likely to report frequent active play with their mothers as compared to all other alters [OR = 0.17, 95 % CI 0.06–0.54].

Table 4.2: Multilevel ordinal regression model results for child frequency of active play with alters

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Intercept 1	0.16	0.08-0.32	<.01	0.09	0.04-0.24	<.01	0.22	0.03-1.51	<.01	0.35	0.02-5.46	<.01	0.45	0.02-8.77	<.01
Intercept 2	1.17	0.62-2.24	.62	0.75	0.30-1.86	.53	1.84	0.28-12.04	.52	2.83	0.18-44.09	.45	4.58	0.24-88.92	.31
Alter Level															
Sex (Female)				0.70	0.36-1.35	.28	0.75	0.39-1.46	.39	0.71	0.36-1.39	.31	0.90	0.30-2.75	.85
Mother				0.18	0.06-0.54	<.01	0.17	0.06-0.52	<.01	0.18	0.06-0.53	<.01	0.17	0.06-0.54	<.01
Father				0.64	0.19-2.08	.45	0.64	0.20-2.10	.46	0.64	0.20-2.07	.45	0.84	0.24-2.89	.77
Sibling				0.55	0.24-1.26	.15	0.56	0.24-1.27	.16	0.58	0.25-1.32	.19	0.72	0.30-1.72	.46
Friend				1.14	0.49-2.67	.75	1.11	0.48-2.58	.81	1.14	0.49-2.67	.75	1.07	0.44-2.63	.88
Time Level															
Program Effect							1.50	0.89-2.51	.12	1.51	0.90-2.54	.11	7.82	3.31-18.46	<.01
Network Size							1.17	0.82-1.67	.37	1.19	0.83-1.70	.34	1.07	0.73-1.59	.71
Ego Level															
Sex (Female)										1.73	0.49-6.14	.39	6.51	1.24-34.25	.02
Age										1.03	0.56-1.89	.92	1.02	0.51-2.02	.96

(continued)

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Interactions															
Alter Sex* Ego Sex													0.91	0.24-3.52	.89
Program* Ego Sex													0.05	0.02-0.17	<.01
Random Effects															
σ^2	3.29														
τ_{00}	3.56														
ICC	0.52														
RMSE		1.03			1.02			1.02			1.02			0.99	
BIC		628.13			624.25			633.29			644.21			616.67	

Activity Perception

A multilevel logistic regression with proportional odds was run to determine the effect of alter level, time level, and ego level variables, on whether children reported that an alter was physically active regularly. Table 4.3 provides model parameters for all five models. Model 1 (null model) showed there was significant variation across children as displayed by the ICC. However, when specifying the model according to the BIC, the null model performed the best. Similarly, the specified models were not deemed significant and did not have significant parameters. A post hoc analysis found that the lack of variability in the dependent variable reduced the utility of these specified models.

Perception of Help

Likewise, a multilevel logistic regression with proportional odds was run to determine the effect of alter level, time level, and ego level variables, on whether the child reported an alter helped them to be physically active. Table 4.4 provides model parameters for all five models. Model 1 (null model) showed there was significant variation across children as displayed by the ICC. However as with the activity perception models, according to the BIC the null model performed the best. Similarly, the specified models were not deemed significant and did not have significant parameters. A post hoc analysis found that the lack of variability in the dependent variable reduced the utility of these specified models.

Table 4.3: Multilevel logistic regression model results for child perception of activity

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Intercept	8.85	3.83-20.43	<.01	7.00	2.26-21.74	.01	10.57	0.69-61.91	.09	1.95	0.06-64.20	.70	1.77	0.05-60.98	.75
Alter Level															
Sex (Female)				0.84	0.35-2.00	.69	0.83	0.35-2.01	.68	0.82	0.33-2.01	.66	0.92	0.26-3.22	.90
Father				0.79	0.18-3.38	.74	0.72	0.16-3.18	.66	0.70	0.16-3.06	.63	0.70	0.16-3.08	.63
Mother				1.58	0.28-8.81	.60	1.47	0.26-8.35	.66	1.46	0.26-8.27	.66	1.47	0.26-8.38	.66
Sibling				1.14	0.38-3.35	.81	1.12	0.38-3.33	.84	1.15	0.39-3.44	.80	1.18	0.39-3.57	.76
Friend				2.00	0.63-6.34	.23	1.95	0.61-6.27	.26	2.05	0.64-6.60	.22	2.11	0.64-6.96	.22
Time Level															
Program Effect							1.24	0.60-2.57	.56	1.27	0.62-2.64	.51	1.46	0.55-3.92	.45
Network Size							0.90	0.54-1.51	.69	0.92	0.56-1.54	.76	0.92	0.55-1.53	.73
Ego Level															
Sex (Female)										1.69	0.37-7.66	.49	2.12	0.32-13.92	.43
Age										1.58	0.77-3.24	.21	1.59	0.77-3.30	.21

(continued)

	Model 1			Model 2			Model 3			Model 4			Model 5		
<i>Predictors</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Interactions															
Alter Sex* Ego Sex													0.81	0.15-4.48	.81
Program* Ego Sex													0.76	0.19-3.08	.70
Random Effects															
σ^2	3.29														
τ_{00}	3.96														
ICC	0.55														
RMSE		0.30			0.30			0.30			0.30			0.30	
BIC		287.33			313.56			334.29			345.70			324.49	

Table 4.4: Multilevel logistic regression model results for child perception of help

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Intercept	17.83	7.13-44.58	<.01	24.02	5.37-107.36	<.01	2.47	0.15-40.32	.52	4.39	0.11-177.83	.43	5.55	0.14-219.56	.36
Alter Level															
Sex (Female)				1.80	0.62-5.23	.27	2.11	0.69-6.43	.19	2.09	0.64-6.75	.22	1.72	0.31-9.55	.53
Father				0.38	0.05-2.85	.34	0.45	0.05-3.94	.47	0.47	0.06-3.77	.47	0.40	0.04-3.62	.41
Mother				-	-	-	-	-	-	-	-	-	-	-	-
Sibling				0.31	0.07-1.41	.13	0.31	0.07-1.49	.14	0.31	0.07-1.42	.13	0.28	0.06-1.36	.11
Friend				0.57	0.13-2.58	.46	0.54	0.11-2.56	.43	0.54	0.12-2.51	.42	0.47	0.09-2.32	.35
Time Level															
Program Effect							1.43	0.60-3.39	.41	1.41	0.60-3.33	.43	0.94	0.31-2.92	.92
Network Size							1.60	0.95-2.71	.08	1.59	0.93-2.69	.08	1.65	0.96-2.84	.07
Ego Level															
Sex (Female)										0.89	0.19-4.16	.87	0.49	0.07-3.39	.46
Age										0.85	0.44-1.65	.63	0.84	0.44-1.61	.59

(continued)

	Model 1			Model 2			Model 3			Model 4			Model 5		
<i>Predictors</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Interactions															
Alter Sex* Ego Sex													1.48	0.15-14.36	.73
Program* Ego Sex													2.51	0.46-13.61	.28
Random Effects															
σ^2	3.29														
τ_{00}	2.88														
ICC	0.47														
RMSE		0.27			0.26			0.26			0.26			0.26	
BIC		224.70			253.51			264.89			275.16			245.00	

Qualitative Results

To add context to the networks, a qualitative analysis was conducted to describe the support felt and activities reported within network members. Before the program, 75.6% of children (n=32) reported that their father did help them to be physically active as compared to 90.0% (n=38) after the program. Similarly, 88.1% of children (n=37) reported that their mother helped them to be physically active before the program as compared to 90.0% (n=38) after the program. In both cases, if the child reported that their father or mother helped them to be active, they were then asked how. Overall, motivational social support was mentioned most often (before n=37, 56.9%; after n=44, 62.0%), followed by conditional (before n=14, 21.5%; after n=22, 31.0%), instrumental (before n=10, 15.4%; after n=1, 1.4%), and informational (before n=4, 6.2%; after n=4, 5.6%).

