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Neighborhood and family social capital and oral health status of children in Iowa

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NEIGHBORHOOD AND FAMILY SOCIAL CAPITAL AND ORAL HEALTH STATUS OF CHILDREN IN IOWA

by

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CERTIFICATE OF APPROVAL

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MASTER'S THESIS

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This is to certify that the Master's thesis of

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ABSTRACT

Oral health disparities in children is an important public health issue in the United States. A growing body of evidence supports the impact of the social determinants of oral health, moving beyond individual predictors of disease to family- and community-level influences. The goal of this study is to examine one such social determinant, social capital, in the family and neighborhood and their relationships with oral health in Iowa children. A statewide representative data source, the 2010 Iowa Child and Family Household Health Survey, was analyzed cross-sectionally for child oral health status as the outcome, a four-item index of neighborhood social capital and four separate indicators for family social capital as the main predictors. Data were analyzed using a mixed linear regression with a random effect for zip code. Soda consumption was checked as a potential mediator between the social capital variables and oral health status. A significant association was found between oral health status and neighborhood social capital ($p=0.005$) and family frequency of eating meals together ($p=0.02$) after adjusting for covariates. Soda consumption was not found to mediate the effect of family or neighborhood social capital on child oral health status. Neighborhood social capital and family function, a component of family social capital, may influence child oral health outcomes.

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CHAPTER I: INTRODUCTION

Across the United States, dental disease continues to negatively impact the lives of hundreds of thousands of schoolchildren. These effects can include chronic pain, loss of self-esteem, and school absenteeism for extensive dental treatment (U.S. Department of Health and Human Services 2000). Dental caries, the medical term for tooth decay, is the most common chronic childhood disease in the U.S., five times as common as asthma (U.S. Department of Health and Human Services 2000). In 2002, 41% of children aged 2-11 in the U.S. had experienced tooth decay (Dye and others 2007). Disease patterns do not occur evenly across the population, however. Children in low-income and minority groups consistently have poorer oral health than their wealthier and white counterparts (Dye, Li, Thornton-Evans 2012).

Fortunately, dental caries is almost entirely preventable. In the last half-century, public health efforts have made significant progress to reduce caries rates in all age groups. However, since the late 1980s the 2-11 age group has been the only cohort whose decay rates have not decreased. In fact, they have increased slightly (Dye and others 2007). Public health interventions have primarily addressed the direct predictors of tooth decay including fluoride exposure, diet, oral hygiene behaviors, and access to care. Yet a significant amount of disease still exists, which may suggest that the public health community is missing a piece in the puzzle of factors that contribute to tooth decay. As the disease burden lies more heavily in low-income and minority groups, this piece may be related to social environment.

Social capital is one such social factor for which its association with oral health outcomes has not been widely studied. A discussion of the definition will take place in

the following chapter, but for general purposes social capital refers to 1) resources inherent in social networks such as trust, reciprocity, information exchange, and social support, and 2) a generalized, community-level resource based on public trust and reciprocity (Coleman 1988; Putnam 2001). The study of social capital has a long history in the fields of sociology, economics, and political science, however it only entered the public health field in the last 10-15 years and dental public health in the past five. For oral health in particular, the number of studies looking at social capital and oral health outcomes have been relatively few. Yet they have generally found significant associations between multiple forms of social capital and various oral health outcomes. These studies have mostly been conducted in Brazil and Japan, and very few have been conducted in the United States. Therefore, additional research should investigate this association in a U.S. population.

The issues outlined above collectively indicate a need to study the effect of social capital on the oral health of children. First, the U.S. has a large population of children, who unjustly continue to suffer from a preventable disease, and this group of children are disproportionately low-income and of minority status. Second, the public health community has been unsuccessful in lowering caries rates in this age group in the last 20 years. Third, it is well known that social factors – such as socioeconomic status (SES), minority status, and education – impact population oral health. Fourth, recent studies on the effect of social capital on oral health have found that there appears to be an association, suggesting that it may be a deeper social construct than simply SES or minority status that affects dental disease prevalence in these populations. These studies

will be discussed in detail in the following chapter. Together, these issues create a necessity for investigating this association further.

The lack of a sound body of evidence on the effect of social capital on oral health clearly necessitates further investigation, particularly in a United States setting. Therefore, the aim of this study is to investigate the association between social capital and oral health status in children.

CHAPTER II: LITERATURE REVIEW

"Why treat people … without changing what makes them sick?" The World Health Organization poses this question, suggesting that without modifying the social determinants of health, medical care may be futile (World Health Organization 2013). These social determinants, argues Dr. Michael Marmot in *Social Determinants of Health*, are the "causes of the causes" that affect health (Marmot and Wilkinson 2006). For example, in smoking as a predictor of lung cancer, social epidemiology seeks to explain what predicts smoking in a population. More broadly, researchers in social determinants of health investigate why, in countries all over the world, there is a social gradient when it comes to health status. Individuals higher up in the social hierarchy invariably have better health outcomes than those toward the bottom. The relationship between oral health and social factors is no exception. Results from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) indicate that low-income children and adults at all ages suffer from almost three times the amount of untreated tooth decay (caries) as their higher-income counterparts (Dye and others 2007). As the evidence points more and more toward the potential of interventions directed at the social determinants of health, as opposed to individual behavior, scholars are calling for oral health researchers to catch up with the public health field by examining how these upstream factors relate to oral health outcomes (Watt 2002; Watt 2007; Zarzar, Ferreira, Kawachi 2012).

In children in particular, untreated caries can lead to detrimental outcomes. The most famous case in the U.S. was the death of Deamonte Driver, a 12-year-old from Maryland, whose dental infection spread to his brain (Gavett 2012). While death from

untreated caries is a rare occurrence, this condition does commonly affect the lives of children in other ways. These include chronic pain, which affects a child's ability to sleep and concentrate in school, issues with self-esteem, and school absenteeism due to pain and recurring dental visits for treatment (U.S. Department of Health and Human Services 2000). Additionally, studies have shown that children who have caries in the primary or baby teeth are more likely to have caries in their permanent teeth as well, so the effects of caries are likely to persist into adulthood (Li and Wang 2002).

Many social factors have been found to be associated with oral health outcomes. These include socioeconomic status, race/ethnicity, access to dental care, and education (Caplan and Weintraub 1993; Edelstein 2002). Neighborhood safety and social capital have also recently been found to predict racial/ethnic dental health disparities in U.S. children (Guarnizo-Herreno and Wehby 2012). With this broad range of predicting factors abounding in the oral health literature, a model for determinants of oral health in children has been proposed which includes three levels of determinants: child-level, family-level, and community-level (Fisher-Owens and others 2007). Three social factors in this conceptual model will be assessed in the proposed study: family functioning (family-level), social support (family-level) and social capital (community-level). This study will conceptualize 'family functioning' as family social capital, as the variables are conceptually quite comparable. Additionally, a model for predictors of oral health disparities contains similar factors (termed community- and family-level social integration and support) (Patrick and others 2006) .

The inclusion of social capital in conceptual models of oral health, such as Fisher-Owens et al., is encouraging. However, there are simply not many studies on this factor

compared to others in this model. Further, the magnitude of effect of social capital on the oral health of children is not well known. As will be discussed in more detail, social capital has a variety of forms, and the form being studied largely depends on the outcome of interest. Therefore, as this study focuses on oral health in children, the two forms of interest in this study are family and neighborhood social capital.

Conceptualizing Social Capital

Social capital emerged as a social determinant in the public health field in the late 1990s. Its brisk entrance into this field has been met with several problems, the most common of which are its definition and how to measure it. Because social capital is a relatively broad concept, health researchers have lumped a myriad of social factors under the umbrella of social capital. Therefore, an extensive discussion about the definition, breakdown, and components of social capital is in order.

The definition of social capital has evolved greatly since its inception in the sociological literature in the mid to late 1980s by James Coleman and Pierre Bourdieu. Coleman and Bourdieu argued that social capital inheres in dense social networks and is identified by its function as a social resource (Bourdieu 1986; Coleman 1988). Currently, however, it has expanded to include many more constructs. Robert Putnam, a political scientist who publicized the concept in his national bestseller, *Bowling Alone*, defined social capital as social networks and the associated norms of reciprocity, which inheres both in the individual and the collective (Putnam 2001). In the health field, Ichiro Kawachi has edited a text, *Social Capital and Health*, in an attempt to standardize definitions and methodologies of measurement. In it, the authors suggest that social

capital can be studied as a group or community-level attribute, sometimes termed "social cohesion", or as an individual attribute via network theory. Whether studied at the individual- or community-level, the authors argue, social capital can be conceptualized in two ways: structural vs. cognitive and bonding vs. bridging. Structurally, social capital measures what people do, such as the number of social groups an individual participates in, and can be measured objectively. Cognitively, it measures how people feel about their social networks, and is therefore a subjective characteristic (Harpham 2008). Bonding and bridging social capital, on the other hand, refer to the structural link within or between groups. Specifically, bonding social capital is the social connectedness within a group whose members are alike in some way (i.e. race/ethnicity, class, language) and bridging social capital refers to social connections that cross groups or other boundaries of social identity (Kawachi, Subramanian, Kim 2008). It is important to make this distinction because the two types can have opposing effects on health. For example, a group of adolescents in a crime-ridden inner-city neighborhood may have a high level of bonding social capital but this may prevent them from wanting to succeed in school or move into a safer neighborhood or may perpetuate smoking and drug habits. For this group, bridging social capital with a teacher or grandparent or boss may be more beneficial for health. Clearly, social capital as a determinant of health can have both beneficial and detrimental effects, and Kawachi et al. note that "the emerging picture from these studies seems to be that bonding capital within disadvantaged communities may be a health liability rather than a force for health promotion" (Kawachi, Subramanian, Kim 2008) . Therefore, it is important to examine the nature of the social

network under study when forming hypotheses about the health effects of social capital in a particular group.

Examples exist in the literature of researchers lumping social characteristics under the heading of social capital inappropriately. Generally, these non-social capital characteristics are often either 1) intermediary factors that connect social capital and health or 2) outcomes of social capital rather than a measure of the factor itself. In *Social Capital and Health*, Harpham lists five factors that are commonly incorrectly labeled as social capital:

- "Sense of belonging
- Enjoyment of area
- Desirability to move/stay
- Neighbourhood quality/desirability (noise, graffiti, litter, greenery, facilities)
- Security/crime" (Harpham 2008)

For example, people living in a neighborhood with a high crime rate are less likely to feel that people in their neighborhood can be trusted or neighborhoods with low social capital may be more likely to allow criminal acts to occur. Here, a high crime rate can be either a predictor or a consequence of low social capital rather than a measure of social capital itself.

Another difficult issue in defining social capital is how to accurately measure it. The above discussion about what does *not* constitute social capital is an important component of this issue, as well as the decision to characterize social capital as an individual attribute, a group attribute, or both. In chapter three of *Social Capital and Health*, Harpham argues that it should be both, and that the best way to do this is to

aggregate individual responses about social capital to obtain an ecologic measure, which has been done in numerous studies on the effect of social capital on health and other outcomes (Harpham 2008). Other ecologic measures have been used, such as union membership, volunteering rates, and congregation size, but these tend not to be valid, reliable measures and therefore aggregates of individual responses are still the collective measurement of choice, according to this author (Harpham 2008).

In this study, a combination of definitions of social capital will be used. The collective conceptualization of social capital as a public good and inhering at a community level, as Putnam described it, informs the 'neighborhood social capital' variable used here. Additionally, Coleman and Bourdieu's dense network theory and Coleman's emphasis on the role of family in the creation of social capital informs the 'family social capital' variable.

Mechanisms of Social Capital's Action on Health

A number of mechanisms have been proposed for exactly how social capital affects health outcomes. In *Social Epidemiology*, Kawachi and Berkman argue that there are three main mechanisms linking social capital to health: by moderating health-related behaviors, improving access to services and amenities, and via psychosocial processes (Kawachi and Berkman 2000). It impacts health behaviors primarily in two ways. First, it facilitates the spread of health information. In populations or geographic regions where social networks proliferate, there is a greater amount of interpersonal communication than in groups where people are more socially isolated. Second, it can affect behavior

through informal social control. This term refers to the actions of non-law enforcement persons (i.e. a neighbor or family member) that seek to correct deviant behavior. For example, if a group of young women under 18 years of age were walking down the street smoking cigarettes, a neighbor may call out to them and tell them to stop. This would be an example of how informal social control, an attribute of social capital, may affect health behavior. This health behavior theory is partially supported by a recent study that found that physical activity attenuated the relationship between neighborhood social capital, but other health-related behaviors (smoking, alcohol intake, sleep duration, and nutrition) did not (Mohnen and others 2012). A recent conceptual model has been developed relating social capital to health behavior theory (Figure 1). This model states that community-level social capital influences individual behaviors via two pathways: by "providing access to social support, which influences behaviors via cognitive factors such as self-efficacy", and via socialization, or the "process in which individuals adapt their behaviors to align with the norms of their community social networks" (Samuel, Commodore-Mensah, Dennison Himmelfarb 2013).

Social capital has been hypothesized to improve access to services by increasing a group's collective efficacy, or their willingness to produce change in a community. For example, if a neighborhood with high social capital faces threats of closing a nearby medical clinic or turning a local park into a parking lot, they would be more likely to get together and lobby to prevent such events from happening than a neighborhood with low social capital.

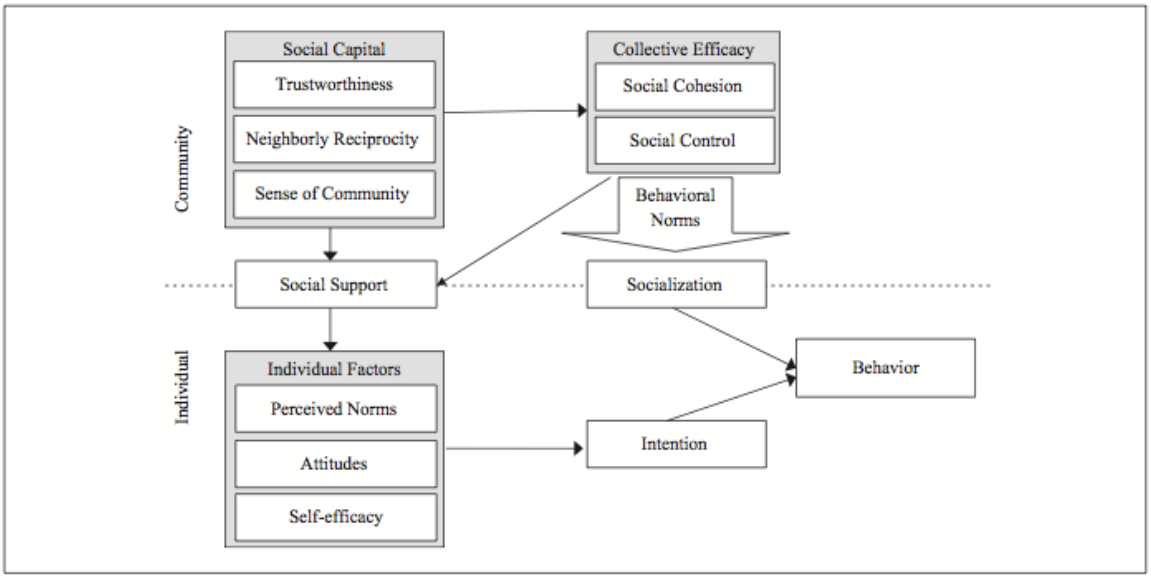
Additionally, the psychosocial mechanism by which social capital has been purported to affect health occurs because of increased social support. Communities with

high levels of social capital tend to be more socially supportive, which can "buffer stress – either by positively affecting the individual appraisals of their ability to cope with a stressful situation, or by directly supplying the resources required to deal with the stressful perturbation" (Kawachi, Subramanian, Kim 2008) .

Putnam refers to several other possible mechanisms, including receiving tangible assistance for healthcare – such as money and transportation – from one's social networks. He also extrapolates the spread of health information theory to argue that social capital can reinforce healthy norms at a societal level, which would be considered an outcome of the 'public good' definition (Putnam 2001).

These mechanisms apply to oral health as well, and this study will measure whether soda consumption is one example of a health behavior-mediating factor through which social capital impacts oral health. Soda consumption has been found to have detrimental effects on the oral health of children and adolescents (Shenkin and others 2003).

Figure 1. Conceptual framework integrating social capital and health behavior theory (Samuel, Commodore-Mensah, Dennison Himmelfarb 2013)



Social Capital and General Health

Just as it is important to place oral health in the context of general health, so too is it important to place the effect of social capital on oral health into the context of social capital's impact on general health. Therefore, systematic reviews on the relationship between social capital and general health will be included here. Three systematic reviews of the existing literature on social capital and health give varying messages about social capital's place in the health literature. Carlson & Chamberlain argue that social capital lacks conceptual and theoretical development in the health literature and therefore its usefulness is limited until these gaps are addressed (Carlson and Chamberlain 2003). Specifically, their review found a lack of congruence on social capital as an individual or

geographic attribute, a broad scope of operational variables used to characterize social capital, and limited evidence of a causal relationship.

Islam et al. furthers the theoretical development of the varying types of social capital to some extent, however some of the limitations demonstrated in Carlson and Chamberlain's review remain (Islam and others 2006). They argue that cognitive (as opposed to structural) and bonding (as opposed to bridging) types of social capital impact health via influencing behaviors, sharing information, and providing mutual support, similar to Berkman and Kawachi's proposed mechanisms for social capital's impact on health. While bridging social capital may impact health by connecting vulnerable individuals and populations to other groups with more resources, no studies had looked at this relationship at the time this review was written. The review included cross-sectional studies using both single- and multilevel analyses. The authors conclude that although the majority of single-level and multilevel studies found a significant association between social capital and health, there is considerable variation in how social capital was conceptualized and operationalized. Additionally, the few number of multilevel studies, they argue, necessitates further research incorporating this type of analysis.

Murayama et al. include only prospective, multilevel studies in their review in order to determine the contextual effect of social capital on individual health outcomes as more than the result of individual attributes, and to assess causality via a temporal relationship (Murayama, Fujiwara, Kawachi 2012). Measures of general health included mortality, hospitalization, self-rated health, health-related behavior, and depression. The community-level unit of analysis varied from zip code to state to work unit. Though the results were not perfectly consistent, the authors concluded that "both area/workplace

social capital and individual social capital generally appear to have positive effects on health outcomes, although the studies varied with regard to participants, setting (including country), follow-up period, and variables used as social capital and health outcomes" (Murayama, Fujiwara, Kawachi 2012) . The authors questioned the robustness of this evidence of causality because of the small number of prospective studies available, and encouraged social capital researchers to conduct more longitudinal studies.

These reviews provide evidence for a need for improved conceptual development and standardized measurement of social capital in the health literature, as well as more multilevel studies that examine the contextual effect of social capital on health. These conclusions are echoed by other social capital scholars (Morrow 1999; Shortt 2004). Murayama et al. note Macinko and Starfield's four analytic levels of association between social capital and health: "the macro level (countries, states, regions, and local municipalities), meso level (neighborhoods and blocks), micro level (social networks and social participants), and individual psychological level (trust and norm)" (Macinko and Starfield 2001) . The present study will examine social capital at the micro/individual level for both neighborhood and family social capital.

Neighborhood Social Capital and Child Health

Neighborhood social capital is defined as "the access to resources that are generated by relationships between people in a friendly, well-connected and tightly knit community", or cohesive communities (Mohnen and others 2012). It has been found to impact self-reported health (Boyce and others 2008; Mohnen and others 2011; Poortinga

2006) via increasing physical activity and reducing smoking (Mohnen and others 2012), reducing cancer mortality and suicide (van Hooijdonk and others 2008). Social capital's influence on health outcomes have been found to be indirect through improving healthy behaviors. The number of studies on child health is limited, however, and have found associations between neighborhood social capital and self-rated health (Boyce and others 2008) and mental health (Drukker and others 2003).

Family Social Capital and Child Health

The World Health Organization has identified familial relationships as a key factor influencing child and adolescent health (World Health Organization 1999). Parcel et al. define family social capital as "the bonds between parents and children useful in promoting child socialization, and as such includes the time and attention parents spend in interaction with children and in monitoring their activities and promoting child well-being", and that these interactions are a form of bonding social capital (Parcel, Dufur, Zito 2010). Family social capital has been found to impact a number of factors in children: behavioral issues (Parcel and Menaghan 1993), academic performance, general well-being, and delinquency (Dufur, Parcel, Troutman 2013; Parcel, Dufur, Zito 2010; Runyan and others 1998), cognitive skills (Caughy and O'Campo 2006), likelihood of dropping out of school (Teachman, Paasch, Carver 1997), and buffers the negative effects of family migration (Hagan, MacMillan, Wheaton 1996).

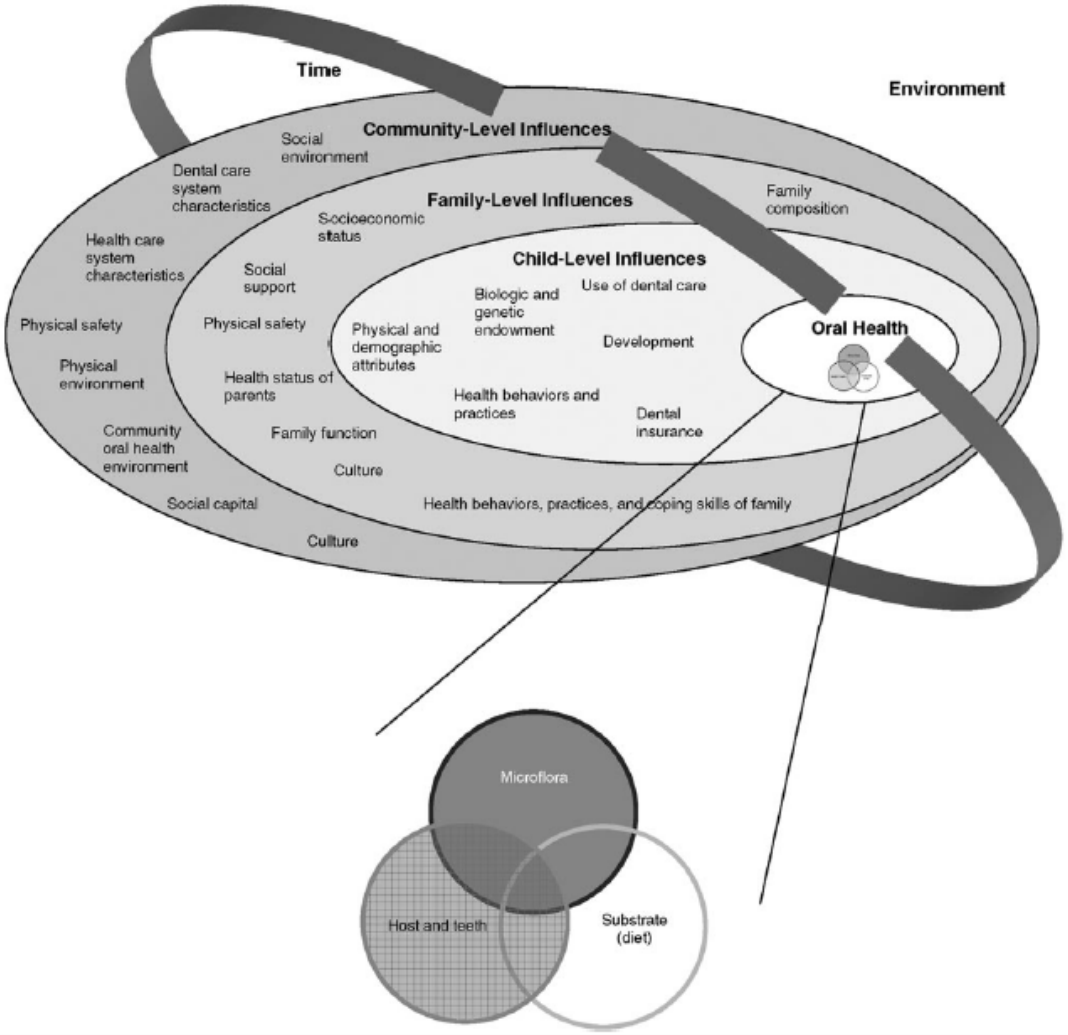
Dr. Pia Christiansen developed a conceptual framework for how families promote health in children (Christensen 2004). She delineates external factors, which include community and societal influences, from internal factors which occur in the family unit

itself. Following this model, it makes sense that neighborhood factors and family influences both simultaneously contribute to child health. This review reveals a lack of studies investigating the association between family social capital and child health and, further, child oral health. Family social capital is likely to impact child health via promotion of healthy behaviors, psychosocial processes, and facilitating access to health services.

Conceptual Framework for Oral Health in Children

In order to broaden the scope of research on the determinants of oral health in children and to give more weight to macro-level predictors, Fisher-Owens et al. built a conceptual model of factors affecting child oral health that incorporates variables at the child, family, and community levels (Fisher-Owens and others 2007) (Figure 2). The two explanatory constructs in this study fall into the family- and community-level realms. While family social capital per se is not listed as a family-level influence, the descriptions of family function and family composition variables in the model are consistent with the operational definition of family social capital used in this study. Additionally, community-level social capital is consistent with the neighborhood conceptualization of social capital used in this study. As will be discussed in detail in the next section, the scant amount of research on the effect of these variables on child oral health, and the need to validate their place in the model, constitute a need to study this topic.

Figure 2. Fisher-Owens conceptual model of influences on child oral health (Fisher-Owens and others 2007)



Social Capital and Oral Health

This review began with literature on social capital and overall health in children, and will now narrow down to oral health, as it is important to place oral health in a context of overall health and well-being. Only a handful of studies have examined the relationship between social capital and oral health, and even fewer in children specifically.

Nearly all published studies evaluating the association between social capital and oral health have assessed the neighborhood conception of social capital. These studies will be reviewed in general by year of publication as this illustrates the evolution of how social capital has been conceptualized and measured in the oral health literature. The first study, published in 2001, is an ecological study investigating social cohesion and neighborhood deprivation as community-level variables and their association with the number of decayed, missing, and filled teeth (DMFT) (Pattussi and others 2001) . While neither of these community-level variables were termed "social capital" in the article, the proxy variables used to characterize social cohesion are within the realm of what is generally considered social capital. Neighborhood deprivation, however, is more of a community-level measure of SES rather than social capital, and results on this variable will therefore not be discussed here. The study was undertaken in order to investigate the association between dental caries and social conditions, including income inequality. In order to assess the two dependent variables, DMFT per child and percent of caries-free children, the authors used DMFT data from a previous oral health survey in which 7296 children were examined by calibrated examiners, and individual scores were averaged for each Administrative Region (RA). Data on social variables were obtained from a previous investigation in the same region in which 13,000 families were surveyed. Social cohesion was characterized by two independent variables: the per thousand number of participants in meetings about budget decisions for each RA, and the per thousand number of homicides and attempts per RA. This information was obtained from census data. Using linear regression analyses, the authors did not find a significant association between the proxy variables for social cohesion (budget decision participation and

homicides) and either DMFT or percent of caries-free children. While ecological studies have been criticized as being inherently weaker than those that use individuals as the unit of analysis rather than communities, this was one of the first studies to examine the relationship between oral health and neighborhood social capital-like variables, so it provided baseline evidence to suggest future research on these topics. However, as discussed previously, using crime or safety as proxy measures for social capital is now discouraged, which limits the validity of the findings as they incorporate homicide as a measure of social cohesion.

In 2006, Pattussi and colleagues published a second study on community-level social capital-related variables that investigated the effect of neighborhood empowerment on dental caries in Brazilian adolescents (Pattussi, Hardy, Sheiham 2006a). Again, there was no discussion in the article of neighborhood empowerment as it related to social capital, however the variables used to assess neighborhood empowerment were similar to neighborhood social capital variables used elsewhere in the literature. This cross-sectional study was conducted on 14-15-year-old public school students and their parents via dental examination (students) and questionnaires (students and parents). DMFT, the outcome variable, was assessed by dental examinations of 1302 students by calibrated examiners. The confounding variables that were assessed using the student questionnaires were related to oral health behaviors such as sugar consumption, toothbrushing frequency, and systemic fluoride exposure. Parent questionnaires addressed empowerment-related predictor variables such as the perceived frequency that people in the neighborhood of signed petitions, made formal complaints, contacted local authorities, and participated in neighborhood improvement groups. These scores were

compiled and averaged for each neighborhood and divided into tertiles. Using multilevel modeling, the authors discovered that low neighborhood empowerment was related to high caries experience after adjustment for individual-level confounders. Specifically, adolescents living in neighborhoods with low empowerment were 1.49 (95% CI 1.1-2.0, $p<0.05$) times as likely to have high caries experience as those living in neighborhoods with high empowerment.

Pattussi's third study, also published in 2006, assessed neighborhood social capital and its impact on dental injuries in the same cohort of 1302 14-15-year-old Brazilian adolescents as in the previous article (Pattussi, Hardy, Sheiham 2006b). The study design was very similar to the previous one as it used an aggregation of parent responses to a 30-item questionnaire containing questions about social trust, empowerment, social control, and security for the neighborhood social capital variable; oral examinations to measure dental injury; and student questionnaires about the place and cause of injury. Both studies used a two-stage random sampling method within the state of Distrito Federal, Brazil. Using a similar multilevel modeling technique to adjust for individual-level confounders for dental injury such as overjet and body mass index (BMI), the authors found a significant association between high neighborhood social capital and low dental injury in boys (OR = 0.55, 95% CI 0.37-0.81, $p=0.002$), however no association was found with girls. These two articles are of very high quality and reflect rigorous research designs, appropriate operational variables to measure social capital, and analyses with adequate generalizability of findings to that age group and region.

The multilevel modeling demonstrated in the previous two articles has been described as the analytic technique of choice for studies that investigate hierarchical relationships between contextual or community-level variables, direct risk indicator variables, and health outcomes (Newton and Bower 2005).