As this program was focused on father-child interaction, paternal support was isolated then stratified by time point and sex of the participating child. Specifically, 14 boys (73.7%) and 17 girls (73.9%) reported that their father helped them before the program as compared to 16 boys (84.2%) and 20 girls (87.0%) after the program. Before the program, boys reported motivational support most often (n=8, 57.1%), followed by instrumental (n=2, 14.3%) and conditional (n=2, 14.3%). Similarly, girls reported motivational support most often (n=8, 47.1%), followed by conditional (n=4, 23.5%), instrumental (n=3, 17.6%) and informational (n=2, 11.8%) before the program. In contrast after the program, boys reported conditional and motivational support at the same frequency (n=8, 50%). After the program, girls reported motivational support most

often (n=13, 65.0%) followed by conditional (n=5, 25.0%) and informational (n=2, 10.0%).

Regarding the types of activities children reported doing with members of their network, general active play was mentioned most often before (n=93, 31.7%) and after the program (n=91, 32.2%). Sport related activities were reported the second most frequent before (n=75, 25.6%) and after the program (n=77, 27.2%). Similarly, running was reported relatively in the same frequency before (n=51, 17.4%) and after the program (n=50, 17.7%). However, there were observed differences in the frequency of chores (before n=33, 11.3%; after n=22, 7.8%), sedentary activities (before n=22, 7.5%; after n=9, 3.2%), and walking (before n=10, 3.4%; after n=24, 8.5%). Lastly, food-related activities were reported relatively in the same frequency before (n=9, 3.1%) and after the program (n=10, 3.5%).

Activities were then separated by sex of the child, timepoint, and relationship with the alter. Tables 4.5-4.6 reports complete frequencies of activities. Most notably, boys reported more sport related activities (before n=56, 38.6%; after n=51, 39.5%) compared to girls (before n=19, 12.8%; after n=14, 11.9%). In contrast, girls reported more general active play (before n=64, 42.9%; after n=52, 44.1%) compared to boys (before n=30, 20.7%; after n=28, 21.7%). Additionally, boys reported more activities with dad after the program (n=31, 24.0%) compared to before the program (n=25, 17.2%). Although relatively consistent over time in total activities reported with dad (before n=20, 13.4%; after n=22, 18.6%), girls reported general active play (before n=7, after n=6) and chores (before n=6, after n=5) as the most frequent activities done with dads.

Table 4.5: Boys self-reported physical activities with network members stratified timepoint and alter relationship

Before Program								
Relationship	Chore	Food Related	General Active Play	Running	Sedentary Activities	Sport Related	Walking	Totals
Dad	10	0	4	4	1	6	0	25
Mom	7	3	3	3	1	2	2	21
Friend Boy	0	0	8	7	6	18	3	42
Friend Girl	0	0	2	0	0	2	0	4
Sibling Boy	1	0	3	4	2	12	0	22
Sibling Girl	0	0	5	2	2	7	0	16
Other Boy	0	0	1	1	0	8	0	10
Other Girl	0	0	4	0	0	1	0	5
Totals	18	3	30	21	12	56	5	145
After Program								
Relationship	Chore	Food Related	General Active Play	Running	Sedentary Activities	Sport Related	Walking	Totals
Dad	5	2	5	4	1	12	2	31
Mom	6	4	4	4	1	4	3	26
Friend Boy	0	0	7	6	2	16	2	33
Friend Girl	0	0	2	0	0	1	0	3
Sibling Boy	1	0	4	2	0	8	0	15
Sibling Girl	0	0	3	2	1	4	0	10
Other Boy	0	0	2	0	1	6	0	9
Other Girl	0	0	1	1	0	0	0	2
Totals	12	6	28	19	6	51	7	129

Table 4.6: Girls self-reported physical activities with network members stratified timepoint and alter relationship

Before Program								
Relationship	Chore	Food Related	General Active Play	Running	Sedentary Activities	Sport Related	Walking	Totals
Dad	6	0	7	5	0	2	0	20
Mom	6	5	3	3	3	2	4	26
Friend Boy	0	0	4	2	0	2	0	8
Friend Girl	0	0	19	4	2	2	0	27
Sibling Boy	0	0	3	3	0	3	0	9
Sibling Girl	1	0	8	4	0	2	1	16
Other Boy	1	0	7	4	3	3	0	18
Other Girl	1	1	13	5	2	3	0	25
Totals	15	6	64	30	10	19	5	149
After Program								
Relationship	Chore	Food Related	General Active Play	Running	Sedentary Activities	Sport Related	Walking	Totals
Dad	5	0	6	4	0	4	3	22
Mom	4	4	7	8	1	1	6	31
Friend Boy	0	0	2	1	0	0	0	3
Friend Girl	0	0	17	5	1	6	1	30
Sibling Boy	0	0	6	0	0	0	0	6
Sibling Girl	1	0	7	3	0	0	2	13
Other Boy	0	0	2	2	0	1	0	5
Other Girl	0	0	5	1	0	2	0	8
Totals	10	4	52	24	2	14	12	118

Discussion

This study aimed to use SNA to examine changes in the composition and activation of social networks of Mexican-heritage children participating in HEPP, a father-focused, family-centered health program. While there weren't significant changes in the network level composition scores, ordinal regression models showed a significant time association for the activation of their social connections, operationalized as increased frequency of activity with alters in their network. To add further context to this

activation, qualitative analysis was used to describe what these children did within their social networks and the types of support they received from their parents.

When assessed at the network level, network size was the only significant change exhibited by the children when comparing before and after the program. All other aggregate measures described in this study showed no significant change. It should be noted the analysis of aggregate measures carry limitations as these measures are restricted in the number of alter nominations that were allowed (Perry et al., 2018). Despite the decrease in the overall number of alters nominated, children still reported statistically similar frequency of PA with alters, number of alters who helped them be physically active, and alters who were regularly physically active. Within these networks, children mention friends and siblings most often as play partners, similar to preliminary studies (Prochnow, Meyer, et al., 2021). Children were also more likely to report same sex alters which is known as homophily (a predisposition to connect with someone similar) and has been reported extensively in child PA SNA literature (Prochnow, Delgado, et al., 2020).

When assessing frequency of active play with alters, multilevel ordinal logistic regression with proportional odds determined alter level, time level, and ego level effects. This model showed children were significantly more likely to report more frequent active play after the program as compared to before the program. In other words, these children were activating their social network to play more frequently. The activation of ties or the perception of more active play suggests the program was successful in increasing activity within network members. Having more active play with alters was significantly associated with objectively measured PA in preliminary studies (Prochnow, Meyer, et al., 2021). Further, there was also a significant interaction term between child's sex and the

program effect, indicating boys disproportionately benefited from the program. More specifically, boys were more likely to increase their frequency of active play with alters as compared to girls. Given that the program was focused on father-child interaction it could be that father-child dyads that included a boy increased their active play more so than father-girl dyads, following social gender norms (Spencer et al., 2015). However, when assessing ego level effects, girls, as compared to boys, were significantly more likely to report more frequent active play with their alters. This is significant as girls often report less PA than boys (Cooper et al., 2015). While this does not show that they were more active overall, it does show that girls perceived more active play with their alters.

Additionally, children were significantly less likely to report frequent active play with their mothers as compared to the other alters. Mothers were mentioned at similar frequencies to fathers in active play networks; however, when looking at the activities mentioned for mothers, they were most often chore or food related. While chores and food-related activities can be active, they may not readily come to mind for children when asked the frequency by which they play with their mothers. In past studies on gender and child PA, mothers and girls report more time spent on household chores and food-related tasks as compared to fathers and boys (Kroska, 2003; Raskind et al., 2020). It should be noted that girls (n=57, 21.3%) were more likely than boys (n=47, 17.2%) to mention any kind of activities with their mothers after the program. This would be consistent with gender norms and a form of homophily as noted above (Prochnow, Delgado, et al., 2020; Spencer et al., 2015).

Motivational forms of social support were the type of social support most often mentioned by the children in this program. Motivational support, such as encouragement and praise for doing active things, has been identified previously as beneficial for child PA (Beets et al., 2010). Specifically, when stratifying paternal support by time point and sex of the participating child, marginally more boys and girls reported their father helped them after the program compared to before the program. Boys reported more conditional support after the program which is most commonly seen as co-participation in activity (Beets et al., 2010). This conditional support could be associated with lessons from the program as the activities within were specifically focused on father-child co-participation in physical activities. Increasing co-participation and encouragement for participating in PA are key ways parents can support healthy child PA habits (Beets et al., 2010).

When analyzing the reported activities children did within their network, there were differences between boys and girls as well as between time points. Specifically, children reported fewer chores and sedentary activities and more walking after the program as compared to before the program. While this is only the child's perception of the most frequent activity, the reduction of sedentary activities is promising. Additionally, walking is reported as a popular PA among children (Sallis et al., 2019). However, some *colonias* lack walkable areas and often have more barriers to active transport (Umstattd Meyer et al., 2013). When activities were separated by child's sex, boys reported more sport related activities compared to girls. In contrast, girls reported more general active play activities compared to boys. Both instances would suggest a gender norm of activity from these children (Spencer et al., 2015). Additionally, boys reported doing more activities with their dad after the program compared to before the

program. This increase in activity would partially correspond to boys being more likely to increase the frequency of active play with alters as compared to girls.

Despite the significant findings related to frequency of active play and descriptive qualitative findings, there were no significant models describing help from alters or perception of alter activity. The lack of variability in the outcome variables made determining these differences difficult. However, despite this difficulty it should be noted that rates of alter activity and perception of help were high before and after the program. In past studies, children were significantly more active if they perceived more of their network to be active (Marks et al., 2015; Prochnow, Patterson, & Umstattd Meyer, 2020). Further, children who perceive more help are also reported to be more active on average (Beets et al., 2010). This amount of support and PA perceived among network members may be an example of the interpersonal factors that have been associated with the Latinx/Hispanic health paradox (Abraído-Lanza et al., 2016).

Limitations

This study was limited by the sample size and specificity. The program sample was limited by resources and COVID-19. Additionally, the specificity of the sample is a limitation to its generalizability; however, it can also be viewed as a strength as it fills a more defined gap in the literature pertaining to culturally and contextually specific health programs and social networks. Further, these measures are self-report which do come with a level of bias (Klesges et al., 2004). However, social network data is often collected by self-report and this procedure was strengthened by being researcher-administered (adams, 2019).

Implications

Despite these limitations the implications of this study are threefold. First, this study suggests that a father-focused family-centered health program tailored for Mexican-heritage families may change the frequency by which children engage in active play with their social networks. This activation is a key concept in the reinforcement of these activities. If children are more active within their networks, they, in turn, promote activity with these other people as well. Next, as a measurement and computational implication, changes can be difficult to measure if network composition is aggregated to the network level. As seen in this sample, significant differences were not found at the network level; however, when assessed at the alter (or dyadic) level, significant associations were found including a program effect. Lastly, this study provides rich descriptive analysis of the activities and support present within these children's networks.

Conclusions

In conclusion, this study fills a lingering gap in the literature pertaining to contextually tailored child PA promotion programs as well as culturally specific social networks. Further, this study benefits from a mixed method approach to add extensive description to the child's network and the differences in these networks before and after a health program.

CHAPTER FIVE

¿Qué Está Haciendo Papá? Changes in Activation of Mexican-Heritage Father Physical Activity Social Networks in Response to a Father-Focused Health Program

Abstract

Physical activity (PA) is a public health priority because of its benefits for physical, mental, and emotional health; however, many adults do not meet PA guidelines to attain health benefits. Within Mexican-heritage families, few studies have examined how fathers interact with their social networks, specifically with whom they are physically active and what they do. This manuscript will examine if participation in a father-focused family-centered health program changes how Mexican-heritage fathers interact with their social networks specifically regarding PA. Participating families consisting of child (aged 9-11), mother, and father were recruited from *colonias* by *promotoras* for participation in a six-week father-focused family-centered health program focused on family dynamics relative to healthy eating and active living. Fathers reported up to five people (alters) they were active with the most in the previous month before and after the program. Fathers also reported each alter's sex, their relationship to the alter, frequency with which they were active with the alter, if they thought the alter was active regularly, if the alter helped them to be active, and what they did most often with that person. Multilevel regression models examined the change in alter level variables. Fathers ($n = 42$, $M \text{ age} = 39.07$, $SD = 7.45$) were significantly more likely to report more frequent PA with their children and wife compared to other alters. Additionally, controlling for covariates, fathers were significantly more likely to report more frequent

PA after the program as compared to before the program. This study provides much needed context to understand the social networks and PA behaviors of Mexican-heritage fathers. Further, this study also provides evidence that a father-focused family-centered health program can increase the frequency of PA with social network connections.

Introduction

Physical activity (PA) is vital to health and wellbeing throughout the lifespan due to its ability to improve physical and mental functioning and decrease risk of chronic diseases (Warburton & Bredin, 2017). Specifically, PA is associated with lower risk for cancer, obesity, and diabetes while also improving mental health and physical functioning (Warburton & Bredin, 2017). Adults are recommended to be physically active for more than 150 minutes each week and engage in muscle strengthening exercises on at least two days to meet guidelines for health benefits (Piercy et al., 2018). However, the rate of adults in the United States and Latin America meeting this recommendation is declining (Guthold et al., 2018). Further, Latinx men in the United States report significantly less PA compared to other racial and ethnic groups (Armstrong et al., 2018). Latinx adults are also disproportionately affected by obesity and obesity-related chronic disease such as diabetes and heart disease, which makes the promotion of PA as a primary prevention method all the more prudent (Falkner & Cossrow, 2014; Wong et al., 2017).

Beyond their personal health, Latinx fathers can have a significant influence on the health and wellbeing of their children by modeling healthy behaviors and forms of social support (Cabrera & Bradley, 2012; Morgan et al., 2017; Stephanie et al., 2016; Wright et al., 2008). Recently, researchers called for a renewed focus on the inclusion of

fathers within child obesity research (Freeman et al., 2012). Parental, and more specifically for the current study paternal, influence is theorized through the family systems theory. Family systems theory suggests that a family functions as a system as the family members influence one another and are expected to abide by family norms which influence health behavior (Broderick, 1993). In empirical preliminary studies, Mexican-heritage fathers who reported being active with more family members (as compared to friends) are more physically active on average (Prochnow, Umstattd Meyer, Patterson, et al., 2020). Due to these influences, family-centered health programs can increase the PA of children as they benefit from family influence and reinforcement (Brown et al., 2016; Kitzman-Ulrich et al., 2010). Unfortunately, many family-centered programs fail to significantly engage fathers (Freeman et al., 2012; Morgan et al., 2017).

Further, the social ecological model encourages researchers to consider interactions between levels of influence, including examining interpersonal effects or social influences on health behavior (Bronfenbrenner, 1977). Social network analysis (SNA) can be used to assess and quantify this social influence from social connections at the interpersonal level (Valente, 2010). In other words, SNA allows researchers to understand the social structure and influences affecting a person and their health behaviors (Borgatti et al., 2018). One SNA approach, egocentric, or personal network analysis, is focused on examining a person's immediate, personal network. Egocentric analysis aims to elicit and understand the influences of the close social connections (termed alters) of each individual being surveyed (termed egos) (Borgatti et al., 2018; Perry et al., 2018). Specifically, in an egocentric SNA study, 58% of Mexican-heritage adults reported at least one member of their network who encouraged them to engage in

regular PA, yet only 10.8% of total network members were reported to be encouraging (Ashida et al., 2012). This encouragement was significant as having at least one social network member who encouraged participants to engage in regular PA was associated with participants' motivation to engage in regular PA (Ashida et al., 2012). However, this was a cross-sectional study and there is limited knowledge on how these networks or social connections may be activated or improved through health programs specifically father-focused family-centered health programming. In other words, fathers can activate social connections when they become more active with that person or receive help from that person.