The next group of investigations on neighborhood social capital all took place in Japan. Dr. Jun Aida from the Tohuku University Graduate School of Dentistry in Sendai, Japan is the lead author of four of them. The first, published in 2008, was a cross-sectional study that assessed the relationship between several measures of social context and caries in three-year-old Japanese children (Aida and others 2008). In a stratified random sample of municipalities in Japan, dmft data were recorded for all three-year-old children in each municipality by non-calibrated dentists employed by the municipalities. A self-administered parent questionnaire assessed individual confounder variables such as demographics, socioeconomic characteristics, and health behaviors. Additionally, the authors compiled census data on five community-related variables, two of which were related to social capital; the number of volunteer case workers per 100,000 residents was used to represent social support, and the number of community centers per 100,000 residents was a proxy for social cohesion. As in earlier studies, the term social capital was not described specifically in this article, however the logic behind the inclusion of these variables – wanting to measure social support and cohesion – indicate that they fall under the realm of social capital. Their multilevel analysis adjusted for individual-level confounders and uncovered an independent association between caries experience and the number of community centers per 100,000 residents, the proxy for social cohesion. No association was found between the number of volunteer case workers ("social support")

and caries experience. The limitations of this article cloud the significance of its findings. Certain aspects of the study design were unclear, and the appropriateness of the variables used as proxies for social support and social cohesion is questionable. However, if all of the three-year-old children in each of the municipalities were actually examined, the study's external validity is a considerable strength. But at the same time, the young, pre-cooperative age of the subjects may have resulted in invalid measures of dmft. At the very least, the study highlights a need for further research on this topic.

The next four studies in this review, three of which were also authored by Aida, are quite similar in study design and variables used and were all conducted in Japan. The first three had a similar population of a random sample of noninstitutionalized elderly Japanese adults age 65+ years. All four studies used self-administered questionnaires as the sole method of data collection. All questionnaires contained items about social capital measures as well as self-rated dental status, and all used multilevel modeling to determine the association between social capital and self-rated oral health. The questions asked regarding both oral health status and social capital varied between the four studies, and will be discussed in detail.

Two of these studies use data from the Aichi Gerontological Evaluation Study (AGES), a prospective cohort study on a random sample of noninstitutionalized Japanese elderly aged 65+ in 10 municipalities in Aichi prefecture (a prefecture is similar to a county), comprised of 79 local districts. Both use cross-sectional data from a mailed questionnaire in 2003, and assess community-level variables by local district. Both have a response rate of 49.9% and a final study population of 5715 subjects. The first study was published in 2009 and examined the relationship between dental status and vertical

and horizontal social capital measures (Aida and others 2009). Vertical and horizontal social capital are somewhat synonymous with bonding and bridging social capital, respectively, in that horizontal social capital measures social networks that are egalitarian in nature, and vertical social capital refers to those networks that have a hierarchical social structure.

Dental status was assessed based on the number of remaining teeth (20 or more, 19 or less), and vertical/horizontal social capital was based on the groups that subjects participated in and the nature of the groups' social structures (egalitarian vs. hierarchical). The questionnaires also contained items about confounding variables such as smoking status, socioeconomic status, and oral health behaviors. Individual responses were averaged for each local district to create community-level social capital variables. After adjusting for individual confounders, the authors found associations between the number of remaining teeth in elderly Japanese and both low/intermediate individual- (OR = 1.45/1.23, 95% CI 1.21-1.73/1.01-1.48, no p values given) and low community-level (OR = 1.25, 95% CI 1.03-1.52, no p value given) horizontal social capital. This study unfortunately suffers from a major limitation; the appropriateness of using current group participation as the one and only vertical and horizontal social capital variable is questionable and therefore limits the validity of the findings. Scholars have criticized the appropriateness of using a quantitative measure of group participation as a proxy for social capital, as it is the quality of group participation that is particularly important for the development of social capital (Stolle and Rochon 1998).

The second study on the same elderly Japanese population (n=5715) was published in 2011 by Dr. Aida et al., and investigated income inequality, social capital,

and self-rated dental status (Aida and others 2011a). Dental status was again measured as having 20 or more, or 19 or fewer teeth remaining. Two items in the questionnaire assessed social capital: belonging to a volunteer group (yes/no) and whether most people can generally be trusted (yes/no). Individual responses were again complied to form community-level social capital variables similar to the previous study's method. Smoking status, educational attainment, demographic and socioeconomic characteristics were assessed as potential confounders. After adjusting for these variables in the multilevel analysis, the authors found a significant relationship between dental status and mistrust at the individual level, and non-volunteerism at the community level. Specifically, individuals who generally believed that people cannot be trusted were 1.41 (95% CI 1.04-1.93, no p value given) times as likely to have fewer than 20 teeth remaining as their counterparts. Also, individuals within groups that had higher rates of non-volunteerism were 1.39 (95% CI 1.13-1.80, no p value given) times as likely to have less than 20 teeth remaining than groups in which more people volunteered. The limited number of questions used to measure social capital is a limitation of this study, as well as the fact that subjects were not asked about oral health behaviors or other common risk factors for oral disease as potential confounders. The randomly sampled population in these two studies improves study generalizability, however the validity of the findings is questionable in both cases.

The next study by Aida et al. used baseline cross-sectional data from a prospective cohort study called the Ohsaki Cohort 2006 study (Aida and others 2011b). The data were from a mailed questionnaire to all elderly Japanese 65+ years old living in Ohsaki City, with a response rate of 73.9% (N=21,736). The questionnaire contained a

wide range of items, including health status and habits, social support, participation in community activities, and dental status. Community-level variables were assessed by each of 356 administrative districts, which the authors defined as "neighborhoods".

The dependent variable, similar to the previous two studies, was number of remaining teeth: 20 or more, or 19 or fewer. The main two predictor variables, social support and social networks, were used to measure social capital both at the neighborhood and individual levels. Social networks were assessed by asking about the frequency of participation in four kinds of networks: civic, sports and hobby, volunteer, and friendship networks. Social support was assessed by asking five questions:

(i) Do you have someone with whom you can consult when you are in trouble?
(ii) Do you have someone with whom you can consult when your physical condition is not good?
(iii) Do you have someone who can help you with your daily housework?
(iv) Do you have someone who can take you to a hospital when you do not feel well?
(v) Do you have someone who can take care of you when you are ill in bed?

The authors also assessed a wide variety of covariates, including daily toothbrushing, brushing time, use of dental floss, having a dental check-up at least once a year, frequency of intake of sweet foods, smoking status, history of diabetes, age, educational attainment, sex, and self-rated general health.

Using a multilevel modeling analysis, the authors' final model included all neighborhood-level and individual-level variables and covariates. From this model, they found a significant association between dentate status and neighborhoods with a high

amount of friendship networks (OR 1.17, 95% CI 1.04-1.30, p=0.007). At the individual level, subjects with the highest participation in sports and hobby networks were 1.12 (95% CI 1.02-1.22, p=0.019) times as likely to have more than 20 remaining teeth compared to subjects with medium to low participation in sports and hobby groups. No individual- or neighborhood-level social support variables were significantly associated with dentate status. This study uses more comprehensive measures of social capital than the previous two studies, however the authors note in the discussion that their questions do not demonstrate a full picture of social capital, and that further research and debate about the definition of social capital should continue. Additionally, the questions about social support in this study only assess support from a functional standpoint, rather than emotional social support, which would capture the psychosocial mechanism by which social capital impacts health. This may reflect a cultural difference between the nature of Japanese and other countries' personal relationships.

Dr. Michiko Furuta at the Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences in Okayama, Japan assessed the relationship between self-rated health and social capital in university students. He and his colleagues had a convenience sample of 967 students complete a self-administered questionnaire that asked about self-rated oral health, social capital indicators, and confounders. The social capital indicators assessed the subjects' level of trust within their family, neighborhood, and school. Oral health behavior, dental fear, and socioeconomic status were assessed as confounders. After adjusting for these confounders in the multilevel analysis, the authors found a significant relationship between poor self-rated oral health and both low neighborhood trust (OR = 2.22, 95% CI 1.40-3.54, no p value given) and

low vertical, or student-teacher, trust at school (OR = 1.71, 95% CI 1.05-2.80, no p value given). The most significant limitation of this study is its generalizability. Subjects were all university students and therefore well educated, and results may look different among a more diverse cohort. However, the larger amount of social capital questions asked in the survey compared to previous studies was a considerable strength (Furuta and others 2012).

Nahouraii et al. studied social support and dental utilization (whether the child had ever visited a dentist) in immigrant children from Latin America. The authors used a cross-sectional, church-based sampling strategy by identifying all Spanish-language churches in the study area, four counties in North Carolina, and a convenience sample of participants were recruited via announcements by priests/ministers. The final sample size was 174 Latina mothers of young children. The authors created an index of social support based on three questions: whether the mother had received help making a dental appointment, getting to the dental appointment, or someone accompanying them to the dental appointment (Nahouraii and others 2008). As discussed previously, there is disagreement in the literature about whether social capital and social support are distinct entities, but this study is pertinent as it captures the tangible assistance mechanism about how social capital impacts health as hypothesized by Putnam. The analysis included using a logistic regression modeling approach to assess the association between the index of social support and children's dental utilization among this cohort. After adjusting for confounding variables, they found that mothers with any social support were 3.13 times as likely to have their children ever visit a dentist (95% CI = 1.67-5.87, $p<0.01$). This is important as dental utilization is a predictor of improved oral health in children.

Bramlett et al. used data from the CDC's National Survey of Children's Health, a nationally representative sample of children and adolescents, to test a myriad of factors in the Fisher-Owens et al. conceptual model, including neighborhood social capital, and a variable that they term "family functioning" but is consistent with the concept of family social capital and includes: religiosity, family time reading, family outings, and eating meals together (Bramlett and others 2010). Family composition is another construct that is important to the Bramlett et al. study. It includes family structure and household size. This variable is consistent with Coleman's conceptualization of social capital, and similar measures will be used in the present study. The study investigates the impact of these variables on parent-rated child oral health status (excellent, very good, or good compared to fair-poor). They limited the sample to children age 1-5, for a final nationally-representative sample of 26,736. Using a multilevel logistic regression modeling procedure, the authors found that neighborhood social capital – as measured by an index of whether the parent feels neighbors help, watch out for, count on or trust each other, and whether the neighborhood is safe – was significantly related to child oral health (adjusted OR=0.756, 95% CI = 0.674-0.848, $p<0.0001$) (Bramlett and others 2010) . Children also had significantly higher odds of having fair/poor oral health as the number of children in the household increased, however the odds were not very strong (adjusted OR = 1.079, 95% CI = 1.032-1.129, $p>0.01$). On the other hand, children in single-mother families did not have higher odds (adjusted OR = 1.049, 95% CI = 0.898-1.225). Children in families with more outings per week were significantly less likely to have fair/poor oral health (adjusted OR = 0.978, 95% CI = 0.957-0.998) but the association

was not very strong. Religiosity, family time reading, and eating meals together did not affect the odds of a child having fair-poor oral health (Bramlett and others 2010).

Guarnizo-Herreno & Webhy used the same dataset as Bramlett et al. to analyze factors that contribute to oral health disparities in children with regard to race/ethnicity. They limited their sample to children age 3-17 for a final sample size of 43,972. They assessed three dental health outcomes: whether the child had any dental problems over the past six months (toothache, decayed teeth or cavities, broken teeth, and bleeding gums), maternal rating of the child's dental health (excellent, very good, good, fair, or poor combined into a binary variable of excellent-good vs. fair-poor), and number of preventive dental care visits during the past 12 months (Guarnizo-Herreno and Wehby 2012). Predictor variables included demographics, maternal health, socioeconomics, and neighborhood conditions including neighborhood social capital. Neighborhood social capital was measured by whether people in the neighborhood helped each other out, watched out for each other's children, counted on each other, and adults helping children if they became hurt or scared while playing outside. Using a decomposition analysis, they found that neighborhood social capital explained 13.8% of the disparity in self-rated dental health and 8.7% of the disparity in any dental problem between white and black children ($p<0.05$), but did not explain any of the oral health disparities between Hispanic and white children (Guarnizo-Herreno and Wehby 2012).

Similar to Bramlett et al. and Guarnizo-Herreño & Webhy, Iida and Rozier also used the NSCH to determine the association between neighborhood social capital and children's oral health status and dental utilization (Iida and Rozier 2013). They included all children ages 1-17 for a final sample size of 65,053. The authors used three outcome

variables: mother's perceived dental status of child (fair-poor, good, and very good-excellent), mother's report of child preventive dental care visits in the past 12 months, and mother's report of child's unmet need for dental care in the past 12 months. Neighborhood social capital was assessed by creating a summative scale with the same four statements described earlier. After controlling for confounding variables, the social capital scale was significantly associated with unmet dental care needs and preventive dental care. Specifically, children in the neighborhoods with lowest social capital were 1.79 times as likely to have unmet dental care needs (95% CI = 1.14-2.80, p = 0.01), and children in neighborhoods with low and lowest social capital were 1.4 and 1.38 times as likely to not have had a preventive visit compared to those in the highest social capital neighborhoods (95% CI = 1.17-1.68, 1.05-1.81, $p<0.001$, 0.02 respectively) (Iida and Rozier 2013) . There was no statistically significant association between neighborhood social capital and child oral health status. The findings from this study suggest that social capital may be operating via functional social support such as tangible assistance in accessing dental care as described by Nahouraii et al. Limitations to this study include the fact that it was analyzed at an individual level and did not use a multilevel analysis as has been declared ideal for measuring the collective aspect of social capital. In addition, the NSCH used only landline telephone numbers, which may skew the results toward a particular cohort.

The previous three studies are particularly important because the dataset that was used, the NSCH, includes the same survey items as the dataset that was used in this thesis, and findings will be able to be compared directly.

Chi and Carpiano analyzed neighborhood social capital in Los Angeles County, California (Chi and Carpiano 2013). They assessed the impact on dental utilization in a sample of adults age 18-64 (n=1800), specifically whether the respondent had visited the dentist for any reason in the past 12 months. Their measure of neighborhood social capital incorporated social support, social leverage, informal social control, and neighborhood organization participation measures. Using census tract as a proxy for neighborhood, they conducted a multilevel analysis to examine the effect of social capital at a neighborhood level. Of the four social capital indicators, social support was the only one found to be associated with dental utilization (OR = 0.85, 95% CI = 0.72-0.99, $p<0.05$). This study used a rigorous design and the smallest (and most appropriate) geographic area for assessing neighborhood social capital.

Costa et al. investigated the relationship between "distal factors", another term for the social determinants of health, and caries severity in Brazilian adults aged 35-44 years (n=360) (Costa, Vasconcelos, Abreu 2013) . Using a case-control method, with cases as adults with more than 14 decayed, missing, or filled teeth (DMFT) and controls as those with less than or equal to 14 DMFT and matched for age and gender, they found that those living in a community that did not petition authorities for community benefits were 2.1 times as likely to have high caries severity (95% CI = 1.2-3.6, no p value given). However, there were not associations between caries severity and participation in groups, willingness to dedicate time to community activities, participation in neighborhood meetings, or empowerment. The design of this study and its lack of clarity on the variable definitions and analysis limit the weight of this evidence.