Specific Aims

Therefore, this paper aims to use SNA to examine changes in the composition and activation of the social networks of Mexican-heritage fathers who participated in a father-focused, family-centered health program. Operationally, activation in this sense means to be active more frequently with people in their social networks. More specifically, this work will detail changes in how these fathers are physically active within their network. This will fill a gap in the literature concerning Mexican-heritage fathers and culturally specific social networks within functionally rural communities as well as a gap in understanding the impacts of a health program on social network activation. Learning more about how social networks change and are activated through a father-focused, family-centered health program within this sample could provide information on how to leverage these social contacts to promote healthy behaviors within the community.

Methods

Setting

As part of the larger *Salud Para Usted y Su Familia* (SPUSF) [Health for You and Your Family] parent project, this study utilized a *promotora*-researcher model. The *promotora*-researcher model is used to develop culturally relevant research and create rapport with traditionally hard to reach and systematically underserved populations (St. John et al., 2013). *Promotora*-researchers (referred to as *promotoras* from this point forward) are members of the community trained in health promotion and research techniques chosen for their ability to create and support community connections and promote health (C. M. Johnson et al., 2013). SPUSF was designed to develop, implement, and evaluate a father-focused, family-centered program promoting active living, healthy eating, and family communication. The program was created for Mexican-heritage families living in *colonia* areas along the south Texas border with Mexico.

The *Haz Espacio para Papi!* (Make Room for Daddy!; HEPP) program was developed as part of this research and outreach effort. While the program outcomes (e.g., nutrition and PA) focused on fathers and children, mothers were engaged in the program, as mothers are family gatekeepers in this cultural context and primarily responsible for caregiving and health (Altenburger et al., 2018; Galanti, 2003). The development of the PA curriculum is explained in detail elsewhere (Prochnow, Umstattd Meyer, et al., 2021). In short, curriculum was developed to embrace existing traditions while creating new active opportunities. Specifically, lessons added physically active variations to traditional games played among Mexican-heritage families. Activities engaged father, mother, and child, but primarily focused on father-child co-participation in light-to-moderate PA.

Sample Recruitment

Program families were recruited from four randomly identified geographic clusters located near unincorporated San Carlos, Texas. *Promotoras* completed door-to-door canvassing, screening, and re-contacting participants from previous studies who had provided consent for re-contact for eligible future studies to identify potential participants. Each participating family member (father, mother, and participant child) needed to meet the following recruitment criteria to be eligible: 1) have no food allergies, 2) have no PA restrictions, 3) both parents at least 21 years of age, 4) at least one parent, or one of their parents (grandparents to child participant), or one of their grandparents (great-grandparents to child participant) born in Mexico (to establish Mexican-heritage), 5) have a child of 9-11 years old living in their household, 6) both parents preferring to speak, write, and read in Spanish, and 7) both parents currently residing in the same household. With these criteria, *promotoras* screened 308 families and recruited 59 families, who were split into five groups of roughly 10-13 families. A modified stepped-wedge cluster randomized trial design was used to maximize benefit to participating families while reducing the amount of resources needed to provide the program (Hussey & Hughes, 2007). Groups were temporally spaced with the first group starting in July 2019 and the fourth group ending in January 2020. Due to COVID-19 pandemic and changes to face-face interactions, Group 5 families were only able to participate in 2 out of the 6 sessions and hence not included in this analysis. Each family group was divided into subgroups of 4-6 families for the weekly weekend sessions. Two separate sessions were conducted on Saturday (morning and afternoon) to allow families to choose the option that best worked for their Saturday schedule.

Measures

Surveys were administered by researchers in Spanish primarily in the father's household. In several cases, and to provide the necessary schedule flexibility, surveys were also administered at the participant's job site, church, or at the home of another family member. Fathers reported their age as demographic information. Surveys were then translated using a forward-translation, back-translation method to ensure accuracy of translation prior to further analysis (Brislin, 1970).

Social network data. Fathers were asked to report initials or pseudonyms of up to five individuals (alters) with whom they were “physically active with most often or actively played with most often” in the previous month. The term alter here is used extensively in egocentric network analysis research corresponding to people listed in an individual's network (Perry et al., 2018). Fathers were limited to five alters as this has been used in past studies to elicit the most salient connections and lessen respondent burden (adams, 2019; Merluzzi & Burt, 2013). Fathers were then asked questions (name interpreters) to better understand the people in their networks. Fathers reported the sex of each alter, his relationship to each alter (spouse, program child, friend, other child, or other), what activities they did most often with each alter (open-ended response), how often they were physically active with each alter (“once in a while”, “sometimes”, or “often”), whether the alter was physically active regularly (“yes”, “no”, or “I don't know”), and if he thought the alter helped him to be physically active (“yes” or “no”).

Fathers were also asked name interpreter questions regarding the child involved in the program even if they were not mentioned originally. In other words, if a father did not mention the participating child when asked who they were physically active with most

often, *promotoras* were instructed to also ask the father the frequency with which they played with the participating child (“once in a while”, “sometimes”, “often”), if they thought they were physically active regularly (“yes”, “no”, or “I don’t know”), and if they helped them to be active (“yes” or “no”) and if so how (open-ended response).

Qualitative Inquiry

A case-study qualitative approach examined the changes reported within fathers’ networks to better understand the activities the fathers engaged in and the support they felt from the program child (Creswell & Poth, 2016). Inductive and deductive approaches were taken by the primary investigator to develop coding frameworks. An inductive coding process for types of PA the father reported was used to develop an initial coding framework (Elo & Kyngäs, 2008). Deductive coding (Elo & Kyngäs, 2008) was used to code social support based on prior research (Beets et al., 2010), using social support categories: motivational, conditional, informational, and instrumental. See Tables 3.1 and 3.2 for full coding framework. Coding was then conducted by independently by two researchers: the primary investigator and a research assistant (O’Connor & Joffe, 2020). Inter-coder reliability was assessed using a kappa score and deemed to be acceptable inter-rater reliability (kappa=0.82) to take into account agreement by chance (O’Connor & Joffe, 2020). Fathers’ activities were classified based on the relationship and alter sex to determine any differences in the types of activities reported with types of alters and between boys and girls. Frequencies for each type of social support are compared before and after the program and by sex of the child. Qualitative coding was facilitated by NVivo v.12 (QSR International Pty Ltd., 2020).

Data Analysis

Network descriptive statistics were generated such as network size as well as frequencies of each network interpreter question at each timepoint separately. As a simplified way of showing change in the network size over time, a paired t-test was used to determine the presence of significant change. Similarly, changes in the amount of physically active network members and members who helped the ego be active were descriptively calculated. Paired t-tests, means, frequencies, and standard deviations for demographic variables were calculated in SPSS v.25 (IBM, 2018). Due to the nomination limit, it was vital to model the change in dyadic level (between each alter and the ego) characteristics through advanced multilevel models accounting for clustering within the ego's network and across time with repeated measures.

Specifically, multilevel modeling is useful for handling egocentric social network data as the alter level observations are nested or clustered under the ego (Luke, 2019; Perry et al., 2018). Measuring networks at the alter level provides more information than aggregating the values to an ego-level variable, and subsequently allows for testing of factors such as alter level covariates (Perry et al., 2018). In the present study three levels were created: 1) alter level, 2) time level, and 3) ego level. At level 3, ego, age, and sex were used as fixed variables across time and alter levels. Level 2 detailed the change in ego across timepoints and added aggregate measures of network size (total number of alters for each ego) at each time point. At level 1, alter sex and relationship were added as independent covariates. Dependent variables in this study were assessed at the alter level (i.e., how often the father reported being active with the alter or if the alter was active regularly). Random-coefficient models, which allow for each respondent to register a

unique intercept and slope in the regression model, were used in order to include interaction effects between levels (Perry et al., 2018). A multilevel ordinal regression model was calculated to determine significant associations between the frequency egos reported being physically active with alters and alter level, time level and ego level variables. Similarly, multilevel logistic regression models were calculated for perception of PA and help. Five models were calculated for each dependent variable: null model, alter model, time model, ego model, and a fully specified model with interactions. Multilevel modeling was done using R studio (RStudio Team, 2020).

Results

Sample

In total, 42 fathers (M age = 39.07, SD=7.45) completed both pre- and post-program evaluations. There was no statistically significant difference in the number of alters fathers reported they were physically active with before the program (M= 4.21; SD=1.16) as compared to after the program (M=4.00; SD=1.06); $t(41)=1.03$, $p=.31$. Before the program, fathers reported 177 total alters: 112 male (63.3%) and 65 female (36.7%). Children were reported more often than any other relationship ($n=91$, 51.4% of alters) with other family members being the next most frequently reported ($n=45$, 25.4%). Similar frequencies were reported after the program. Fathers reported 168 total alters, 110 male (65.5%) and 58 female (34.5%). Similarly, 51.6% of alters were children ($n=85$) and 29.2% were other family members ($n=49$). See Table 5.1 for network descriptive statistics.

Table 5.1: Descriptive statistics for father social networks

Network Variable	Before Program		After Program	
	M (SD)	Frequency (%)	M (SD)	Frequency (%)
Network Size	4.21 (1.16)		4.00 (1.06)	
Frequency of Activity	0.58 (0.60)		0.63 (0.54)	
Active Regularly	3.90 (1.19)		3.79 (1.14)	
Helps	3.95 (1.17)		3.90 (1.08)	
Relationship				
Wife		16 (9.0%)		15 (8.9%)
Child		91 (51.4%)		85 (51.6%)
Friend		25 (14.1%)		19 (11.3%)
Other		45 (25.4%)		49 (29.2%)

Note: Frequency of Activity – Corresponds to the average frequency the father reported being physically active with alters in their network. Active Regularly – Corresponds to the number of alters in a father’s network who were reported to be active regularly. Helps – Corresponds to the number of alters in a father’s network who were reported to help the father be physically active. Relationship – Corresponds to the reported relationship between the father and the alter.

Further, there was no significant difference in the average frequency with which fathers reported being active with their alters when comparing before ($M=0.58$; $SD=0.60$) and after the program ($M=0.63$; $SD=0.54$); $t(41)=-0.43$, $p=.67$. Likewise, there was no significant difference in the number of alters fathers reported to be active when comparing before ($M=3.90$; $SD=1.19$) and after the program ($M=3.79$; $SD=1.14$); $t(41)=0.55$, $p=.59$. Before the program fathers perceived 92.7% of alters ($n=164$) as physically active regularly compared to 94.6% after the program ($n=159$). Similarly, there also was no significant difference in the number of alters they reported help them be active between before ($M=3.95$; $SD=1.17$) and after the program ($M=3.90$; $SD=1.08$); $t(41)=0.22$, $p=.83$. Before the program fathers perceived 93.8% of alters ($n=166$) as helping them to be active compared to 97.6% after the program ($n=164$). As these are aggregate measures of network composition scores also restricted by nomination limits,

some interpretability and information are lost in this process. Hence, multilevel modeling was conducted to determine change among these networks.

Frequency of Activity

A multilevel ordinal logistic regression with proportional odds was run to determine the effect of alter level, time level, and ego level variables, on the frequency by which fathers reported PA with alters. Table 5.2 provides model parameters for all five models. Model 1 (null model) showed there was significant variation in the frequency of PA across fathers as displayed by the ICC. When specifying the model according to the BIC, the Model 3 (including alter and time levels) performed the best. After adjusting for other variables at the alter level and time level, fathers were significantly more likely to report more frequent PA with their children [OR = 2.92, 95 % CI 1.41–6.06] and wife compared [OR = 3.24, 95 % CI 1.03-10.19] to other alters. Additionally, after controlling covariates fathers were significantly more likely to report more frequent PA after the program [OR = 1.81, 95 % CI 1.50–2.76] as compared to before the program.

Table 5.2: Multilevel ordinal regression model results for father frequency of physical activity with alters

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Intercept 1	1.92	1.27-2.88	.02	3.83	1.94-7.59	<.01	1.07	1.34-16.63	<.01	0.82	0.04-15.14	.89	1.34	0.07-26.63	.85
Intercept 2	4.55	2.93-7.07	<.01	9.70	4.71-20.01	<.01	3.42	2.17-28.48	<.01	2.08	0.11-38.46	.62	3.42	0.17-68.48	.42
Alter Level															
Sex				0.80	0.41-1.55	.51	0.81	0.42-1.58	.54	0.79	0.41-1.53	.48	3.39	0.64-18.13	.15
Wife				3.28	1.04-10.31	.04	3.24	1.03-10.19	.04	3.29	1.04-10.38	.04	3.47	1.09-11.05	.03
Friend				2.18	0.90-5.30	.08	2.23	0.91-5.44	.07	2.18	0.89-5.34	.09	2.33	0.94-5.78	.06
Child				2.89	1.40-5.98	<.01	2.92	1.41-6.06	<.01	2.85	1.37-5.93	<.01	2.87	1.37-5.99	<.01
Other				1.92	0.76-4.82	.16	1.92	0.76-4.83	.16	1.87	0.74-4.73	.18	1.95	0.77-4.96	.16
Time Level															
Program Effect							1.81	1.50-2.76	<.01	1.65	1.05-1.74	.04	1.65	1.05-1.73	.04
Network Size							0.89	0.64-1.24	.49	0.90	0.64-1.26	.53	0.89	0.64-1.25	.51
Ego Level															
Age										0.97	0.91-1.03	.33	0.97	0.91-1.03	.32

(continued)

	Model 1			Model 2			Model 3			Model 4			Model 5		
<i>Predictors</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Interactions															
Alter Sex* Program													0.37	0.13-1.06	.06
Random Effects															
σ^2	3.29														
τ_{00}	1.06														
ICC	0.24														
RMSE		1.03			1.02			1.02			1.02			1.02	
BIC		645.44			638.22			620.71			627.16			643.08	

Activity Perception

A multilevel logistic regression with proportional odds was run to determine the effect of alter level, time level, and ego level variables, on the odds the father reported the alter was physically active regularly. Table 5.3 provides model parameters for all five models. Model 1 (null model) showed there was significant variation across fathers as displayed by the ICC. However, when specifying the model, according to the BIC the null model performed the best. Similarly, the specified models were not deemed significant and did not have significant parameters. A post hoc analysis found that the lack of variability in the dependent variable reduced the utility of these specified models.

Perception of Help

Likewise, a multilevel logistic regression with proportional odds was run to determine the effect of alter level, time level, and ego level variables, on the odds the fathers reported the alter helped them to be physically active. Table 5.4 provides model parameters for all five models. Model 1 (null model) showed there was significant variation across fathers as displayed by the ICC. However as with the activity perception models, according to the BIC the null model performed the best. Similarly, the specified models were not deemed significant and did not have significant parameters. A post hoc analysis found that the lack of variability in the dependent variable reduced the utility of these specified models.

Table 5.3: Multilevel logistic regression model results for father perception of activity

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
(Intercept)	30.34	10.95-84.10	<.01	12.28	4.37-34.53	<.01	35.12	0.67-89.85	.07	62.74	0.42-92.46	.10	83.04	0.51-138.17	.09
Alter Level															
Sex				4.96	0.56-44.19	.15	4.90	0.55-43.62	.15	4.69	0.52-42.28	.16	1.07	0.02-61.89	.97
Wife				0.24	0.02-3.19	.27	0.23	0.02-3.04	.26	0.23	0.02-3.12	.26	0.23	0.02-3.11	.26
Friend				1.14	0.30-4.23	.85	1.02	0.27-3.85	.97	0.99	0.26-3.76	.99	1.03	0.27-3.98	.96
Child				1.46	0.25-8.51	.67	1.43	0.24-8.34	.69	1.38	0.24-8.15	.71	1.39	0.24-8.24	.71
Other				2.99	0.69-12.90	.14	2.92	0.66-12.82	.15	2.83	0.64-12.50	.17	2.85	0.64-12.70	.16
Time Level															
Program Effect							1.29	0.49-3.37	.60	1.29	0.49-3.39	.60	1.06	0.36-3.10	.91
Network Size							0.73	0.36-1.49	.38	0.74	0.36-1.50	.40	0.74	0.36-1.52	.41
Ego Level															
Age										0.99	0.91-1.06	.69	0.98	0.91-1.06	.69