Lamarca et al. examined the impact of social capital on oral health-related quality of life (OHRQoL), a measure of the adverse effects of poor oral health on quality of life, in pregnant and post-partum women in Brazil (Lamarca and others 2013). The sample was made up of women seeking antenatal care from one of four main public health clinics in the study area (n=1248). Neighborhood social capital was assessed using a questionnaire containing four dimensions: social trust, social control, neighborhood security and political efficacy, and responses were aggregated by neighborhood area. Individual social capital was measured using the level of social networks and social support. Using a multilevel modeling approach to examine both individual-level and neighborhood-level effects, and adjusting for potential confounding variables, the authors did not find significantly higher odds of poor mean OHRQoL for low and moderate neighborhood-level social capital (OR = 1.33, 1.28, 95% CI = 0.99-1.75, 0.97-1.69, respectively, $p>0.05$). However, they did find that positive social interaction and having no family social networks, both measures of individual-level social capital, were associated with OHRQoL. Specifically, women with no family social networks were 1.44 times as likely to have poor OHRQoL (95% CI = 1.08-1.92, $p<0.05$), and those with higher positive interactions were 0.90 times as likely to have poor OHRQoL (95% CI = 0.82-0.98, $p<0.05$).

Finally, Santiago et al. assessed the association between social capital and dental pain in Brazilian adolescents, adults, and elderly (Santiago, Valenca, Vettore 2013). A random sample of neighborhoods in a state in Northeast Brazil were selected, and individuals from three age groups, 15-19 years, 35-44, and 65-74 years, were randomly selected within each age group from health services records (n=624). Data were

collected in face-to-face interviews in the subjects' homes about dental pain (i.e., a toothache in the last 6 months), and a 30-item contextual social capital survey was conducted, which included questions about social trust, social control, empowerment, political efficacy, and neighborhood safety. Responses to contextual social capital items were aggregated to a neighborhood level. Individual social capital was measured via questions related to social support and social networks. Using a multilevel logistic regression analysis, the authors found that dental pain was significantly related to individual-level social capital in the form of positive social interaction (OR 0.88, 95% CI = 0.80-0.91), and individuals in neighborhoods with high levels of social capital were 0.48 times as likely to report dental pain than those in neighborhoods with low social capital (95% CI = 0.27-0.85) after adjusting for confounding factors. This and the previous study reflect rigorous measurements of social capital and indicate that perhaps individual and neighborhood social capital effects vary depending on the population.

These studies as a group have a few common limitations. First, their cross-sectional or ecological designs pose inherent limitations in their ability to measure causality rather than correlation. In order to measure causality, longitudinal studies must be conducted to assess changes in social capital are assessed over time, as was emphasized in Muryama et al.'s systematic review (Murayama, Fujiwara, Kawachi 2012). Cross-sectional studies are also limited by not being able to rule out reverse causation. For example, a person's poor oral health may prevent him from participating in community activities or trusting his peers if he is being made fun of, rather than vice versa. Many of these cross-sectional studies used an aggregation of individual responses to form community-level variables. These are essentially ecologic variables, so one

could argue that these studies are partially ecologic in nature. However, because of the need to characterize entire communities in order to assess their effects on oral health, such methods are necessary.

An important strength in the design of a number of these studies is the multilevel modeling technique that is used to both adjust for confounding variables and to model individual- and contextual-level effects of social capital on oral health simultaneously. These analyses strengthen the evidence that community-level social capital is an important predictor of oral health independent of individual-level factors.

As discussed earlier in this chapter, defining and objectively measuring social capital are well-known problems in social capital research. The studies reviewed here are no exception to this problem. These studies contain a wide variety of variables used to measure social capital or similar constructs. Trust was the most common factor: either general trust, trust between peers, between students and teachers, or within the neighborhood. The next was participation in community activities (which at times was called neighborhood empowerment), including, but not limited to, petition-signing, meetings about neighborhood improvement, social groups, making formal complaints, and volunteerism. Other assessments included neighborhood security, family support, and student collaboration.

There was also considerable variety in the confounders that were assessed in these studies. Harpham suggests a minimum of seven confounders: gender, ethnicity, socioeconomic status, age, home ownership, education, and employment. Most of the studies assessed at least 3-4 of these, along with oral health predictors such as oral health behaviors, systemic fluoride exposure, sugar consumption, and dental fear. It is

important to select appropriate confounding variables in order to ensure that study findings cannot be explained by something for which the study was not adjusted.

As discussed previously, all of the reviewed studies on social capital and oral health had either cross-sectional or ecological designs. Within these designs, however, they used several different methods to test their hypotheses. The work of Pattussi and colleagues generally used oral examinations by calibrated examiners to determine oral health status of the subjects, whereas Aida's and Furuta's work utilized self-reported measures of dental status such as the number of missing teeth or a more global measure of good/fair/poor oral health. While dental examinations give a more detailed measure of oral health, self-perceived oral health status has been shown to be a valid and reliable measure of actual oral health (Divaris and others 2012; Pinelli and de Castro Monteiro Loffredo 2007; Sohn and others 2008; Talekar and others 2005). Therefore, if actual increments of DMFT are not as important as overall oral health as an outcome, it seems that self-perceived oral health would be a better measure because it requires considerably fewer resources. Most of the studies reviewed used a randomized sample from their target populations while some used a convenience sample. A randomized sample is ideal in order to maximize generalizability of the findings.

As was evident in the systematic reviews, social capital has received considerable attention regarding its effect on general health. However, the published literature on the association with oral health is relatively limited. These few studies have shown that there may be an independent relationship between social capital and oral health, but the findings so far are quite mixed. This topic is clearly a ripe area for new research. Further evidence of associations between social capital and oral health could provide momentum

for social programs on community engagement and participation. Therefore, the potential impact that a clear body of evidence may one day have on public programs and policy warrants new research on social capital. This study will add to the evidence base for family and neighborhood social capital constructs within the Fisher-Owens conceptual model of influences in child oral health.

CHAPTER III: METHODS

Although the rates of dental caries have decreased dramatically since the mid-20th century, the disease still disproportionally affects the lives of our most vulnerable populations, particularly low-income and minority groups and children. In fact, the prevalence of caries in this country has increased in our youngest cohort in recent years (Dye and others 2007). It is becoming more evident that social factors play a significant role in disease outcomes in general, and dental caries is no exception. Social capital is a social factor that has not been widely studied as a predictor of oral health status, and the few studies on this factor as a predictor of oral disease suggest that there is likely a relationship between lower social capital and poor oral health outcomes (Aida and others 2008; Aida and others 2009; Aida and others 2011a; Aida and others 2011b; Bramlett and others 2010; Chi and Carpiano 2013; Costa, Vasconcelos, Abreu 2013; Furuta and others 2012; Guarnizo-Herreno and Wehby 2012; Iida and Rozier 2013; Lamarca and others 2013; Nahouraii and others 2008; Pattussi, Hardy, Sheiham 2006a; Pattussi, Hardy, Sheiham 2006b; Santiago, Valenca, Vettore 2013). However, these studies suffer multiple limitations, and few have been conducted in the United States to date. Thus, the impact of social capital as a predictor of oral disease necessitates further study, particularly in a U.S. setting. Therefore, the purpose of this study is to examine the association between oral health status of children and two constructs of social capital: family and neighborhood. In addition, as social capital has been theorized to impact health through changing health behaviors (among other mechanisms), the present study aims to also examine the mediating effect of one type of health behavior, soda consumption. Another theorized mechanism for social capital's impact on health is

through access to care, and the decision not to examine the mediating effect of a relevant measure of access to dental care will be discussed in more detail below.

The research questions are as follows:

1) Is there an association between family social capital and child oral health after controlling for covariates?

2) Is there an association between neighborhood social capital and child oral health after controlling for covariates?

3) Does soda consumption mediate the relationship between family/neighborhood social capital and oral health status?

This chapter will outline the details about the development and administration of the data source used for this study, hypotheses to be tested, human subjects approval, and discussion of and rationale for the statistical techniques used to test the hypotheses.

Data Source/Sample

The present study investigated the research question by analyzing data from a telephone/online survey of a random sample of Iowa's households, called the Iowa Child and Family Household Health Survey (HHS). This survey was developed by a group of researchers and public health officials from the University of Iowa and Iowa Department of Public Health in order to monitor the health and wellbeing of Iowa's children. The first year of administration was 2000, and it was repeated in 2005 and 2010. Data used for the present study were from the 2010 survey, which was funded by the Iowa Department of Public Health, the U.S. Department of Health and Human Services Maternal and Child Health Bureau (MCHB), Blank Children's Hospital, American

Academy of Pediatrics –Iowa Chapter, and the Iowa Child Health Specialty Clinics. The survey instrument contained questions on a wide variety of topics, including physical and emotional health, access to care and insurance status, social determinants of health, and many others. A national survey, called the National Survey of Children's Health (NSCH), was modeled after the HHS and administered nationwide by the National Center for Health Statistics at the Centers for Disease Control and Prevention (CDC). It was administered nationally in 2003 and 2007. As the NSCH contains many of the same survey items as the HHS, findings from this study will be able to be compared with published studies on the NSCH.

Iowa households were selected randomly using an address-based sampling approach, and African American and Latino families were oversampled in order to be able to detect statistically significant differences between groups. The oversample data were not used in this study because the data were found not to be significantly different in the descriptive results than the original sample. Letters were mailed to a random sample of addresses selected from the United States Postal Service Delivery Sequence File. These letters included information about the study as well as instructions regarding how to fill out the online survey. The letter also indicated that potential subjects would be contacted to participate in the interview by telephone if they did not complete it online within one week. The telephone and online surveys asked for the participation of one adult that was most knowledgeable about the health and well being of one randomly selected child under age 18 in the household. All data collection was completed by the University of Northern Iowa Center for Social and Behavioral Research.

Dependent Variable

The dependent variable in this study was parent-rated child oral health status on a scale of excellent, very good, good, fair, and poor. Fair and poor categories were collapsed into one group due to the small number of respondents with these responses. Many previous studies have collapsed these into two categories: excellent, very good, and good vs. fair and poor. However, grouping categories in this way was not possible for this study because of the small group of respondents who answered fair or poor. Additionally, dichotomizing the dependent variable was undesirable due to the loss of information contained in the ordinal nature of the outcome. Consideration was given to treating oral health status as an ordinal outcome. However, the large number of predictor variables and the complexity of model interpretation for ordinal regression made it a less desirable option. Therefore, oral health status was treated as a continuous variable to facilitate an ordinary least squares (OLS) linear regression.

While parent-rated child oral health status may not seem like an accurate measure of oral health, several studies have compared it to a clinical oral health assessment, and have found that it is generally a moderate to good predictor of oral health in young children (Divaris and others 2012; Sohn and others 2008). However, Divaris et al. found that parents were poorer predictors of their child's oral health status if the child was under two years of age, and Sohn et al. assessed only children age 1-5. We are unaware of any studies that have examined the accuracy of parent rating of the oral health status of children over five. Based on these findings, children under age two were excluded from this study in order to minimize the risk of inaccurate parental oral health assessment. Findings from bivariate analyses showed very little variation in outcome responses for

children under age two, which confirmed the decision to exclude children in this age range from the analyses.

Independent Variables

The two main independent variables in this study were neighborhood social capital and family social capital. Neighborhood social capital was assessed in this study by asking the degree to which the respondent agrees or disagrees with the following four statements concerning trust and cohesion in the neighborhood:

1. People in the neighborhood help each other out.
2. We watch out for each other's children in this community.
3. There are people I can count on in this community.
4. If my child were outside playing and got hurt or scared, there are adults nearby who I trust to help my child.

Response options were "definitely agree, somewhat agree, somewhat disagree, and definitely disagree". In order to assess the internal consistency of these four responses, Cronbach's alpha was calculated to be 0.87, indicating a high degree of consistency. Based on the results from the alpha and how these same variables have been treated in previous studies, an index was created to combine all four questions. Items were scored from 1-4 for strongly agree (1) to strongly disagree (4), and the mean was calculated for each case to create a scale. Cases were retained if they had valid responses for three to four of these items, and were considered missing if they only answered 1-2 of the items.

These neighborhood social capital items are measures of cognitive social capital as opposed to structural social capital. An additional question about neighborhood safety was included in this survey, however researchers have argued that neighborhood crime/safety signifies an outcome of low neighborhood social capital rather than a measure of it, so the item was not included in this analysis (Harpham 2008). Studies on neighborhood social capital and health have utilized a variety of geographical dimensions, including zip code, electoral ward, administrative area, municipality, or state (Murayama, Fujiwara, Kawachi 2012). Due to increasing calls for using multilevel analysis to assess the levels of social capital, the original plan for this study was to aggregate individual responses to some geographic level, either zip code or county. However, there were an insufficient number of responses per county (and therefore also per zip code), therefore a multilevel analysis could not be performed. However, it is the belief of the authors that analyzing individual-level perceptions of neighborhood social capital is still worthwhile, despite not being able to analyze them at an aggregate level.

This study conceptualized family social capital as a combination of constructs based on the working definition, foundational theories about the components of social capital, and the available data. The constructs are the following:

1. Family function, as measured by 1) the frequency with which the family eats a meal together, and 2) the frequency with which the child attends religious services
2. Family composition, as measured by 1) the number of children in the household and 2) one- vs. two-parent families

Both components of family function relate to the bonding and structural constructs of social capital that Parcel et al. allude to in their definition of family social

capital (Parcel, Dufur, Zito 2010). Participation in religious services has commonly been included in measures of family social capital in other studies (Dufur, Parcel, Mckune 2008; Parcel and Dufur 2001; Parcel and Dufur 2009; Runyan and others 1998). The number of children in the household and two- vs. one-parent households refer to Coleman's view of social capital in which he argues that two-parent households and households with fewer numbers of children result in better child outcomes due to the increased amount of time available for parent-child contact and individualized attention per child (Coleman 1988).

Family function was measured using the following two survey items. First, frequency of eating meals together: "During the last week, how often did all of the family members who live in the household eat a meal together?" Response options included "every day, most days, some days, or never," and the first two and latter two were grouped together to create two categories. Second, religiosity: "During the last 12 months, about how often has the child attended a religious service or activity?" Response options included "once a week or more, a few times a month, a few times a year, or never". All four levels were retained due to adequate response variation.

Family composition was measured by 1) the number of children living in the household, and 2) two-parent vs. one-parent households. The number of children were collapsed into four categories: one child, two children, three children, and 4-11 children. Two-parent households included respondents who were married or living with partner, and one-parent households included those who were divorced, separated, widowed, or never married.

Even though these constructs have been measured separately in other literature, a Cronbach's alpha was calculated in order to measure the internal consistency of these four items. The value was -0.237, which indicates that there is a low and reverse internal consistency of the items, which will be discussed in more detail in the next chapter. This finding led to the conclusion that the four items should be treated as separate variables rather than combined into a single index.