(continued)

	Model 1			Model 2			Model 3			Model 4			Model 5		
<i>Predictors</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Interactions															
Alter Sex* Program													3.00	0.21-42.95	.41
Random Effects															
σ^2	3.29														
τ_{00}	1.80														
ICC	0.35														
RMSE		0.23			0.23			0.23			0.23			0.23	
BIC		167.91			189.58			199.91			205.59			210.71	

Table 5.4: Multilevel logistic regression model results for father perception of help

<i>Predictors</i>	Model 1			Model 2			Model 3			Model 4			Model 5		
	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Intercept	18.09	8.68-39.11	.01	26.40	5.35-38.28	.02	42.97	1.94-55.89	.03	39.30	1.86-85.80	.03	17.62	0.09-23.57	.10
Alter Level															
Sex				1.08	0.16-7.04	.93	1.01	0.14-7.24	.99	0.92	0.13-6.74	.93	1.35	0.01-171.15	.90
Wife				1.04	0.08-13.77	.97	0.77	0.05-11.92	.85	0.81	0.05-12.53	.88	0.83	0.04-15.60	.90
Friend				1.00	0.16-6.40	.99	0.55	0.07-4.42	.57	0.52	0.07-4.09	.53	0.52	0.05-5.33	.58
Child				2.46	0.21-29.35	.47	1.95	0.14-26.30	.61	1.87	0.14-25.28	.63	1.88	0.11-33.22	.66
Other				1.79	0.27-11.83	.54	1.68	0.22-12.68	.61	1.60	0.21-12.08	.64	1.63	0.17-15.23	.66
Time Level															
Program Effect							2.50	0.52-12.05	.25	2.56	0.53-12.30	.24	2.92	0.32-26.31	.33
Network Size							0.17	0.02-1.35	.09	0.18	0.02-1.38	.09	0.20	0.02-2.37	.20
Ego Level															
Age										0.96	0.84-1.09	.53	0.96	0.84-1.10	.59

(continued)

	Model 1			Model 2			Model 3			Model 4			Model 5		
<i>Predictors</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Interactions															
Alter Sex* Program													0.74	0.02-25.27	.86
Random Effects															
σ^2	3.29														
τ_{00}	6.45														
ICC	0.66														
RMSE		0.18			0.18			0.17			0.17			0.17	
BIC		120.00			148.18			151.02			156.39			162.25	

Qualitative Results

To add context to the networks, qualitative analysis was conducted to describe the support felt and activities reported within network members. Before the program, 90.5% of fathers (n=38) reported that the participating child helped them to be physically active as compared to all fathers (n=42) after the program. Overall, conditional social support was mentioned most often (before n=22, 57.9%; after n=29, 69.0%) followed by motivational support (before n=14, 36.8%; after n=13, 31.0%). Fathers only mentioned instrumental and informational support once each before the program (n=1, 2.6%).

Regarding the types of activities fathers reported doing with members of their network, general active play was mentioned most often before (n=53, 23.2%) and after the program (n=62, 27.6%). Likewise, work related activities were reported relatively in the same frequency before (n=46, 20.2%) and after the program (n=52, 23.1%). Sport related activities were reported more frequently before (n=50, 21.9%) compared to after the program (n=33, 14.7%). Similarly, chore activities were reported more frequently before (n=36, 15.8%) as compared to after the program (n=27, 12.0%). However, walking was reported more frequently after the program (n=22, 9.8%) compared to before the program (n=12, 5.3%). Running was reported with similar frequencies before (n=17, 7.5%) and after the program (n=15, 6.7%). Sedentary activities were also reported in similar frequencies before (n=13, 5.7%) and after the program (n=7, 3.1%) Lastly, food-related activities were reported least frequent before (n=1, 0.4%) and after the program (n=7, 3.1%).

Activities were then separated by timepoint and relationship with the alter. Table 5.5 reports complete frequencies of activities. Most notably, fathers reported more sport

related activities with boys (before n=24, 32.4%; after n=17, 21.3%) compared to girls (before n=5, 7.7%; after n=4, 7.3%). In contrast, fathers reported more general active play with girls (before n=33, 50.8%; after n=24, 43.6%) compared to boys (before n=14, 18.9%; after n=23, 28.8%). Further, fathers reported walking more with girls after the program (n=11, 4.9%) as compared to before the program (n=2, <1%). Fathers reported more activities with both boys (n=80, 35.1%) yet less activities with girls (n=55, 24.1%) after the program compared to before the program (boys n=68, 30.2%; girls n=65, 28.9%).

Table 5.5: Fathers reported activities with network members

Before Program									
Relationship	Chore	Food Related	General Active Play	Run	Sedentary Activities	Sport Related	Walk	Work	Total
Participant Boy	6	0	1	1	2	5	0	1	16
Participant Girl	2	0	11	2	1	1	0	0	17
Other Boy child	9	0	13	3	3	19	1	4	52
Other Girl child	8	0	22	6	6	4	2	0	48
Friend	4	0	1	3	0	12	1	8	29
Wife	5	1	3	2	0	0	5	2	18
Other	2	0	2	0	1	9	3	31	48
Total	36	1	53	17	13	50	12	46	228
After Program									
Relationship	Chore	Food Related	General Active Play	Run	Sedentary Activities	Sport Related	Walk	Work	Total
Participant Boy	4	2	6	2	0	9	1	2	26
Participant Girl	3	2	14	1	0	2	8	0	30
Other Boy child	9	0	17	4	2	8	3	11	54
Other Girl child	2	1	10	4	2	2	3	1	25
Friend	3	0	6	0	1	5	0	4	19
Wife	4	2	3	2	0	1	5	2	19
Other	2	0	6	2	2	6	2	32	52
Total	27	7	62	15	7	33	22	52	225

Discussion

This study aimed to examine changes in the composition and activation of the social networks of Mexican-heritage fathers participating in *HEPP* a father-focused, family-centered health program. Specifically, this work determined differences in how these fathers were physically active within their networks. Significant associations were determined across time related to the frequency by which these fathers engaged in PA with members of their networks. Additionally, there were differences in the types of activities the fathers reported with their children based on the sex of the child. These findings readily fill a gap in the literature concerning Mexican-heritage fathers and culturally specific social networks within functionally rural communities as well as a gap in understanding the impacts of a health program on social network activation.

There are three main concepts when descriptively assessing the fathers' networks. First, they reported more male alters than female alters which may be a form of homophily or connection based on a similar characteristic (McPherson et al., 2001). It may also be due to gender and social norms where fathers would be more likely to be active with their male family members (e.g., sons and brothers) (Spencer et al., 2015). Next, friends were reported less than 15% of the time. This is significant as preliminary work has associated a higher percentage of friends in social networks with higher levels of sedentary behavior among Mexican-heritage fathers (Prochnow, Umstattd Meyer, Patterson, et al., 2020). Lastly, more than 90% of the fathers reported that their alter was physically active regularly and the alter helped them to be physically active. This is substantially higher than a previous study that stated only 58% of Mexican-heritage adults in their sample reported at least one member of their network who encouraged

them to engage in regular PA and only 10.8% of total network members were said to be encouraging (Ashida et al., 2012). While the network reported by Ashida et al (2012) was generated in differently which may bias a comparison between the two, they did report having an encouraging member significantly increased the odds of the adult's motivation and intention to be physically active.

Multilevel logistic regression with proportional odds determined significant effects at the alter level and time level, on the frequency by which fathers reported PA with the alter. Most notably, fathers were significantly more likely to report more frequent PA after the program as compared to before the program. Despite a lack of significant differences reported in the aggregate measure of average activity with alters, analyzing the possible change at the alter (or dyadic) level revealed significant findings. This increase of activity may be due to the activities in the program which focused on co-participation in light to moderate PA. A qualitative study on parental impressions of child PA reported that parents valued co-participation because of the quality time they got to spend with their children (Hnatiuk et al., 2020). Similarly, quality time was mentioned by participants of the HEPP study as a benefit of the program during weekly process evaluation calls (Prochnow, Umstattd Meyer, et al., 2021). Co-participation was also reported as beneficial for fathers' PA during a father-child PA promotion program in Australia (Morgan et al., 2019). This increase in reported frequency may also signal a greater awareness of the activities that the fathers were doing with the individuals in their networks. Even if it is just a perception, a perception of more PA within one's network has also been associated with more PA by the ego (Leroux et al., 2012).

Further, fathers were significantly more likely to report more frequent active play with their children and wife compared to other alters. This focus on the family would suggest framing within the family systems theory was a valid choice. The focus on more activity with the family would also fit within the established cultural value of familism often exhibited in Mexican-heritage families (Sabogal et al., 2016; Steidel & Contreras, 2016). Fathers were reported to be more physically active in preliminary studies when a greater number of their reported network was family as compared to friends (Prochnow, Umstattd Meyer, Patterson, et al., 2020). To further detail what these fathers were doing with these network members, qualitative analysis was conducted.

Specifically, general active play, sport specific activities, and work-related activities were all mentioned frequently with members within their network. While fathers most often reported doing general active play and sport specific activities with their children, they reported work-related activities with other network members such as extended family and co-workers. Walking was reported more frequently after the program compared to before the program. Walking is commonly reported as a PA for families to do together (Izenstark et al., 2016; Quarmby et al., 2011). Fathers also reported engaging in different activities with boys and girls. Most notably, fathers reported more sport related activities with boys compared to girls. In contrast, fathers reported more general active play with girls compared to boys. This differentiation fits traditional gender norms (Spencer et al., 2015). Further, fathers reported more activities with both boys yet less activities with girls after the program compared to before the program. The increased activity with boys after the program also corresponds to findings

reported by children related to the frequency of activity with their network members. In this case boys benefited from the program above what was reported by girls.

Limitations

One of the main limitations of this study was the size and specificity of the sample. The size was limited to provide a quality experience for the families participating. While the specificity of the sample is a limitation to its generalizability, the level of specificity is needed to fill a more defined gap in the literature pertaining to culturally and contextually specific health programs and social networks. Additionally, the measures presented in the study are self-report which do come with potential bias (Klesges et al., 2004); however, social network data is most often collected by self-report (adams, 2019). While this bias cannot be completely removed, researcher-administered surveys were used and have been shown to increase the validity of the data as well as reduce respondent burden (adams, 2019). Further, the high level of reported network PA and support may also be a sign of social desirability bias (Bergen & Labonté, 2019; Klesges et al., 2004). As fathers have signed up for a family focused health program, they may feel a need to respond positively to these questions and portrait a supportive active family picture. This bias may have limited our ability to interpret changes in this measure.

Implications

Despite these limitations, this study suggests that this father-focused family-centered health program was successful at increasing the frequency by which fathers engaged in PA with those in their social networks. This activation of social network

connections could be vital to reinforce active behaviors as theorized by both the family systems theory and the social cognitive theory. Increased PA with social network connections also suggests that this program could have ripple effects or the ability to promote PA with other individuals outside of the participants. These effects, particularly in family members, would also be supported by the family systems theory.

Subsequently, further research should be conducted to determine if this activation of social network ties is significantly associated with increased PA as theorized. It could be that the successful activation of these ties may moderate the effectiveness of the intervention particularly as it promotes long term behavior change. Moderation and mediation analysis should be conducted to determine what role, if any, these network changes play in the program's effect on objectively measured PA.

Conclusions

This study provides much needed context to understand the social networks and PA behaviors of Mexican-heritage fathers. Building on the findings here, researchers and health professionals have a more complete view of who these fathers are physically active with and what they are doing with their social network connections. Further, this study also provides evidence that a father-focused family-centered health program can increase the frequency of PA with social network connections. This activation or increase in PA frequency through the health program is promising for future PA behavior change as posited through the family systems theory and social cognitive theory.

CHAPTER SIX

Conclusions

This study aimed to use SNA to examine changes in the composition and activation of social networks of Mexican-heritage children and fathers participating in a father-focused, family-centered health program. Specifically, this work determined differences in how these children and fathers were physically active with their networks. While there weren't significant changes in the network level composition scores, ordinal regression models showed significant associations for increased frequency of activity with alters in their network. To add further context to the activation of social network ties, qualitative analysis was also used to describe what these children and fathers did within their social networks and the types of support they received from each other. These findings primarily fill a gap in the literature concerning Mexican-heritage families, specifically fathers and children, and culturally specific social networks within functionally rural *colonias*. Additionally, this work also fills a gap in understanding the impacts of a health program on social network activation.

Synthesis of Study Findings

Descriptively, children mentioned friends and siblings most often as play partners while fathers most often reported being physically active with children and other family members. This focus on the family would suggest framing within the family systems theory was a useful choice. The focus on more activity with the family would also fit within the established cultural value of familism often exhibited in Mexican-heritage

families (Sabogal et al., 2016; Steidel & Contreras, 2016). Preliminary results, published elsewhere, indicated that having a higher percentage of friends in a child's play network was associated with more moderate-to-vigorous PA and less sedentary time (Prochnow, Meyer, et al., 2021); however, a higher percentage of friends in social networks was associated with higher levels of sedentary time among Mexican-heritage fathers (Prochnow, Umstattd Meyer, Patterson, et al., 2020). Children and fathers in the present study were also more likely to report same sex alters which is known as homophily (a predisposition to connect with someone similar) and has been reported extensively in child PA SNA literature (Prochnow, Delgado, et al., 2020). This may also be due to gender and social norms where fathers could be more likely to be active with their male family members (e.g., sons and brothers) as opposed to daughters and sisters (Spencer et al., 2015).

When assessed at the network level, child network size was the only significant change exhibited by the between before and after the HEPP! program. Children nominated significantly fewer alters after the program as compared to before the program. All other aggregate measures described in this study showed no significant change. It should be noted the analysis of aggregate measures carries limitations as these measures are restricted in the number of alter nominations that were allowed to five (Perry et al., 2018). Children and fathers both reported high rates of physically active alters and alters who helped them to be physically active. Specifically, more than 90% of the fathers reported that their alter was physically active regularly and the alter helped them to be physically active. This is substantially higher than a previous study that stated only 58% of Mexican-heritage adults in their sample reported at least one member of

their network who encouraged them to engage in regular PA and only 10.8% of total network members were said to be encouraging (Ashida et al., 2012). While the network reported by Ashida et al (2012) was generated differently, which may bias a comparison between the two, they reported having an encouraging member significantly increased the odds of the adult's motivation and intention to be physically active. Likewise, the presence of physically active alters is commonly associated with greater levels of PA for both adults and children (Leroux et al., 2012; Marks et al., 2015). However, the high level of reported PA and support may also be from social desirability bias (Bergen & Labonté, 2019; Klesges et al., 2004). Since the fathers are signed up for a health program directed at PA with family members, they may feel a need to respond positively to these questions.

When assessing these variables at the alter (or dyadic) level, multilevel ordinal logistic regression with proportional odds determined alter level, time level, and ego level effects. Despite a lack of significant differences reported in the aggregate measures, analyzing the possible change at the alter (or dyadic) level revealed significant findings. Significant effects were only exhibited for frequency of active play or PA with alters. Specifically, children and fathers were significantly more likely to report more frequent active play or PA after the program as compared to before the program. The activation of ties or the perception of more active play suggests the program was successful in increasing activity with network members. Children who reported having more active play with alters also engaged in significantly more objectively measured PA in preliminary studies (Prochnow, Meyer, et al., 2021). This increase of activity may be due to the activities in the program which focused on co-participation in light to moderate

PA. Co-participation and concurrent activity have both been noted in the literature to be beneficial for child PA behaviors (Dlugonski et al., 2020; Prochnow, Umstattd Meyer, & Pollack Porter, 2020; Uijtdewilligen et al., 2017).