Covariates

Six control variables were included in this study based on available evidence of having an impact on oral health status of children. These were child gender, child age in years, child race/ethnicity, household income, parent education, and dental insurance. Soda consumption was assessed as a mediating variable. Child gender was measured as male or female. Child age was categorized as 2-3 years, 4-6 years, 7-12 years, and 13-17 years. These categories were formed to correspond with stages of dentition. Child race/ethnicity was measured as African American (non-Hispanic), Latino/Hispanic (all races), whites (non-Hispanic), Asian/Pacific Islanders, and other. Individuals identifying mixed racial status were treated as follows: if respondents identified as Latino/Hispanic, regardless of race, they were kept in the Latino/Hispanic category. If they identified as mixed African American and white, they were placed into the African American category. If they identified as Asian/Pacific Islander and white, they were put into the Asian/Pacific Islander category. If they identified as some other race, they were put into the other category. This was done in order to maximize the number of individuals of any level of non-white racial backgrounds in each racial category.

Household income was broken down into the following categories for the bivariate analyses: $0-25,000, $25,001-40,000, $40,001-55,000, $55,001-70,000, $70,001-80,000, $80,001+. This breakdown is consistent with other reports using this dataset. For the regression analysis, income – measured at $5,000 increments – was kept as a continuous variable in order to preserve the more detailed level of information. Parent education was categorized as less than high school graduate, high school graduate or GED, some college or 2-year degree, 4-year college graduate, and more than 4-year college graduate.

In the survey, respondents were asked whether they had any source of insurance that paid for some or all of the child's dental care, with yes or no as possible responses. However, there is a well-known relationship between the type (public vs. private) of insurance and oral health status. Public insurance is a measure of low-income status and therefore is generally associated with poorer oral health status, and vice versa for private insurance. Therefore, responses to another survey item about the type of general health insurance that the child has was merged with the dental insurance survey item to create a new variable. If the respondent answered no about his/her child having dental insurance, the category for the new variable remained no. If they answered yes, and also answered public health insurance, then it was assumed that their child's dental insurance was also public (i.e. Medicaid or hawk-i, Iowa's Children's Health Insurance Program). If they answered yes, and also answered private health insurance, then it was assumed that their child's dental insurance was also private. In this process, there were 19 subjects who were lost, which comprised those who answered "yes" to having dental insurance for their child, but "no" to having health insurance. As this is an extremely unlikely

scenario, it is possible that these respondents were confused about their child's insurance status and good candidates to be eliminated from the sample.

Soda consumption is a measure of how many cans of soda, pop, or soft drinks the child drinks on an average day. This was categorized into zero versus one or more cans per day, due to the finding in the bivariate analyses that above one can per day, the association with the dependent variable did not vary considerably from those drinking one can per day.

Dental utilization, measured by the child's last dental visit, was also considered as a potential mediating variable, as social capital has been theorized to affect health via access to care. However, there was so little variation in responses to this question that it was decided not to include it.

Table 1 presents the variables and how they were collapsed and coded.

Table 1. List of variables and questions from the HHS used to measure variables

Variable	Question used to assess variable	Original Potential responses	Final categories (code)
Dependent Variable			
Oral health status	How would you rate your child's overall dental health?	Excellent Very Good Good Fair Poor	Excellent (4) Very good (3) Good (2) Fair or Poor (1)
Independent Variables			
Neighborhood social capital	Index of responses to four questions: 1. People in the neighborhood help each other out. 2. We watch out for each other's children in this community. 3. There are people I can count on in this community. 4. If my child were outside playing and got hurt or scared, there are adults nearby who I trust to help my child.	Definitely agree Somewhat agree Somewhat disagree Definitely disagree	Codes to original responses: Definitely agree (4) Somewhat agree (3) Somewhat disagree (2) Definitely disagree (1) Final variable is a continuous index from 1-4 based on an average of responses to the four survey items.
Family Social Capital Variables: Family Function			
Frequency of family eating meals together	During the last week, how often did all of the family members who live in the household eat a meal together?	Every day Most days Some days Never	Every day or Most days (2) Some days or Never (1)
Frequency of religious service attendance	During the last 12 months, about how often has the child attended a religious service or activity?	Once a week or more A few times a month A few times a year Never	Once a week or more (4) A few times a month (3) A few times a year (2) Never (1)
Family Social Capital Variables: Family Composition			
Number of children in the household	How many children under age 18, including infants, live in your household?	Open-ended	1 child (1) 2 children (2) 3 children (3) 4-11 children (4)

Table 1. continued

Two- vs. Single-parent family	Are you currently… If not married: Are you currently living with a partner? This includes people who share resources and are in a marriage-like relationship.	Married Divorced Widowed Separated Never married Yes No	Divorced, Widowed, Separated, or Never married (1) Married or Living with partner (2)
Covariates			
Child gender	What is the age and gender of the child?	Open-ended	Male (1) Female (2)
Child age in years	What is the age and gender of the child?	Open-ended	2-3 years (1) 4-6 years (2) 7-12 years (3) 13-17 years (4)
Child race/ethnicity	Is the child of Hispanic or Spanish origin? What is the child's race?	Yes No African-American White American-Indian/Native American/Aleutian or Eskimo Asian/Pacific Islander Some other race	African American (non-Hispanic) (1) Latino/Hispanic (all races) (2) Other (non-Hispanic) (3) Asian/Pacific Islander (non-Hispanic) (4) White (non-Hispanic) (5)
Household income	What was the total combined income in 2009 for all persons in your household?	$5,000 increments from $0-$80,000 More than $80,000	N/A (continuous)
Parent education	What is the highest grade or level of school that you have completed?	8th grade or less Some high school but did not graduate High school graduate or GED Some college or 2-year degree 4-year college graduate More than 4-year college graduate	8th grade or less or Some high school but did not graduate (1) High school graduate or GED (2) Some college or 2-year degree (3) 4-year college graduate (4) More than 4-year college graduate (5)

Table 1. continued

Dental insurance coverage	Does the child currently have insurance that covers dental care? What type of health care coverage do you use to pay for most of your child's medical care?	Yes No Your employer Someone else's employer A plan that you or someone else buys on your own The HAWK-I program Medicaid or Title 19 The Military, Champus or the VA The Indian Health Service Some other source	No dental insurance (0) Public dental insurance (1) Private dental insurance (2)
Soda consumption	On an average day, how many cans of soda, pop, or soft drinks does your child drink in a single day?	Open-ended	0 cans/day (0) 1+ cans/day (1)

Hypotheses

Specific hypotheses for this study are as follows:

1. Neighborhood social capital will be positively associated with child oral health status after adjusting for confounding variables.
2. Family frequency of eating meals together, a component of family social capital, will be positively associated with child oral health status after adjusting for confounding variables.
3. Religiosity, a component of family social capital, will be positively associated with child oral health status after adjusting for confounding variables.
4. The number of children in the household, a component of family social capital, will be negatively associated with child oral health status after adjusting for confounding variables.

5. Two parent households, a component of family social capital, will be positively associated with child oral health status after adjusting for confounding variables.
6. Soda consumption will mediate the relationship between neighborhood and family social capital variables and child oral health status.

Study Approvals

A human subjects research determination form was submitted to the University of Iowa's Institutional Review Board, and the Board determined that because the data are deidentified, no human subjects approval was needed. Use of the 2010 HHS survey data for research purposes was approved by the Iowa Department of Public Health.

Statistical Analysis

Data were analyzed using SPSS (Chicago, Illinois). As previously mentioned, Cronbach's alpha was calculated for neighborhood and family social capital variables to check internal consistency. Descriptive statistics and bivariate associations were generated for all variables. All bivariate associations between oral health status and categorical independent or control variables were tested for statistical significance using a chi-square test. The bivariate association between oral health status and neighborhood social capital was tested using analysis of variance (ANOVA). An alpha level of 0.05 was used for all statistical tests.

Due to the fact that a multilevel modeling approach was not able to be used for this study, the next best option to account for potential correlation based on geographic location was to do a mixed linear regression model, adding zip code as a random effect.

Therefore, a mixed linear regression modeling approach was used to measure multivariate associations. Variable inclusion in the models were as follows:

Model 1: Neighborhood social capital only

Model 2: Family social capital variables only

Model 3: Neighborhood social capital and family social capital variables

Model 4: Neighborhood social capital, family social capital, and all covariates

Model 5: Neighborhood social capital, family social capital, all covariates, and soda consumption

Model residuals were examined to ensure equal variance and normality. Due to the fact that the outcome variable is not a "true" continuous variable, and has only four possible values, the plot of residuals vs. predicted values does not appear as a random scatter as would be ideal if there were true equal variance. Additionally, as more variables were added to the model, residual frequencies approached normal distribution, but still did not follow a true normal distribution. Therefore, results are only reported for Models 4 and 5. Two factors indicate that a multiple linear regression is appropriate in this case despite the fact that the data do not perfectly fit model assumptions: 1) the large sample size and 2) the fact that other types of analyses, such as ordinal regression, will likely produce similar results in regard to trends and significance, which is what we are concerned with in this study. This is common practice in other fields, such as psychology, where Likert scales are frequently used as outcome variables and linear regression models are used to model them.

Oral health status was coded with positive responses having higher values (i.e. 4 = excellent oral health status, 3 = very good, etc.) so positive beta coefficients are interpreted as resulting in an incremental increase in oral health status.

Soda consumption was checked for mediating the relationship between the independent and dependent variables. By definition, a mediation model is one that "offers and explanation of how, or why, two variables are related, where an intervening or mediating variable … is hypothesized to be intermediate in the relation between an independent variable … and an outcome" (Fairchild and MacKinnon 2009) . The mediating effect of soda consumption was assessed by comparing the model slopes of independent predictor variables with and without soda consumption in the model. A 10% difference in beta coefficients between the models with and without soda consumption was used as an indicator for having a mediating effect.

CHAPTER IV: RESULTS

Descriptive Statistics

There were 2386 total participants in the survey – 1859 by telephone and 527 online - and 200 were excluded for being under age two, for a final sample size of 2186. Interviews lasted 22 minutes on average. Weighted descriptive statistics about participants and the children about whom they responded are found in Table 2. The weighted values correspond to the 2010 census population of Iowa, and cases were weighted on the basis of age group, gender, and family size. The minimum, maximum, and mean weighting factors for the 2010 HHS were 0.28, 3.84, and 0.763, respectively. A large proportion of respondents were high-income (50.2% with household income over $70,000), highly educated (45% with 4-year college graduate or higher), and reported white as their child's race (86.3%). Survey respondents were mostly mothers (79%), while 15% were fathers and 6% were mostly other relatives. The majority of respondents reported that their child had private dental insurance (62.5%) and drank zero cans of pop/soda per day (78.1%).

Only five percent of respondents rated their child's oral health as fair or poor. Respondents tended to rate their neighborhoods as having higher social capital, with a mean score of 3.47 on a 1-4 scale. Families tended to eat a meal together most days or more (78.2%), attend religious services several times a month or more (68.4%), have three or fewer children (82.8%), and have two parents in the household (88.5%).

Table 2. Descriptive statistics for all independent and dependent variables

Variable	Unweighted N (%) or Mean (SD)	Weighted N (%) or Mean (SD)
Dependent Variable		
Oral Health Status		
Excellent	923 (42.4)	274,529 (42.6)
Very Good	780 (35.8)	223,151 (34.6)
Good	381 (17.5)	117,255 (18.2)
Fair-Poor	95 (4.4)	30,030 (4.7)
Oral Health Status (as continuous variable)	3.16 (0.86)	3.15 (0.88)
Independent Variables		
Neighborhood Social Capital Index	3.46 (0.64)	3.47 (0.64)
People in this neighborhood help each other out		
Definitely agree	959 (44.6)	292,303 (45.8)
Somewhat agree	902 (41.9)	256,212 (40.2)
Somewhat disagree	172 (8.0)	53,190 (8.3)
Definitely disagree	119 (5.5)	35,908 (5.6)
We watch out for each other's children in this community		
Definitely agree	1158 (53.8)	350,875 (54.9)
Somewhat agree	789 (36.7)	227,515 (35.6)
Somewhat disagree	121 (5.6)	34,676 (5.4)
Definitely disagree	84 (3.9)	26,065 (4.1)
There are people I can count on in this community		
Definitely agree	1438 (66.5)	432,444 (67.3)
Somewhat agree	589 (27.2)	171,411 (26.7)
Somewhat disagree	69 (3.2)	19,060 (3.0)
Definitely disagree	68 (3.1)	19,381 (3.0)
If my child were outside playing and got hurt or scared, there are adults nearby who I trust to help my child		
Definitely agree	1555 (72.4)	462,211 (72.7)
Somewhat agree	456 (21.2)	133,412 (21.0)
Somewhat disagree	77 (3.6)	21,472 (3.4)
Definitely disagree	60 (2.8)	18,404 (2.9)
Family Social Capital Variables: Family Function		
Frequency of family eating meals together		
Every day or Most days	1665 (76.2)	505,317 (78.1)
Some days or Never	519 (23.8)	141,274 (21.8)

Table 2. continued

Frequency of religious service attendance		
Once a week or more	972 (44.5)	310,038 (48.0)
A few times a month	462 (21.2)	131,652 (20.4)
A few times a year	468 (21.4)	127,444 (19.7)
Never	280 (12.8)	77,041 (11.9)
Family Social Capital Variables: Family Composition		
Number of children in household		
1 child	760 (34.8)	110,993 (17.2)
2 children	865 (39.6)	253,878 (39.2)
3 children	386 (17.7)	170,590 (26.4)
4-11 children	175 (8.0)	111,683 (17.3)
Two- vs. Single-parent families		
Two-parent family	1885 (86.4)	571,135 (88.5)
Single-parent family	297 (13.6)	74,467 (11.5)
Covariates		
Child gender		
Female	1065 (48.7)	315,114 (48.7)
Male	1121 (51.3)	332,030 (51.3)
Child age in years		
2-3 years	236 (10.8)	80,849 (12.5)
4-6 years	345 (15.8)	120,683 (18.6)
7-12 years	757 (34.6)	240,930 (37.2)
13-17 years	848 (38.8)	204,682 (31.6)
Child race/ethnicity		
African-American (non-Hispanic)	80 (3.7)	27,441 (4.3)
Latino/Hispanic (all races)	126 (5.8)	39,564 (6.1)
White (non-Hispanic)	1896 (87.0)	557,048 (86.3)
Asian/Pacific Islander (non-Hispanic)	51 (2.3)	14,530 (2.3)
Other (non-Hispanic)	27 (1.2)	6845 (1.1)
Household income		
$0-$25,000	187 (9.8)	52,518 (9.3)
$25,001-$40,000	219 (11.5)	66,524 (11.8)
$40,001-$55,000	258 (13.5)	81,453 (14.4)
$55,001-$70,000	285 (14.9)	81,306 (14.4)
$70,000-$80,000	214 (11.2)	68,026 (12.0)
$80,000 +	749 (39.2)	216,240 (38.2)

Table 2. continued

Parent Education		
Less than high school graduate	82 (3.8)	27,731 (4.3)
High school graduate or GED	323 (15.7)	96,913 (15.0)
Some college or 2-year degree	803 (36.8)	231,845 (35.8)
4-year college graduate	610 (27.9)	187,276 (29.0)
More than 4-year college graduate	347 (15.9)	103,086 (15.9)
Dental insurance coverage		
No dental insurance	367 (17.0)	107,596 (16.9)
Public dental insurance	423 (19.6)	131,186 (20.6)
Private dental insurance	1363 (63.3)	398,700 (62.5)
Soda consumption		
0 cans/day	1606 (74.0)	502,712 (78.1)
1+ cans/day	563 (26.0)	140,791 (21.9)

Bivariate Statistics

Bivariate associations between the dependent and all independent variables can be found in Table 3. Bivariate statistics were generated using weights that are proportionally the same as the census population, but the sample size is reduced to inflate the variance so that the tests are not overpowered to detect associations. There were statistically significant associations between the dependent variable, oral health status, and the following independent variables: neighborhood social capital ($p=0.001$), frequency of family eating meals together ($p=0.003$), two- vs. single-parent families ($0<0.001$), child gender ($p=0.004$), child age in years ($p=0.013$), child race/ethnicity ($p<0.001$), household income ($p<0.001$), parent education ($p<0.001$), dental insurance coverage ($p<0.001$), and soda consumption ($p<0.001$). There was no statistically significant bivariate association between oral health status and frequency of religious service attendance ($p=0.264$) or number of children in the household ($p=0.062$).