There was also a significant interaction term between sex of the child and program effect indicating boys disproportionately benefited from the program. Additionally, boys reported more activities with dad after the program compared to before the program in qualitative results which may partially explain this interaction. Further, fathers reported more activities with both boys yet less activities with girls after the program compared to before the program. The increased activity with boys after the program also corresponds to findings reported by children related to the frequency of activity with their network members. In this case boys benefited from the program above what was reported by girls. However, when assessing ego level effects, girls, as compared to boys, were significantly more likely to report more frequent active play with their alters. This is significant as girls often report less PA than boys (Cooper et al., 2015). While this does not show that they were more active overall, results suggest they perceived more active play with their alters. In past studies, girls often reported more active play with larger groups while boys often played in smaller groups (Marks et al., 2015; Spencer et al., 2015).

Fathers also reported engaging in different activities with boys and girls. Most notably, fathers reported more sport related activities with boys compared to girls. In contrast, fathers reported more general active play with girls compared to boys. Boys also reported more sport related activities compared to girls. In contrast, girls reported more general active play compared to boys. It should be noted here general active play does not

mean less vigorously active than sports related activities; however, it is qualitatively different (Butte et al., 2018). This differentiation between sport and active play fits traditional gender norms as fathers may be more likely to report tag, chase, or dancing with daughters and soccer or basketball with sons (Spencer et al., 2015).

Children reported fewer chores and sedentary activities yet more walking after the program as compared to before. While this is only the child's perception of the most frequent activity, the reduction of sedentary activities is promising. Fathers also reported walking more frequently after the program compared to before the program. Walking is commonly reported as a PA for families to do together (Izenstark et al., 2016; Quarmby et al., 2011). However, some *colonias* lack walkable areas and often have more barriers to active transport (Umstattd Meyer et al., 2013).

Motivational forms of social support were mentioned most often by the children in this program. Motivational support such as encouragement and praise for doing active things has been identified previously as beneficial for child PA (Beets et al., 2010). Boys reported more conditional support after the program which is most commonly seen as co-participation in activity (Beets et al., 2010). Overall, fathers mentioned conditional social support most often followed by motivational. This conditional support could be associated with lessons from the program as the activities within were specifically focused on father-child co-participation in physical activities. Increasing co-participation and encouragement for participate in PA are key ways parents can support healthy child PA habits (Beets et al., 2010). In a previous study, parents reported valuing co-participation because of the quality time they got to spend with their children (Hnatiuk et al., 2020). Additionally, quality time was also mentioned by participants of HEPP as a

benefit of the program during weekly process evaluation calls (Prochnow, Umstattd Meyer, et al., 2021). Co-participation also supported and promoted father PA during a father-child PA promotion program in Australia (Morgan et al., 2019).

Despite the significant findings related to frequency of active play and descriptive qualitative findings, there were no significant models describing help from alters or perception of alter activity. The lack of variability in the outcome variables made determining these differences difficult. However, despite this difficulty it should be noted that rates of alter activity and perception of help were high before and after the program.

Limitations

The specific focus on Mexican-heritage families residing in *colonias* limits generalizability outside this geographic area but adds vital specificity which is lacking in PA social network and family focused programming research (Prochnow, Delgado, et al., 2020). The networks in this study were limited to five alters (or people the participant said were in their network) which should be considered a limitation. It is possible that this left out important connections; however, limits have been used in past studies in order to limit respondent burden and in an attempt to only elicit the most important connections (adams, 2019). As noted previously, the high level of reported network PA and support may also be a sign of social desirability bias (Bergen & Labonté, 2019; Klesges et al., 2004). As fathers and children have signed up for a family-centered health program, they may feel a need to respond positively to these questions and portrait a supportive active family picture. This bias may have limited our ability to interpret changes in this measure.

Impact to Field of SNA and PA

This study fills multiple gaps in the literature and contributes to the understanding of family PA, social network activation, and family-centered health programs. First, this study is among the first to detail the change in the social networks of fathers and children during a health program (Prochnow, Delgado, et al., 2020). One previous study measured social networks as part of a school health program and found that the program mitigated detrimental influence of peer sedentary behavior if it was present (Shin et al., 2014). However, Shin et al (2014) only measured social networks within the school setting. The study presented here utilizes networks within a family-centered program outside of the school setting to specifically include the family environment. Filling this gap provides additional support for focusing on reciprocal determinism and systems dynamics within the family unit.

This study also fills a lingering gap in the literature pertaining to contextually tailored family PA promotion programs and culturally specific social networks. Adding vital specificity, this article fills a gap in the social network literature (Prochnow, Delgado, et al., 2020). As noted previously, Latinx children are less likely to meet PA recommendations and 1.5 times more likely to be obese or overweight when compared to non-Latinx white children (Fakhouri et al., 2013b; Yusuf et al., 2020). Further, Mexican-heritage families residing in *colonias*, may be particularly impacted by systematic and structural health barriers (Anders et al., 2010; Waisel, 2013). Providing cultural and contextual specific social network implications will support researchers promoting health within these communities.

This study also adds vital descriptive context to a significant gap in knowledge of Mexican-heritage fathers. Engaging fathers in the care and health of their child has been underreported in the literature. This study helps to fill this gap by providing a view of paternal social networks and the activities and support present in those networks. Further, the father-focused nature of the *HEPP* health program fills a need in understanding the role of fathers and supporting them within Mexican-heritage families.

Lastly, this study also adds to the literature by utilizing a mixed method approach to investigate the change in social networks. While previous articles have used a mixed method approach to understand cross-sectional and longitudinal social networks (Garcia, Sirard, et al., 2016; Garcia et al., 2019), there is little evidence in the literature of mixed method approaches used specifically in family PA SNA research. Using both SNA and qualitative analysis provides a richer context to the activities the children and fathers were doing within their networks.

Next Steps

Further research should be done to determine if this activation of social network ties is significantly associated with increased PA as theorized. It could be that the successful activation of these ties may moderate the effectiveness of the intervention particularly as it promotes long term behavior change. Moderation and mediation analysis should be conducted to determine what role, if any, these network changes play in the program's effect on objectively measured PA. Additionally, these measurements were taken directly after participation in the program. It may be worthwhile to determine if these effects are maintained. Maintenance of the beneficial social environment and PA behaviors would be vital for long term health benefits. Lastly, further qualitative

research will need to be conducted to determine why these networks changed over time. The analysis above infers that it is due in part to participation in a health program but specifically determining why alters may have been added or removed from the networks as well as change within the specific alter would provide more details into the activation reported here.

Public Health Impact and Implications

As part of the broader public health literature, this dissertation provided an examination of the combination of social cognitive theory, family systems theory, and theory of social networks in the scope of a father-focused family-centered health program. The combination of these theories to promote health behavior change is further facilitated by the social ecological model through the interpersonal level of influences. Further, the health equity focus and specificity of the program further adds context to promoting health behaviors among Mexican-heritage families residing in *colonias*. Culturally and contextually tailoring the health program to a specific population with the help of *promotoras* was vital to the efficacy and effectiveness of the program.

Broadly, public health is recognizing the impact of social connections and the need to understand the implications for individual and population health. Specifically, the National Institutes of Health have deemed social connectedness a priority topic in recent years and have even promoted special funding opportunities to investigate the impact of social connectedness on health and well-being (e.g., PAR-19-384 and PAR-21-144). This dissertation provides an example of how social connectedness may be measured during a father-focused, family-centered health program. Further, the results here indicate these measures can change during a health program suggesting these programs can impact

social connectedness. Acknowledging, understanding, and measuring these changes is important for public health at large as the change in connectedness could have implications for multiple health behaviors and subsequently health and well-being outcomes.

Conclusion

This study suggests that the father-focused family-centered health program was successful at increasing the frequency by which fathers and children engaged in PA with those in their social networks. This activation of social network connections could be vital to reinforce active behaviors as theorized by both the family systems theory and the social cognitive theory. Increased activity with social network connections also suggests that this program could have ripple effects or the ability to promote activity with other individuals outside of the participants. These effects, particularly in family members, would also be supported by the family systems theory. Further, this study benefited from a mixed method approach to add extensive description to the children and father's network and the differences in these networks before and after a health program.

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