Following are the directions of association between dependent and independent variables that were statistically significantly related. Higher neighborhood social capital was associated with higher oral health status. Family eating together "every day" or "most days" was associated with the highest oral health status. Two-parent households were associated with higher oral health status compared to single-parent households. Parents of female children reported "excellent" oral health status more frequently, but also "fair-poor", oral health status more frequently, than parents of male children. Lowest age, 2-3 years, was associated with higher oral health status, and age 7-12 years was associated with the poorest oral health status. Asian/Pacific Islander and "other" race/ethnicity were associated with the highest oral health status, whereas Hispanic/Latino race/ethnicity was associated with the poorest. There were positive relationships between oral health status and both household income and parent education. Public dental insurance was associated with poorest oral health status, and private insurance with the highest oral health status. Soda consumption of one or more cans per day was associated with poorer oral health status compared to zero cans per day.

Bivariate associations were generated between the four family social capital variables in order to 1) examine the relationships between these constructs, and 2) to explain the negative Cronbach's alpha value for these four variables (-0.182). Results for bivariate associations between these four variables can be found in Table 4.

There were significant associations between the following groups of variables: frequency of family eating meals together and number of children in the household ($p=0.006$); frequency of family eating meals together and frequency of religious service attendance ($p<0.001$); number of children in the household and two- vs. single-parent

family ($p<0.001$); number of children in the household and frequency of religious service attendance ($p<0.001$); frequency of religious service attendance and two- vs. single-parent families ($p<0.001$).

The directions of association are as follows. A higher number of children was associated with eating meals together more frequently, having a two-parent household, and a higher frequency of religious service attendance. There was an inconsistent relationship between frequency of eating meals together and religious service participation, with those never attending religious services more likely to eat meals together everyday, and those attending a religious service a few times a year most likely to eat meals together some days or never. Two-parent families were associated with higher frequency of religious service attendance compared to single-parent families.

These findings show that although social capital theory postulates that *fewer* children in the household is associated with higher family social capital due to increased parent-child contact time, the relationship between number of children and other family social capital variables here is actually opposite than would be expected based on social capital theory. That is, having *more* children is associated with eating meals together more frequently, attending religious services more frequently, and having a two-parent family. This explains the finding of a negative Cronbach's alpha for these four variables. Even after eliminating the number of children from the reliability assessment, there is a low internal consistency between the other three family social capital variables ($\alpha = 0.079$), confirming that these four variables should be treated separately rather than in one index.

Table 3. Bivariate associations between independent and dependent variables

Variable	**Dependent Variable: Oral Health Status N (%) or Mean (SD)**				**P value**
	Excellent	Very good	Good	Fair-Poor	
Independent Variables					
Neighborhood Social Capital	3.55(0.61)	3.44(0.64)	3.40(0.67)	3.38(0.58)	0.001
Family Social Capital Variables: Family function					
Frequency of family eating meals together					0.052
Every day or Most days	558 (44.3)	423 (33.6)	224 (17.8)	55 (4.4)	
Some days or Never	127 (36.2)	135 (38.5)	69 (19.7)	20 (5.7)	
Frequency of religious service attendance					0.264
Once a week or more	353 (45.5)	265 (34.2)	128 (16.5)	29 (3.7)	
A few times a month	141 (42.9)	114 (34.7)	59 (17.9)	15 (4.6)	
A few times a year	120 (38.0)	111 (35.1)	67 (21.2)	18 (5.7)	
Never	71 (37.4)	68 (35.8)	39 (20.5)	12 (6.3)	
Family Social Capital Variables: Family composition					
Number of children in household					0.062
1 child	110 (39.9)	108 (39.1)	48 (17.4)	10 (3.6)	
2 children	289 (45.7)	211 (33.4)	106 (16.8)	26 (4.1)	
3 children	181 (42.7)	149 (35.1)	77 (18.2)	17 (4.0)	
4-11 children	106 (38.0)	90 (32.3)	61 (21.9)	22 (7.9)	
Two- vs. Single-parent families					<.001
Two-parent family	620 (43.6)	500 (35.1)	246 (17.3)	57 (4.0)	
Single-parent family	65 (35.1)	55 (29.7)	47 (25.4)	18 (9.7)	
Covariates					
Child gender					0.004
Female	361 (46.0)	265 (33.8)	118 (15.1)	40 (5.1)	
Male	325 (39.3)	293 (35.4)	175 (21.1)	35 (4.2)	
Child age in years					0.013
2-3 years	102 (51.5)	53 (26.8)	38 (19.2)	5 (2.5)	
4-6 years	133 (44.2)	112 (37.2)	42 (14.0)	14 (4.7)	
7-12 years	230 (38.1)	213 (35.3)	123 (20.4)	37 (6.1)	
13-17 years	222 (43.4)	179 (35.0)	91 (17.8)	20 (3.9)	

Table 3. continued

Child race/ethnicity					<.001
African-American (non-Hispanic)	25 (36.8)	27 (39.7)	13 (19.1)	3 (4.4)	
Latino/Hispanic (all races)	26 (26.3)	28 (28.3)	30 (30.3)	15 (15.2)	
White (non-Hispanic)	603 (43.4)	481 (34.6)	248 (17.9)	57 (4.1)	
Asian/Pacific Islander (non-Hispanic)	20 (55.6)	15 (41.7)	1 (2.8)	0 (0.0)	
Other (non-Hispanic)	9 (50.0)	8 (44.4)	0 (0.0)	1 (5.6)	
Household income					<.001
$0-$25,000	46 (35.4)	39 (30.0)	29 (22.3)	16 (12.3)	
$25,001-$40,000	57 (34.5)	60 (36.4)	35 (21.2)	13 (7.9)	
$40,001-$55,000	80 (39.2)	78 (38.2)	36 (17.6)	10 (4.9)	
$55,001-$70,000	71 (35.1)	73 (36.1)	49 (24.3)	9 (4.5)	
$70,000-$80,000	71 (41.8)	58 (34.1)	38 (22.4)	3 (1.8)	
$80,000 +	286 (52.9)	185 (34.2)	59 (10.9)	11 (2.0)	
Parent Education					<.001
Less than high school graduate	21 (30.0)	17 (24.3)	23 (32.9)	9 (12.9)	
High school graduate or GED	75 (31.1)	89 (36.9)	59 (24.5)	18 (7.5)	
Some college or 2-year degree	235 (40.6)	193 (33.3)	120 (20.7)	31 (5.4)	
4-year college graduate	220 (47.2)	177 (38.0)	58 (12.4)	11 (2.4)	
More than 4-year college graduate	136 (52.9)	81 (31.5)	34 (13.2)	6 (2.3)	
Dental insurance coverage					<.001
No dental insurance	107 (40.1)	93 (34.8)	52 (19.5)	15 (5.6)	
Public dental insurance	114 (34.9)	106 (32.4)	83 (25.4)	24 (7.3)	
Private dental insurance	456 (45.9)	354 (35.6)	150 (15.1)	34 (3.4)	
Soda consumption					<.001
0 cans/day	566 (45.2)	424 (33.8)	211 (16.8)	52 (4.2)	
1+ cans/day	118 (33.6)	130 (37.0)	80 (22.8)	23 (6.6)	

Table 4. Bivariate associations for family social capital variables

Variable	**Frequency of family eating meals together N (%)**				**P value**
	Every day or Most days		Some days or Never		
Number of children in household					0.075
1 child	201 (72.6)		76 (27.4)		
2 children	501 (79.1)		132 (20.9)		
3 children	344 (80.6)		83 (19.4)		
4-11 children	217 (77.8)		62 (22.2)		
Two- vs. Single-parent family					0.237
Two-parent family	1120 (78.5)		306 (21.5)		
Single-parent family	139 (74.7)		47 (25.3)		
Frequency of religious service attendance					0.006
Once a week or more	634 (81.8)		141 (18.2)		
A few times a month	245 (74.2)		85 (25.8)		
A few times a year	235 (73.9)		83 (26.1)		
Never	148 (77.5)		43 (22.5)		
	Number of children in household N (%)				**P value**
	1 child	2 children	3 children	4-11 children	
Two- vs. Single-parent family					<.001
Two-parent family	222 (15.5)	566 (39.6)	387 (27.1)	254 (17.8)	
Single-parent family	55 (29.6)	68 (36.6)	39 (21.0)	24 (12.9)	
Frequency of religious service attendance					<.001
Once a week or more	108 (13.9)	265 (34.1)	227 (29.3)	176 (22.7)	
A few times a month	59 (17.9)	137 (41.6)	93 (28.3)	40 (12.2)	
A few times a year	66 (20.8)	150 (47.2)	67 (21.1)	35 (11.0)	
Never	45 (23.3)	81 (42.0)	39 (20.2)	28 (14.5)	
	Frequency of religious service attendance N (%)				**P value**
	Once a week or more	A few times a month	A few times a year	Never	
Two- vs. Single-parent family					0.014
Two-parent family	704 (49.4)	286 (20.1)	272 (19.1)	164 (11.5)	
Single-parent family	69 (37.1)	42 (22.6)	46 (24.7)	29 (15.6)	

Multivariable Results

Results from the full models without and with the mediating variable, soda consumption, can be found in Tables 5 and 6, respectively. In the model without soda consumption, neighborhood social capital (p=0.003), family frequency of eating meals together (p=0.047), gender (p=0.001), age (p<0.001), race/ethnicity (p=0.029), education (p=0.001), and income (p=0.001) were all significant independent predictors of child oral health status (Table 5).

In the model with soda consumption all of the same independent variables were statistically significantly associated with oral health status: neighborhood social capital (p=0.004), family frequency of eating meals together (p=0.02), gender (p=0.005), age (p<0.001), race/ethnicity (p=0.021), education (p=0.004), income (p=0.001), and soda consumption (p=0.007) were all significant independent predictors of child oral health status (Table 6).

The fixed effects variables that are positively related to oral health status are as follows: neighborhood social capital, family frequency of eating meals together, religiosity, number of parents in the household (two vs. one), household income, and parent education. That is, increases in the levels of these variables are associated with better oral health status. The number of children in the household and soda consumption were negatively associated with oral health status; therefore, more children in the household and increased soda consumption are associated with poorer oral health status. Male gender was associated with poorer oral health status compared to female gender. Compared to age 13-17, child age 7-12 was associated with poorer oral health, while age 2-3 was associated with better oral health. Age 4-6 was associated with better oral health

in the model without soda consumption and poorer oral health in the model with soda consumption compared to 13-17-year-olds. Relative to White race/ethnicity, African American, Asian/Pacific Islander and "Other" race/ethnicity were associated with better oral health status, while Hispanic/Latino race/ethnicity was associated with poorer oral health status. Relative to private dental insurance, no dental insurance and public dental insurance were associated with poorer oral health status.

The random effect variance estimate for zip code was found not to be statistically different from zero in this study (Tables 5 and 6). The intraclass correlation, or the proportion of total variance in the outcome that is explained by the clustering of zip code, is 1.3 percent. This was calculated by dividing the variance estimate for zip code (Tables 5 and 6) by the sum of variance estimate for zip code plus the total residual variance, which is 0.67.

It is somewhat difficult to interpret beta coefficients in this study because the outcome is a perceptive scale rather than a clinical measurement. While the specific beta values should be viewed with caution because the outcome does not completely follow a normal distribution, it is valuable to compare magnitudes of association across model variables. For example, the effect of a one-standard deviation (0.64) increase in neighborhood social capital (on a scale of 1-4), or 0.06, is three times the effect of a one-unit ($5,000) increase in household income, or approximately equivalent to the effect of a $15,000 increase in household income. Relative to parent education, the effect of one standard deviation increase in neighborhood social capital on oral health status is approximately equivalent to one-quarter of the difference between children whose parents have more than a four-year college degree compared to those with less than a high school

education. The same effect of neighborhood social capital is also equivalent to half of the difference in oral health status between children who had zero cans of pop per day and those consuming one or more cans per day.

The final regression model equations without and with soda consumption are as follows:

y = 2.56 + 0.093(NSC) – 0.11(Mealsomedaysnever) – 0.033(Religfewtimesmonth) – 0.098(Religfewtimesyear) – 0.046(Relignever) + 0.11(1child) + 0.16(2children) + 0.12(3children) – 0.033(Twoparentfamily) – 0.12(Malegender) + 0.07(2-3yearsold) + 0.003(4-6yearsold) – 0.20(7-12yearsold) + 0.004(4yearcollege) – 0.14(2yrcollege) – 0.24(HSgraduate) – 0.22(LessthanHS) + 0.28(Asian/PI) + 0.17(Otherrace) – 0.15(HispanicLatino) + 0.16(AfricanAmerican) – 0.06(NoInsurance) – 0.04(PublicInsurance) + 0.02(Income) + 0.009(zipcode)

y = 2.47 + 0.096(NSC) – 0.11(Mealssomedaysnever) – 0.032(Religfewtimesmonth) – 0.086(Religfewtimesyear) – 0.021(Relignever) + 0.12(1child) + 0.16(2children) + 0.11(3children) – 0.031(Twoparentfamily) – 0.11(Malegender) + 0.01(2-3yearsold) - 0.04(4-6yearsold) – 0.23(7-12yearsold) + 0.002(4yearcollege) – 0.13(2yrcollege) – 0.22(HSgraduate) – 0.21(LessthanHS) + 0.30(Asian/PI) + 0.22(Otherrace) – 0.15(HispanicLatino) + 0.15(AfricanAmerican) – 0.06(NoInsurance) – 0.04(PublicInsurance) + 0.02(Income) + 0.13(Soda0cans/day) + 0.009(zipcode)

The goal of testing whether a variable acts as a mediator or not is to explain how the independent variable acts to affect the outcome variable. For the independent variables that were significant in the final models – neighborhood social capital and family frequency of eating meals together – the beta coefficients do not change by more than 10% with the addition of soda consumption into the model. Therefore, it appears

that soda consumption is not a mediating factor in how these variables are associated with oral health status of children.

Six hypotheses drove the analyses in this study. Here we relist the hypotheses and state whether they were accepted or rejected on the basis of their statistical association with the dependent variable:

1. Neighborhood social capital will be positively associated with child oral health status after adjusting for confounding variables. - *Accepted*
2. Family frequency of eating meals together, a component of family social capital, will be positively associated with child oral health status after adjusting for confounding variables. – *Accepted*
3. Religiosity, a component of family social capital, will be positively associated with child oral health status after adjusting for confounding variables. - *Rejected*
4. The number of children in the household, a component of family social capital, will be negatively associated with child oral health status after adjusting for confounding variables. - *Rejected*
5. Two parent households, a component of family social capital, will be positively associated with child oral health status after adjusting for confounding variables. - *Rejected*
6. Soda consumption will mediate the relationship between neighborhood and family social capital variables and child oral health status. – *Rejected*

Table 5. Multivariable associations between independent and dependent variables

	Beta coefficient	Standard error	t statistic	P value	F statistic	P value
Neighborhood social capital	0.096	0.033	2.93	0.003	8.58	0.003
Family Social Capital Variables: Family function						
Family frequency of eating meals together					5.73	0.017
Every day or Most days	0	0	-	-		
Some days or never	-0.11	0.047	-2.39	0.017		
Frequency of religious service attendance					1.21	0.31
Once a week or more	0	0	-	-		
A few times a month	-0.033	0.051	-0.72	0.47		
A few times a year	-0.098	0.052	-1.90	0.058		
Never	-0.046	0.064	-0.65	0.52		
Family Social Capital Variables: Family composition						
Number of children in household					1.51	0.21
1 child	0.12	0.079	1.51	0.13		
2 children	0.16	0.077	2.08	0.038		
3 children	0.11	0.083	1.34	0.17		
4-11 children	0	0	-	-		
Two- vs. Single-parent family					0.26	0.61
Single-parent family	-0.033	0.064	-0.51	0.61		
Two-parent family	0	0	-	-		
Covariates						
Child gender					10.38	0.001
Female	0	0	-	-		
Male	-0.12	0.039	-3.22	0.001		
Child age in years					8.95	<.001
2-3 years	0.076	0.071	1.00	0.32		
4-6 years	0.003	0.059	0.051	0.96		
7-12 years	-0.20	0.047	-4.22	<.001		
13-17 years	0	0	-	-		

Table 5. continued

Child race/ethnicity					2.70	0.029
African-American (non-Hispanic)	0.16	0.11	1.50	0.14		
Latino/Hispanic (all races)	-0.15	0.095	-1.56	0.12		
Other (non-Hispanic)	0.17	0.17	0.99	0.32		
Asian/Pacific Islander (non-Hispanic)	0.28	0.13	2.16	0.030		
White (non-Hispanic)	0	0	-	-		
Household income	0.020	0.0059	3.36	0.001	11.31	0.001
Parent Education					4.53	0.001
Less than high school graduate	-0.22	0.15	-1.45	0.15		
High school graduate or GED	-0.24	0.074	-3.24	0.001		
Some college or 2-year degree	-0.14	0.060	-2.29	0.022		
4-year college graduate	0.0042	0.060	0.071	0.94		
More than 4-year college graduate	0	0	-	-		
Dental insurance coverage					0.68	0.51
No dental insurance	-0.059	0.054	-1.09	0.28		
Public dental insurance	-0.043	0.064	-0.66	0.51		
Private dental insurance	0	0	-	-		
Zip code (random effect)	0.0093	0.0097	-	-	0.96*	0.34*

* Results from Wald Z test

Table 6. Multivariable associations between independent and dependent variables with soda consumption as mediating variable

	Beta coefficient	Standard error	t statistic	P value	F statistic	P value
Neighborhood social capital	0.093	0.033	2.82	0.005	7.13	0.005
Family Social Capital Variables: Family Function						
Family frequency of eating meals together					5.45	0.020
Every day or Most days	0	0	-	-		
Some days or never	-0.11	0.047	-2.34	0.02		
Frequency of religious service attendance					0.94	0.42
Once a week or more	0	0	-	-		
A few times a month	-0.021	0.051	-0.41	0.68		
A few times a year	-0.086	0.052	-1.67	0.095		
Never	-0.032	0.065	-.50	0.62		
Family Social Capital Variables: Family composition						
Number of children in household					1.49	0.22
1 child	0.12	0.080	1.54	0.12		
2 children	0.16	0.077	2.07	0.039		
3 children	0.11	0.083	1.35	0.18		
4-11 children	0	0	-	-		
Two- vs. Single-parent family					0.23	0.63
Single-parent family	-0.031	0.064	-0.48	0.63		
Two-parent family	0	0	-	-		
Covariates						
Child gender					8.01	0.005
Female	0	0	-	-		
Male	-0.11	0.039	-2.83	0.005		
Child age in years					9.80	<.001
2-3 years	0.013	0.073	0.17	0.86		
4-6 years	-0.041	0.061	-0.66	0.51		
7-12 years	-0.23	0.048	-4.81	<.001		
13-17 years	0	0	-	-		

Table 6. continued

Child race/ethnicity					2.89	0.021
African-American (non-Hispanic)	0.15	0.11	1.39	0.17		
Latino/Hispanic (all races)	-0.15	0.095	-1.57	0.12		
Other (non-Hispanic)	0.22	0.17	1.24	0.22		
Asian/Pacific Islander (non-Hispanic)	0.30	0.13	2.28	0.023		
White (non-Hispanic)	0	0	-	-		
Household income	0.020	0.0060	3.38	0.001	11.45	0.001
Parent Education					3.84	0.004
Less than high school graduate	-0.21	0.15	-1.36	0.17		
High school graduate or GED	-0.22	0.074	-2.94	0.003		
Some college or 2-year degree	-0.13	0.060	-2.18	0.030		
4-year college graduate	0.0024	0.060	0.041	0.968		
More than 4-year college graduate	0	0	-	-		
Dental insurance coverage					0.70	0.50
No dental insurance	-0.062	0.054	-1.15	0.26		
Public dental insurance	-0.035	0.065	-0.54	0.59		
Private dental insurance	0	0	-	-		
Soda consumption					7.14	0.008
0 cans/day	0.13	0.049	2.67	0.008		
1+ cans/day	0	0	-	-		
Zip code (random effect)	0.0088	0.0098	-	-	0.89*	0.37*

*Results from Wald Z test

CHAPTER V. DISCUSSION

Overview and Interpretations

The goal of this study was to evaluate the independent associations between oral health status and two types of social capital – neighborhood and family – after adjusting for known confounding factors, and to apply the findings to the Fisher-Owens model for factors influencing child oral health. In addition, soda consumption was evaluated as a potential mediating factor between the social capital variables and oral health status. As the studies reviewed in Chapter 2 indicate, many studies have found that various forms of social capital are independently associated with a number of general health and oral health outcomes. This study found that neighborhood social capital, an indicator of how supportive and cohesive one's neighborhood is, was significantly associated to child oral health status after adjusting for known confounding factors. It also found that the broad concept of family social capital, which conceptually encompasses two family-level constructs in the Fisher-Owens conceptual model – family function and family composition – was generally not associated with oral health status except for one component, frequency of family eating meals together. One of the variables used to measure family function, religiosity, and the two used to measure family composition, number of children in the household and single- vs. two-parent family, were all not statistically related to the outcome after adjusting for known confounding variables.

Because such variation exists in the indicators that are used to represent the different forms of social capital, it is difficult to compare findings across the extant literature. However, three studies use some or all of the same indicators for

neighborhood and/or family social capital that are used in the present study, which may be compared directly. Findings of the present study are consistent with the findings of Bramlett et al. and Guarnizo-Herreno & Webhy, which found significant associations between neighborhood social capital and oral health status in children (Bramlett and others 2010; Guarnizo-Herreno and Wehby 2012). Iida & Rozier found that neighborhood social capital – as also measured by the same four indicators – was associated with unmet need for dental care and preventive dental visits but not oral health status (Iida and Rozier 2013). They also found that parent structure was not significantly related to oral health status.

The study by Bramlett et al. is the only reviewed study that used the same indicators to measure family function and family composition. They found that religiosity, frequency of eating meals together, and two- vs. single-parent families were not significantly related to oral health status, and the number of children in the household was weakly but significantly related. Their sample was limited to children age 1-5, which may indicate that the effects of families eating meals together and the number of children in the household on oral health – the findings that were inconsistent with ours – vary for children of different age groups. Other literature on each of these specific variables show conflicting findings. Two recent studies found a significant association between higher religiosity and better oral health in adults (Zini, Sgan-Cohen, Marcenes 2012) and children (Ismail and others 2008). Recent studies on family functioning and family composition show mixed results, with some finding that these constructs influence child oral health and some that they do not (Duijster, Verrips, van Loveren 2013; Listl 2011; Renzaho and de Silva-Sanigorski 2013).

This study adds to the scant evidence bases around the relationships between both neighborhood social capital and oral health, and the constructs of family social capital – including family functioning and family composition – and oral health. While these relationships have been investigated in other nations and nationwide in the U.S., no studies using our specific indicators have been conducted on social capital and oral health for a single state. Studies have found variation in the amount of state-level social capital across various states, and therefore these relationships may prove to be different by region (Putnam 2001). Additionally, this study combines health and sociology literature around the concepts of family social capital, family functioning, and family composition.

The findings from this study may be explained by several of the purported mechanisms about how social capital impacts health. First, having a neighborhood with a high stock of social capital, an indicator of a supportive and tightly-knit community, may affect oral health outcomes by shaping the health behaviors of people in that community. This could happen either via the spread of health information, such as information about the detrimental impact of sugared beverages on teeth or healthy feeding practices for babies, or it could modify behaviors by influencing healthy norms such as healthy diet or exercise. Second, social capital may impact health via increasing a community's collective efficacy to make positive changes in the community. An example of this is using participatory action to create healthy communities with access to healthy foods and safe, walkable areas. Third, neighborhood social capital may impact health directly via psychosocial processes. That is, higher neighborhood trust and social support have been shown to reduce individual stress (Phongsavan and others 2006; Yang and Matthews 2010). An example of lower stress and improved mental health affecting oral health

outcomes could be young parents' increased willingness to brush their young babies' and children's teeth every night despite the children potentially fighting them to do so.

The finding that the frequency of the family eating meals together is associated with improved oral health status of children could be due to several reasons. First, studies have found relationships between the frequency of family dinners and improved diet, including less soda and lower glycemic load (Gillman and others 2000; Videon and Manning 2003). Additionally, adolescents who never eat meals with their family are more likely to be overweight, another indicator that families having dinner together influences diet (Fulkerson and others 2008; Fulkerson and others 2009; Goldfield and others 2011).

Several findings from the analyses in this study are unexpected based on findings from previous literature. First, all minorities other than Hispanic/Latinos had better oral health status compared to Whites in the final models. This is unexpected for African American and Asian/Pacific Islander children, who nationally have been found to have poorer oral health than their White counterparts (Dye, Li, Thornton-Evans 2012; Flores and Lin 2013). However, another report on a survey of Iowa Head Start children found similar results, with Hispanic/Latino children having poorer oral health than their African American and White counterparts (Rodgers and Chen 2009). This begs the question: do different racial/ethnic groups have systematic differences in the way that they self-report oral health status? Sohn et al. found that low-income African American parents in Detroit generally made accurate predictions about their children's oral health status (Sohn and others 2008).

Another unexpected finding is the fact that dental insurance was not found to be a significant predictor of oral health status in this study. One national study found that children with no dental insurance were significantly more likely to have poorer oral health status than those who had dental insurance, however our analyses show that there is no independent association between dental insurance and oral health status after adjusting for other factors (Bramlett and others 2010).

Limitations and Future Research

This study suffers from several limitations. First, as these data are cross-sectional, no inferences about causality can be made between the two types of social capital and oral health status of children. This underscores the message from previous systematic reviews about the importance of conducting longitudinal studies on the effects of social capital on health. Second, some scholars argue that measurements of social capital of children should include two things that were not included in this study: 1) the perceptions of the children themselves, rather than only assessing parents' perspectives, and 2) peer and school influences, as they have an important impact on children (Morrow 1999). Future studies should take this perspective into consideration when measuring social capital in children.

Another limitation concerns how the main independent variables were measured in this study. As has been emphasized previously, there is no standardized way to measure social capital or its component types. The four indicators for neighborhood social capital in this study capture several important elements within social capital: neighborhood trust, cohesion, and intergenerational closure. However, some may argue

that these indicators are too limited to capture the complex components of neighborhood social capital, including social networks, organizational involvement, and collective efficacy (Sampson and Graif 2009). The same goes for family social capital, where some may argue that there are additional constructs that are not captured in our indicators, such as the quality of parent-child relations, adult's interest in the child, or parents' monitoring of child activities, and extended family exchange and support (Harpham 2008). However, any secondary analysis of an existing data source that was not originally designed to measure social capital in a detailed way will likely suffer from similar limitations.

It would have been desirable to assess the potential mediating effects of more variables than just soda consumption in this study to see how neighborhood social capital is acting to influence child oral health. Other examples of possible mediating factors could be other diet-related measures and oral hygiene behaviors.

Additionally, as mentioned previously, treating oral health status, a four-level variable, as a continuous outcome poses limitations on the interpretation of associations. Whereas accepted continuous measures such as the number of teeth with decay or fillings are easy to interpret – e.g. the number of decayed or filled teeth, on average, is 1.2 higher for low-educated compared to high-educated parents – the interpretation of "units of oral health status" is much more nebulous. Nonetheless, it is valuable to make comparisons of the strength of association across variables within the model.

Finally, the fact that we were not able to conduct a multilevel analysis was a limitation in this study. Based on the assumption that neighborhood social capital is a collective, rather than individual, characteristic, scholars have called for more multilevel

studies in order to measure the impact of this community-level characteristic on individuals in the community (Murayama, Fujiwara, Kawachi 2012). However, we believe that assessing individual-level perceptions of a neighborhood characteristic is beneficial in assessing the impact of this characteristic on the oral health of children. We addressed the potential clustering of neighborhood social capital by geographic location by incorporating a random effect for zip code into the models.

Future studies could improve upon these limitations in a number of ways. First, they should utilize a multilevel analysis where possible and appropriate. Studies on non-community types of social capital, such as family, are examples where multilevel analyses may not be appropriate. Second, studies should be designed to specifically assess the impact of different types of social capital on multiple health and oral health outcomes. This way, detailed measures of social capital can be constructed. Additionally, studies should assess multiple health outcomes, situating oral health with other health outcomes in order to maximize the understanding of social capital on the health of children. Finally, a number of potential mediating factors should be assessed to examine the mechanisms by which social capital impacts the health and oral health of children.

Summary and Conclusions

This cross-sectional study on a generalizable sample of Iowa households found that neighborhood social capital and the frequency of families eating meals together, a component of family social capital, have significant independent relationships with the oral health of children in Iowa. This study tested three factors in the Fisher-Owens

conceptual model for influences on child oral health – community-level social capital, family function, and family composition – and found that community-level social capital and a component of family social capital and family function, frequency of families eating meals together, does impact child oral health, but family composition did not in this study.

This study adds to the growing body of literature around the social determinants of oral health, indicating that it is more than just individual characteristics or behaviors that influence oral health outcomes. This literature suggests that interventions designed to improve oral health should be conducted on multiple levels rather that solely aiming to impact factors on an individual level.

REFERENCES

Aida J, Ando Y, Oosaka M, Niimi K, Morita M. 2008. Contributions of social context to inequality in dental caries: A multilevel analysis of japanese 3-year-old children. Community Dent Oral Epidemiol 36(2):149-56.

Aida J, Kondo K, Kondo N, Watt RG, Sheiham A, Tsakos G. 2011a. Income inequality, social capital and self-rated health and dental status in older japanese. Soc Sci Med 73(10):1561-8.

Aida J, Kuriyama S, Ohmori-Matsuda K, Hozawa A, Osaka K, Tsuji I. 2011b. The association between neighborhood social capital and self-reported dentate status in elderly japanese--the ohsaki cohort 2006 study. Community Dent Oral Epidemiol 39(3):239-49.

Aida J, Hanibuchi T, Nakade M, Hirai H, Osaka K, Kondo K. 2009. The different effects of vertical social capital and horizontal social capital on dental status: A multilevel analysis. Soc Sci Med 69(4):512-8.

Bourdieu P. 1986. The forms of capital. In: Handbook of theory and research for the sociology of education. Richardson JG, editor. New York: Greenwood Press.

Boyce WF, Davies D, Gallupe O, Shelley D. 2008. Adolescent risk taking, neighborhood social capital, and health. J Adolesc Health 43(3):246-52.

Bramlett MD, Soobader MJ, Fisher-Owens SA, Weintraub JA, Gansky SA, Platt LJ, Newacheck PW. 2010. Assessing a multilevel model of young children's oral health with national survey data. Community Dent Oral Epidemiol 38(4):287-98.

Caplan DJ and Weintraub JA. 1993. The oral health burden in the united states: A summary of recent epidemiologic studies. J Dent Educ 57(12):853-62.

Carlson ED and Chamberlain RM. 2003. Social capital, health, and health disparities. J Nurs Scholarsh 35(4):325-31.

Caughy MO and O'Campo PJ. 2006. Neighborhood poverty, social capital, and the cognitive development of african american preschoolers. Am J Community Psychol 37(1-2):141-54.

Chi DL and Carpiano RM. 2013. Neighborhood social capital, neighborhood attachment, and dental care use for los angeles family and neighborhood survey adults. Am J Public Health 103(4):e88-95.

Christensen P. 2004. The health-promoting family: A conceptual framework for future research. Soc Sci Med 59(2):377-87.

Coleman JS. 1988. Social capital in the creation of human capital. American Journal of Sociology 94(, Supplement: Organizations and Institutions: Sociological and Economic Approaches to the Analysis of Social Structure):S95-S120.

Costa SM, Vasconcelos M, Abreu MH. 2013. High dental caries among adults aged 35 to 44 years: Case-control study of distal and proximal factors. Int J Environ Res Public Health 10(6):2401-11.

Divaris K, Vann WF,Jr, Baker AD, Lee JY. 2012. Examining the accuracy of caregivers' assessments of young children's oral health status. J Am Dent Assoc 143(11):1237-47.

Drukker M, Kaplan C, Feron F, van Os J. 2003. Children's health-related quality of life, neighbourhood socio-economic deprivation and social capital. A contextual analysis. Soc Sci Med 57(5):825-41.

Dufur MJ, Parcel TL, Troutman KP. 2013. Does capital at home matter more than capital at school? social capital effects on academic achievement. Research in Social Stratification and Mobility 31(0):1-21.

Dufur MJ, Parcel TL, Mckune BA. 2008. Capital and context: Using social capital at home and at school to predict child social adjustment. Journal of Health and Social Behavior 49(2):146-61.

Duijster D, Verrips GH, van Loveren C. 2013. The role of family functioning in childhood dental caries. Community Dent Oral Epidemiol .

Dye BA, Li X, Thornton-Evans G. 2012. Oral health disparities as determined by selected healthy people 2020 oral health objectives for the united states, 2009–2010. . Hyattsville, MD: National Center for Health Statistics. Report nr 104.

Dye BA, Tan S, Smith V, Lewis BG, Barker LK, Thornton-Evans G, et al. 2007. Trends in oral health status: United states, 1988-1994 and 1999-2004. National Center for Health Statistics. Report nr 248.

Edelstein BL. 2002. Disparities in oral health and access to care: Findings of national surveys. Ambul Pediatr 2(2 Suppl):141-7.

Fairchild AJ and MacKinnon DP. 2009. A general model for testing mediation and moderation effects. Prev Sci 10(2):87-99.

Fisher-Owens SA, Gansky SA, Platt LJ, Weintraub JA, Soobader MJ, Bramlett MD, Newacheck PW. 2007. Influences on children's oral health: A conceptual model. Pediatrics 120(3):e510-20.

Flores G and Lin H. 2013. Trends in racial/ethnic disparities in medical and oral health, access to care, and use of services in US children: Has anything changed over the years? Int J Equity Health 12:10,9276-12-10.

Fulkerson JA, Neumark-Sztainer D, Hannan PJ, Story M. 2008. Family meal frequency and weight status among adolescents: Cross-sectional and 5-year longitudinal associations. Obesity (Silver Spring) 16(11):2529-34.

Fulkerson JA, Kubik MY, Story M, Lytle L, Arcan C. 2009. Are there nutritional and other benefits associated with family meals among at-risk youth? J Adolesc Health 45(4):389-95.

Furuta M, Ekuni D, Takao S, Suzuki E, Morita M, Kawachi I. 2012. Social capital and self-rated oral health among young people. Community Dent Oral Epidemiol 40(2):97-104.

Tragic Results When Dental Care is Out of Reach [Internet]: PBS.org; c2012 [cited 2013 September/18]. Available from: http://www.pbs.org/wgbh/pages/frontline/health-science-technology/dollars-and-dentists/tragic-results-when-dental-care-is-out-of-reach/ .

Gillman MW, Rifas-Shiman SL, Frazier AL, Rockett HR, Camargo CA,Jr, Field AE, Berkey CS, Colditz GA. 2000. Family dinner and diet quality among older children and adolescents. Arch Fam Med 9(3):235-40.

Goldfield GS, Murray MA, Buchholz A, Henderson K, Obeid N, Kukaswadia A, Flament MF. 2011. Family meals and body mass index among adolescents: Effects of gender. Appl Physiol Nutr Metab 36(4):539-46.

Guarnizo-Herreno CC and Wehby GL. 2012. Explaining racial/ethnic disparities in children's dental health: A decomposition analysis. Am J Public Health 102(5):859-66.

Hagan J, MacMillan R, Wheaton B. 1996. New kid in town: Social capital and the life course effects of family migration on children. Am Sociol Rev 61(3):368-85.

Harpham T. 2008. Chapter 3: The measurement of community social capital through surveys. In: Social capital and health. Kawachi I, Subramanian S,Kim D, editors. 1st ed. New York: Springer.

Iida H and Rozier RG. 2013. Mother-perceived social capital and children's oral health and use of dental care in the united states. Am J Public Health 103(3):480-7.

Islam MK, Merlo J, Kawachi I, Lindstrom M, Gerdtham UG. 2006. Social capital and health: Does egalitarianism matter? A literature review. Int J Equity Health 5:3.

Ismail AI, Lim S, Sohn W, Willem JM. 2008. Determinants of early childhood caries in low-income african american young children. Pediatr Dent 30(4):289-96.

Kawachi I and Berkman L. 2000. Chapter 8: Social cohesion, social capital, and health. In: Social epidemiology. Berkman L and Kawachi I, editors. 1st ed. USA: Oxford University Press.

Kawachi I, Subramanian S, Kim D. 2008. Chapter 1: Social capital and health. In: Social capital and health. Kawachi I and Subramanian S, editors. 1st ed. New York: Springer.

Lamarca GA, Leal MD, Leao AT, Sheiham A, Vettore MV. 2013. The different roles of neighbourhood and individual social capital on oral health-related quality of life during pregnancy and postpartum: A multilevel analysis. Community Dent Oral Epidemiol .

Li Y and Wang W. 2002. Predicting caries in permanent teeth from caries in primary teeth: An eight-year cohort study. J Dent Res 81(8):561-6.

Listl S. 2011. Family composition and children's dental health behavior: Evidence from germany. J Public Health Dent 71(2):91-101.

Macinko J and Starfield B. 2001. The utility of social capital in research on health determinants. Milbank Q 79(3):387,427, IV.

Marmot M and Wilkinson RG, editors. 2006. Social determinants of health. 2nd ed. New York: Oxford University Press. 376 p.

Mohnen SM, Volker B, Flap H, Groenewegen PP. 2012. Health-related behavior as a mechanism behind the relationship between neighborhood social capital and individual health--a multilevel analysis. BMC Public Health 12:116,2458-12-116.

Mohnen SM, Groenewegen PP, Volker B, Flap H. 2011. Neighborhood social capital and individual health. Soc Sci Med 72(5):660-7.

Morrow V. 1999. Conceptualising social capital in relation to the well-being of children and young people: A critical review. Sociol Rev 47(4):744-65.

Murayama H, Fujiwara Y, Kawachi I. 2012. Social capital and health: A review of prospective multilevel studies. J Epidemiol 22(3):179-87.

Nahouraii H, Wasserman M, Bender DE, Rozier RG. 2008. Social support and dental utilization among children of latina immigrants. J Health Care Poor Underserved 19(2):428-41.

Newton JT and Bower EJ. 2005. The social determinants of oral health: New approaches to conceptualizing and researching complex causal networks. Community Dent Oral Epidemiol 33(1):25-34.

Parcel TL and Dufur M. 2009. Family and school capital explaining regional variation in math and reading achievement. Research in Social Stratification and Mobility 27(3):157-76.

Parcel TL and Dufur MJ. 2001. Capital at home and at school: Effects on student achievement. Social Forces (University of North Carolina Press) 79(3):881-911.

Parcel TL and Menaghan EG. 1993. Family social capital and children's behavior problems. Soc Psychol Q 56(2):120-35.

Parcel TL, Dufur MJ, Zito RC. 2010. Capital at home and at school: A review and synthesis. Journal of Marriage and Family 72(4):828-46.

Patrick DL, Lee RS, Nucci M, Grembowski D, Jolles CZ, Milgrom P. 2006. Reducing oral health disparities: A focus on social and cultural determinants. BMC Oral Health 6 Suppl 1:S4.

Pattussi MP, Hardy R, Sheiham A. 2006a. The potential impact of neighborhood empowerment on dental caries among adolescents. Community Dent Oral Epidemiol 34(5):344-50.

Pattussi MP, Hardy R, Sheiham A. 2006b. Neighborhood social capital and dental injuries in brazilian adolescents. Am J Public Health 96(8):1462-8.

Pattussi MP, Marcenes W, Croucher R, Sheiham A. 2001. Social deprivation, income inequality, social cohesion and dental caries in brazilian school children. Soc Sci Med 53(7):915-25.

Phongsavan P, Chey T, Bauman A, Brooks R, Silove D. 2006. Social capital, socio-economic status and psychological distress among australian adults. Soc Sci Med 63(10):2546-61.

Pinelli C and de Castro Monteiro Loffredo L. 2007. Reproducibility and validity of self-perceived oral health conditions. Clin Oral Investig 11(4):431-7.

Poortinga W. 2006. Do health behaviors mediate the association between social capital and health? Prev Med 43(6):488-93.

Putnam R. 2001. Bowling alone: The collapse and revival of american community. 1st ed. Touchstone Books by Simon & Schuster.

Renzaho AM and de Silva-Sanigorski A. 2013. The importance of family functioning, mental health and social and emotional well-being on child oral health. Child Care Health Dev .

Rodgers T and Chen X. 2009. 2009 head start oral health survey report. Iowa Department of Public health.

Runyan DK, Hunter WM, Socolar RR, Amaya-Jackson L, English D, Landsverk J, Dubowitz H, Browne DH, Bangdiwala SI, Mathew RM. 1998. Children who prosper in unfavorable environments: The relationship to social capital. Pediatrics 101(1 Pt 1):12-8.

Sampson RJ and Graif C. 2009. Neighborhood social capital as differential social organization: Resident and leadership dimensions. American Behavioral Scientist 52(11):1579-605.

Samuel LJ, Commodore-Mensah Y, Dennison Himmelfarb CR. 2013. Developing behavioral theory with the systematic integration of community social capital concepts. Health Education & Behavior .

Santiago BM, Valenca AM, Vettore MV. 2013. Social capital and dental pain in brazilian northeast: A multilevel cross-sectional study. BMC Oral Health 13:2,6831-13-2.

Shenkin JD, Heller KE, Warren JJ, Marshall TA. 2003. Soft drink consumption and caries risk in children and adolescents. Gen Dent 51(1):30-6.

Shortt SE. 2004. Making sense of social capital, health and policy. Health Policy 70(1):11-22.

Sohn W, Taichman LS, Ismail AI, Reisine S. 2008. Caregiver's perception of child's oral health status among low-income african americans. Pediatr Dent 30(6):480-7.

Stolle D and Rochon TR. 1998. Are all associations alike? member diversity, associational type, and the creation of social capital. Am Behav Sci 42(1):47-65.

Talekar BS, Rozier RG, Slade GD, Ennett ST. 2005. Parental perceptions of their preschool-aged children's oral health. J Am Dent Assoc 136(3):364,72; quiz 381.

Teachman JD, Paasch K, Carver K. 1997. Social capital and the generation of human capital. Social Forces 75(4):1343-59.

U.S. Department of Health and Human Services. 2000. Oral health in america: A report of the surgeon general. Rockville, MD: U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health.

van Hooijdonk C, Droomers M, Deerenberg IM, Mackenbach JP, Kunst AE. 2008. The diversity in associations between community social capital and health per health outcome, population group and location studied. Int J Epidemiol 37(6):1384-92.

Videon TM and Manning CK. 2003. Influences on adolescent eating patterns: The importance of family meals. J Adolesc Health 32(5):365-73.

Watt RG. 2007. From victim blaming to upstream action: Tackling the social determinants of oral health inequalities. Community Dent Oral Epidemiol 35(1):1-11.

Watt RG. 2002. Emerging theories into the social determinants of health: Implications for oral health promotion. Community Dent Oral Epidemiol 30(4):241-7.

Social Determinants of Health: Posters [Internet]: World Health Organization; c2013 [cited 2013 22 July]. Available from: http://www.who.int/social_determinants/tools/multimedia/posters/en/ .

World Health Organization. 1999. Programming for adolescent health and development: Report of a WHO/UNFPA/UNICEF study group on programming for adolescent health. Geneva: World Health Organization. Report nr 886.

Yang TC and Matthews SA. 2010. The role of social and built environments in predicting self-rated stress: A multilevel analysis in philadelphia. Health Place 16(5):803-10.

Zarzar PM, Ferreira EF, Kawachi I. 2012. Can social capital contribute to the improvement of oral health? Braz Oral Res 26(5):388-9.

Zini A, Sgan-Cohen HD, Marcenes W. 2012. Religiosity, spirituality, social support, health behaviour and dental caries among 35- to 44-year-old jerusalem adults: A proposed conceptual model. Caries Res 46(4):368-75.